Global Solar PV Market Review

CLEANBRIDGE

About

This report provides insights into the Global Solar PV market. It is based on research conducted by CleanBridge and its research partner, Alchemy Research and Analytics. The report provides an overview of the industry, including recent trends, drivers, challenges, and outlook in major countries across Europe and the Americas. The report provides an overview of the Global Solar PV industry, with insights on prevailing market conditions, recent trends, drivers, challenges, and outlook in major countries across Europe and the Americas. The report begins with a high-level view of the industry's dynamics, addressing the regional variations and analyzing the implications of the same. It then profiles the major markets on a country-by-country basis to provide a holistic view of the industry's status in these countries. This includes highlighting growth opportunities, demand drivers, and prevailing challenges. Macroeconomic data was sourced from the publications of multilateral institutions such as the International Monetary Fund (IMF). Industry-specific data is attributed to industry associations, government authorities/statistical departments, Bloomberg New Energy Finance (BNEF) and International Energy Agency (IEA). This data was supplemented by news reports, trade journals and related sources.

This report is the result of a collaboration between CleanBridge and its research partner, Alchemy Research and Analytics, and was completed between May and July 2023.

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Introduction

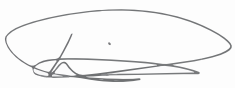
The ongoing global energy crisis has highlighted the need for more resilient energy systems. To address this issue, there is an urgent need to transition towards renewable energy. According to the International Energy Agency, investments in clean power generation resources could increase by 7% in 2023, reaching USD2.75 trillion. However, there is still a lot more that needs to be done to balance the demand and sustainability in energy generation and consumption cycles.

Currently, demand pressures are affecting the short-term through high fossil fuel prices and a competitive environment for supply chains. While countries may be tempted to address their immediate issues, it is important to remember the longer-term priorities of sustainability and resilience. A deliberate and focused policy push is needed to achieve this goal. Globally, oil and gas companies are seeing almost 10% higher investments this year, with projected cumulative profitability crossing USD2 trillion.

The increased push for renewable energy projects in several markets is a positive sign. Utility-scale power projects, such as those based on wind and solar, are the most important, given the burden on power generation for its fossil fuel dependence and emissions. Mature renewable energy technology options, such as solar PV, are instrumental in scaling up the share of clean energy at competitive costs. Furthermore, hybrid configurations involving solar-plus-storage or even wind-plus-solar-plus-storage, are increasingly making commercial sense for the flexibility and dispatch that were long regarded as the bane of renewable energy projects.

Although the optimistic outlook for the energy market and solar PV is promising, there are still some challenges that must be addressed. High borrowing costs, a potential recession, and adjustments in pricing across the supply chain all contribute to a difficult road ahead. However, these are issues that must be endured until market forces can balance out. We believe that capital flows in the energy market, and specifically in solar PV, will ultimately align with fundamental principles rather than short-term shocks and concerns. As a result, we do not anticipate any significant changes in investment commitments.

CleanBridge's Annual Primer series aims to offer an overview of the demand drivers, opportunities, challenges, and outlook prevalent in various major markets for different renewable energy technologies, including solar PV and onshore wind. We hope you find our annual review of Global Solar PV informative and enjoyable to read.



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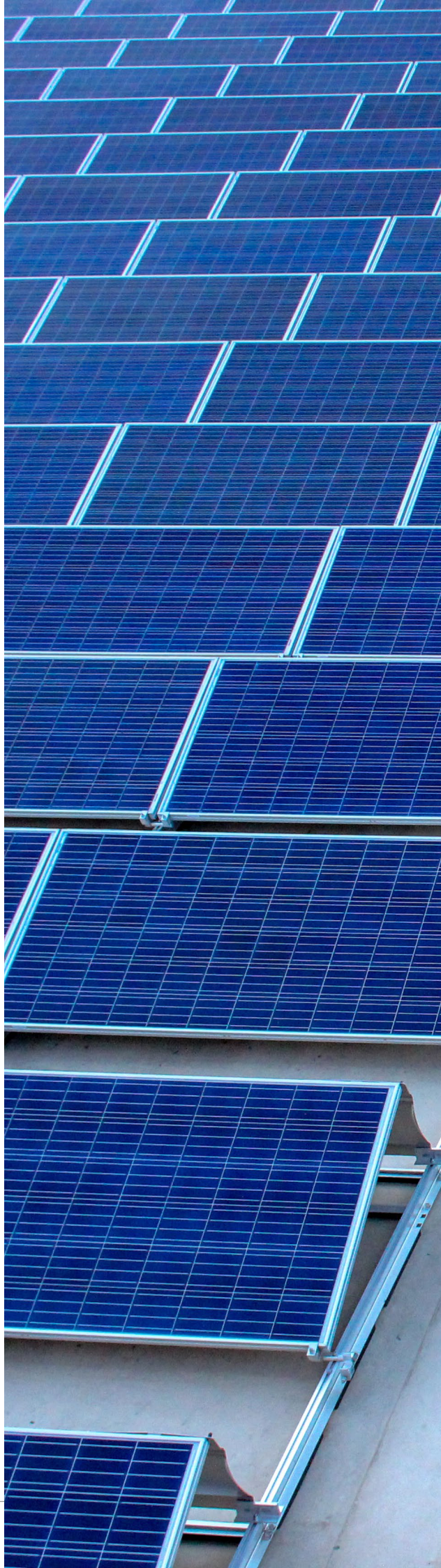


01

Executive Summary

1.0

Executive Summary

Solar PV, as a renewable energy technology, has recently taken the lead in the global renewable energy expansion plan. For the first time ever, solar power investments are expected to exceed that of oil production by the end of 2023. The progression toward this milestone is evident in the trend so far. By 2022, solar PV accounted for over two-thirds of the total clean energy investments. During the same year, total installed global PV capacity exceeded 1TW, surpassing many leading projections and achieving this milestone ahead of schedule. The growth has continued at the same pace, with nearly three-quarters of the renewable energy capacity of 2023 being attributed to solar PV.

China continues to play an outsized role in global solar PV capacity addition – the 86GW it added in 2022 dwarfs Japan's total installed capacity for that year. A strong domestic demand, coupled with supply chain to meet the project requirements, helps sustain Chinese growth momentum. However, the growth pattern has changed since 2021, with rooftop/small-scale solar PV installations driving growth instead of utility-scale solar projects. The shift is the result of key challenges that plateaued the Chinese utility-scale PV segment, including volatility in capital costs, supply chain uncertainties, especially those related to the trade barriers, and transmission connectivity challenges, among others.

Executive Summary

The challenges of an inflationary environment and supply chain bottlenecks are evident across markets. Capacity auctions, a preferred route in the policy-led procurement in European and Asia-Pacific markets, have experienced a decrease in participation, resulting in under-subscription. Similarly, high input costs have led to an increase in solar PV costs. In 2022, the price of polysilicon reached its highest level, while freight rates in 2022 were nearly six time higher than those in 2000. Consequently, solar PV prices can no longer sustain their historically declining trend. Nevertheless, the relative competitiveness remains unchanged. The capital costs of solar PV projects are the lowest when compared to other prevailing clean energy technologies.

The fundamentals regarding solar PV adoption remain robust. Market-based procurement is gradually making a dent in global procurement practices. This includes the growing trend of direct corporate power purchase agreements (PPAs), with the US leading the world in this market, as well as the emerging but promising sub-segment of merchant power sales, where developers aim to capitalize on opportunities in wholesale power market participation. Such a shift is progressively expanding the potential for various business models, such as virtual PPAs for corporate purchases. Furthermore, the reduction in subsidies has led to industry consolidation.

In recent years, there have been innovative developments in the configurations of solar power projects. The co-location of solar PV with battery, for instance, has been a rapidly growing segment in the US. Similar hybrid approaches, such as wind-solar and hydro-solar, are also being explored. These combinations enable developers to achieve cost advantages in terms of land use, transmission, or grid dispatchability of the projects. Additionally, floating solar PV has gained prominence as a potentially emerging and untapped opportunity worldwide. Realizing this potential could lead to a significant transformation in the current global solar PV market landscape. It is not only just the absolute capacities, but also the penetration of solar PV in total grid-connected generation that holds the utmost importance for the final outcome.

The global average solar PV penetration, as share of total generation, stands at about 6.5%. Remarkably, China is not among the top countries in terms of solar penetration, reflecting the practical challenge of integrating renewable energy into the grid's power mix. Despite an appealing project pipeline, the global supply chain for solar PV equipment and materials, global capital flow (skewed by government support for localization) and investment commitments in transmission infrastructure are all prerequisites for the success of targeted expansion. Episodes of energy crises in 2022 have led to a shift in policy attention to expedite the energy transition, benefitting solar PV as much as other technology-based projects. However, achieving the ambitious goals of net-zero decarbonization requires a more concerted and larger-scale effort than ever before. With the right steps, the solar PV sector seems poised to play an instrumental role in the coming decades.

02

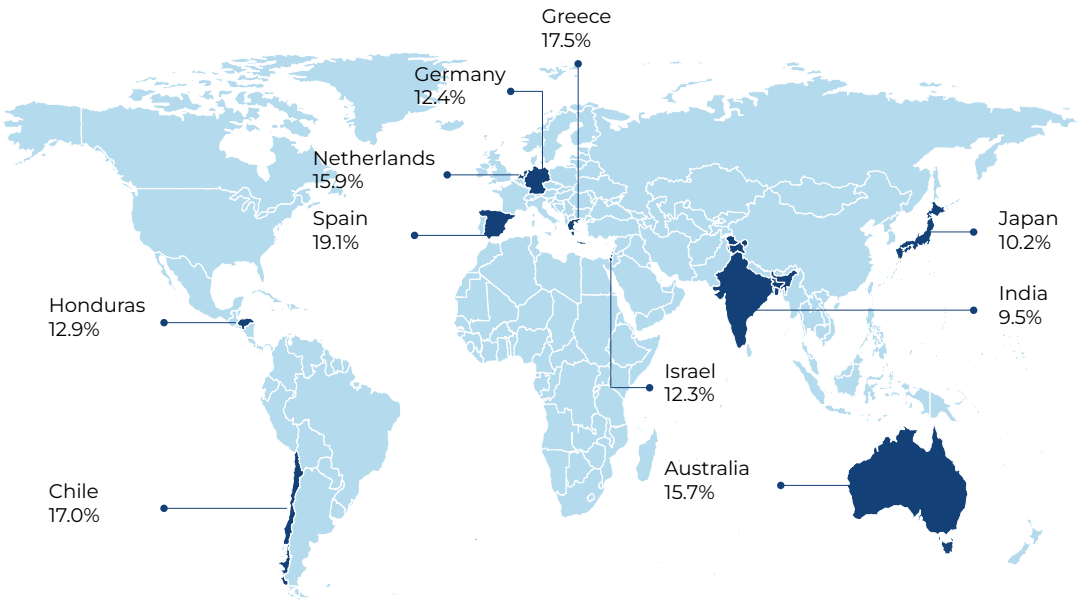
Regional PV Overview

2.1

Regional Overview: Penetration and Growth

Globally, a disparity in solar PV development is observed in both capacity and penetration parameters. In terms of installed capacity, the Asia-Pacific region, primarily due to China, takes the lead, followed by the Americas (largely due to the US) and Europe. In terms of penetration, however, a different set of countries lead the way. As the latest IEA estimates indicate, the global average solar PV penetration stands at 6.2% of total grid- based energy generation. The world's top two countries in solar PV capacity – US and China – are not among the leading countries in solar PV penetration. This emphasizes the challenges in replacing conventional energy sources within a country's grid power mix.

The Leading Countries in Solar PV Penetration



Note: Penetration is meant to convey share in total grid-based power generation

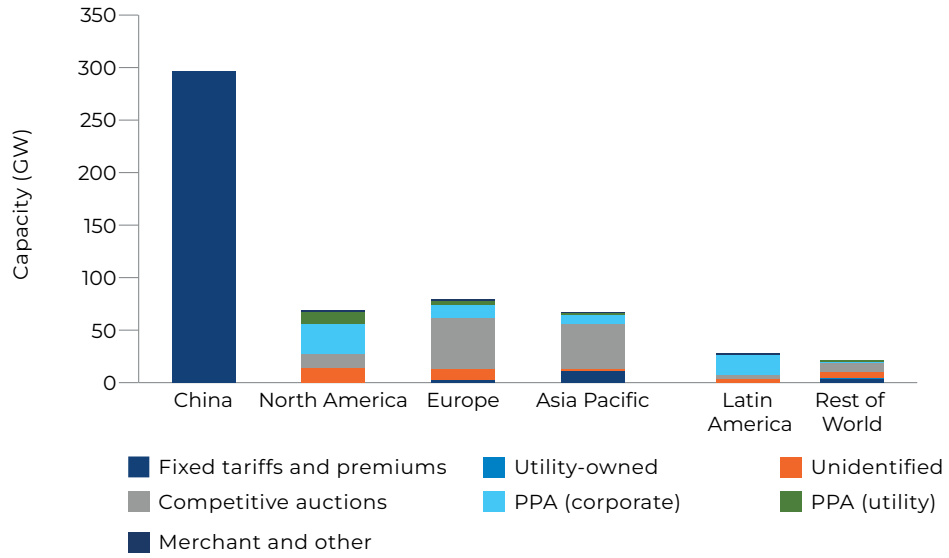
Source: IEA

The policy-led drive towards energy transition also contributes to the increase in solar PV penetration. One noteworthy aspect in this regard is how energy procurement practices are established across regions. It is evident that policy-led procurement, whether through administratively set tariffs or competitively bid auctions, accounts for the majority (60%) of this trend. The auction-based approach is prominent for utility-scale solar PV projects in the European and Asia-Pacific regions (excluding China). In China, the practice involves tariffs set at the provincial benchmark electric price level, as feed-in tariffs have been phased out.

In such a setup, market-based power procurement holds a relatively small but rising and promising share (17%). This is primarily led by corporate power purchase agreements. Presently, the US leads globally in this model, followed by Brazil, Australia, Spain and Sweden, among others. Merchant power purchase agreements constitute a minority portion of this sector but are gaining traction due to the potential opportunities in wholesale power market participation. The recent episode of European power market volatility serves as an illustrative example.

Regional Overview: Penetration and Growth

Primary Procurement Type across Regions over 2023-2024



Note: Data above includes both wind and solar and is meant to indicate the prevalent procurement modes.

Source: IEA

Policy thrust is perhaps one reason why four European countries are among the top-10 globally in solar PV penetration. As of March 2023, the European Union reached a provisional agreement on higher renewable energy share targets, aiming for 42.5% by 2030, up from the previous target of 32%. Regional policymakers are thus actively promoting rapid capacity expansion to meet these goals. The urgency in adopting renewable energy was further heightened by the energy crisis resulting from the Ukraine conflict and inflationary pressures. Progressively, solar PV has emerged as the preferred technology choice in this context due to its relatively lower development phase and a mature technology configuration. Data from the research agency Ember indicates that solar power generation contributed to Europe's energy savings worth €10 billion during 2022.

The increase in policy-level priority was evident in 2022. Emerging markets such as Poland, which traditionally relied on a coal-based energy mix, added about 4GW in capacity. The Netherlands had the highest share of total new capacity in the region. New measures were implemented to expand the market.

For instance, in April 2023, the European Union launched the first cross-border tender, inviting bidders to establish new solar PV projects with a combined 400MW capacity in Finland. Permitting procedures were reviewed to expedite the projects, and, for the first time, regulatory authorities gave prime attention to addressing bottlenecks.

The steps on energy transition are also underway in the otherwise hydrocarbon-rich Middle East region. Solar PV plays a significant role in the region's energy shift, thanks to its abundant solar resources and the declining costs in utility-scale projects, which attract investors' interest. Cumulative solar PV capacity in the Middle East region increased by 35% year-on-year in 2022, with new capacity additions growing by 42% during the same period. Recently, there has been an increase in solar auctions in the Middle East, with projects awarded to Independent Power Producers – the most commonly used model for energy projects within the Gulf Cooperation Council. Approximately three-quarters of the region's capacity is distributed among Israel, UAE and Jordan.

2.2

Regional Overview: Top Countries

The Chinese market maintained its leadership in solar PV throughout 2022, adding over 86GW in capacity. This is about five times the capacity added during the same period by its closest competitor and the second-ranked global solar PV capacity holder, the US. Between 2020 and 2022, the country experienced an average annual PV capacity growth of 24%. China's solar PV pipeline growth continues to outpace the rest of the world. A report by Global Energy Monitor estimates that the country is on track to achieve its 2030 renewable energy targets (wind and solar) five years ahead of schedule. The solar PV pipeline, driven by domestic demand, significantly surpasses other leading markets.

The strong domestic demand for solar power, however, does not fully translate into the share of this energy in the total grid power supply. As of the end of 2022, solar power accounted for only about 4.8% of total grid-based power generation. In 2019, this figure was at 3%.

The relatively slower growth in solar penetration in total energy mix partly reflects a plateau in utility-scale solar projects. Investment in large- scale centralized solar plants has slowed down due to cost fluctuations in PV modules, a lack of business models (such as merchant capacities and corporate PPAs) and an inadequate grid infrastructure. Consequently, the focus of growth shifted to distributed solar. Starting from 2021, the distributed solar segment has been responsible for the growth momentum. By the end of 2022, the country had added over 50GW in distributed solar. In effect, close to 60% of total solar PV capacity added came from distributed solar PV installations in the commercial and industrial sectors.

In other markets, however, the utility-scale solar PV segment continues to be the driving force for growth. This is the case for the US market, which ranks second after China in installed solar PV capacity. The market faced some headwinds that impacted capacity additions, with a 19% year-on-year growth in 2022, compared to an average of 25% in the previous two years. Trade restrictions on imported solar modules, especially those from China, played a significant role in disrupting planned capacities.

However, policy measures implemented since then could ease such bottlenecks. As of Q1 2023, the US solar panel imports rose 87% year-on-year, following the government's decision to ease tariffs on imports from four Southeast Asian countries, which supply 80% of the US's solar panel requirements.

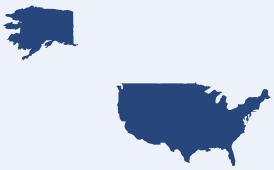
The Inflation Reduction Act (IRA) represents a major and landmark federal policy initiative toward clean energy. For solar PV, the tax credits serve as incentives for domestic PV module production. The IRA's provisions also extend incentives for solar PV projects using US-made products, even if the solar modules and other components are imported. Developers, however, look forward to further clarifications to make use of the incentives on offer. Meanwhile, another sub-segment that has experienced rapid growth in the US in recent years is hybrid solar-plus-storage. This growth is largely attributed to the investment tax credit provisions that were previously applicable to storage linked to clean energy. Per NREL's estimates, transmission requests for hybrid solar projects increased from 6GW in 2015 to 173GW in 2022. There are expectations of a shift in this growth trend following the IRA's incentives for standalone battery storage.

Contrary to the global trend, incentives remain a key instrument for the Japanese solar PV market, which also ranks third globally in installed capacity. While feed-in tariffs have been gradually rationalized over time, they continue to play a pivotal role in Japanese solar PV capacity deployment, both for utility-scale and the residential segments. However, the capacity expansion has not been very encouraging, with annual growth in 2021 and 2022 at 6% each, compared to 10% in 2020. Select measures are in line to change the approach and business model. These include offering better incentives for rooftop solar installations, providing wholesale market-linked premiums for upcoming solar PV plants (especially if linked with storage), and introducing a third-party ownership business model for PV systems in residential locations. Overall, the small-scale or rooftop solar segment could be the next major growth driver for the Japanese solar PV market, as indicated by the planned incentive measures.

Regional Overview: Top Countries

In some markets, a crisis in conventional energy sources acted as a major catalyst for solar PV (along with other renewables). Germany, ranking fourth globally in installed solar PV capacity, registered a 12% year- on-year growth as of the end of 2022. Incremental capacity growth was at its highest in 2022, contributing to the trend of an accelerating capacity addition rate. The European energy crisis, aggravated by inflationary pressures and the Ukraine-Russia armed conflict, led to expedited approvals for utility-scale solar PV projects. The residential solar sub-segment received additional support from the policymakers due to its impact on mitigating energy costs for residential and commercial consumers. Also important was the German decision to raise ceiling prices for utility-scale solar PV auctions. While the bids still faced under-subscription during 2022, there was a sign of recovery in the subsequent auction of early 2023, which saw marginal over-subscription. Projections, such as those of IEA's, indicate a significant increase in the German solar PV market due to the ongoing momentum.

Top Five Countries Globally by Installed Capacity in 2022

China	Capacity (GW)
	392
USA	
	112
Japan	
	79
Germany	
	67
India	
	63

Region-wise Top Five Countries by Installed Capacity in 2022

Asia-Pacific	Country	Capacity (GW)
	China	392.4
	Japan	78.8
	India	62.8
	Korea Rep	21.0
	Vietnam	18.5

Europe	Country	Capacity (GW)
	Germany	66.6
	Italy	25.1
	Netherlands	22.6
	Spain	18.2
	France	17.4

Americas	Country	Capacity (GW)
	USA	111.5
	Brazil	24.1
	Mexico	9.0
	Chile	6.1
	Canada	4.4

MEA	Country	Capacity (GW)
	South Africa	5.8
	Israel	4.2
	UAE	2.9
	Jordan	1.9
	Egypt	1.7

Source: IRENA

03

Trends and Drivers

3.0

Trends and Drivers

Solar PV was the only renewable energy technology to break the record for capacity addition in 2022. With each passing year, solar PV has solidified its predominant position in the renewable energy sector for all stakeholders, including investors, developers, policymakers, and regulators. Its low initial base partly contributed to the current high growth rates. From an investment perspective, solar PV is increasingly the preferred choice due to its key advantages, such as a mature and cost-effective technical configuration, policy support for capacity allocation, and a growing market orientation. The energy crisis of 2022 was another factor that catalyzed the industry's project pipeline by expediting policy approvals and streamlining permitting procedures.

In 2022, Solar PV broke the record for capacity additions among all renewable technologies.

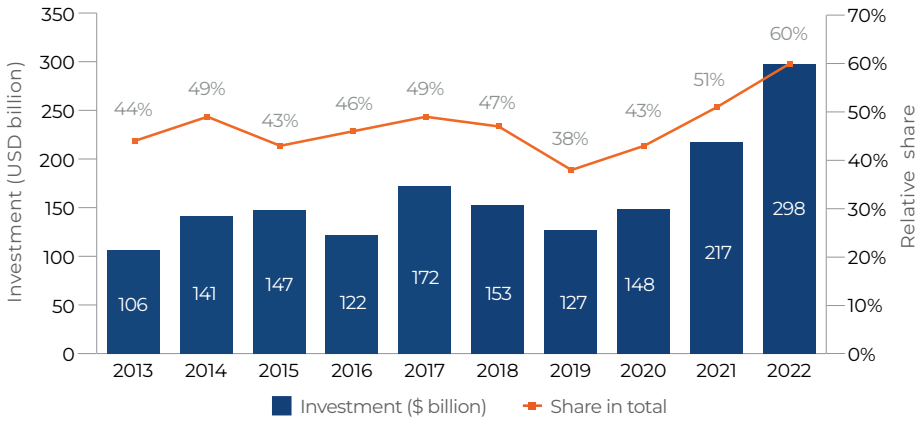
Trends and Drivers

Solar PV as the Leading Choice

Solar PV outlay is rising faster than most of the other energy technologies.

In the competitive space of investments, solar PV projects have surpassed onshore wind in their position. Policy support and incentives explain one part of such growth. The other can be attributed to the attractiveness of solar PV due to its shorter development lead time, modular and distributed nature. In fact, solar PV investments are increasing at a faster rate than most other energy technologies, including conventional ones. The IEA's latest report on global energy investments, as of May 2023, estimates that solar PV investments will exceed those in the upstream oil sector by the end of 2023, reaching approximately $380 billion.

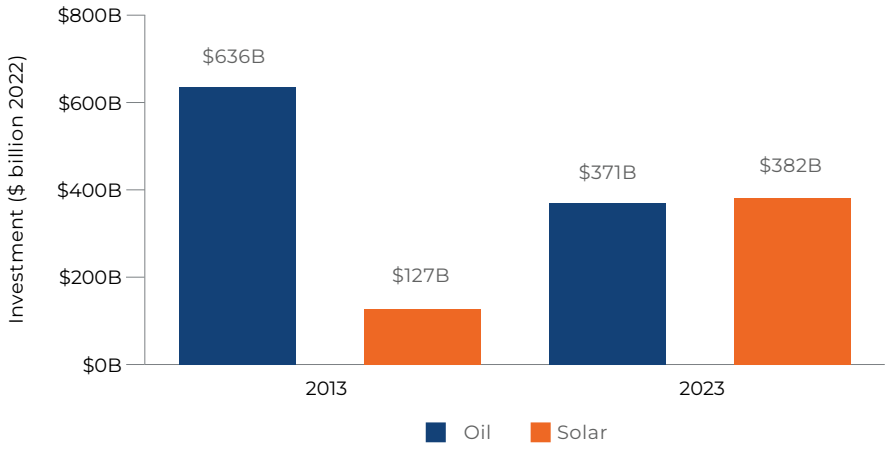
Solar PV Investment and its Relative Share in Renewable Energy



Source: IRENA

IEA's projection for solar power investment in 2023 could mark the first time when solar investment surpasses spending on oil production. The decade-long comparison highlights the stark contrast between the two sectors in their competition for investment capital. The solar PV project pipeline remains in a consistent expansion mode, in contrast to other energy technologies, whether renewable or otherwise, where the project pipeline hasn't been as reliably robust over the long term.

Investment in Oil Production vs Solar Power



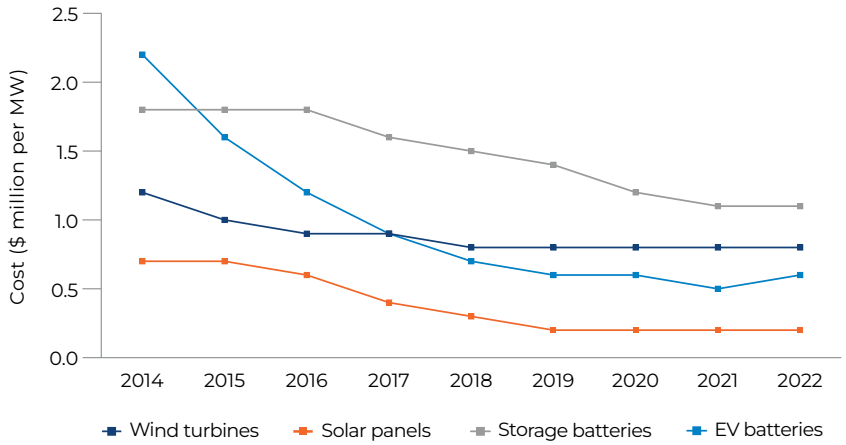
Source: IEA

Trends and Drivers

The competitive choice of solar PV over other technologies is also reinforced by the relative consistency in the cost trend. Despite inflationary pressures and supply chain challenges, solar PV project costs have been the most attractive amongst the various competitive clean energy technologies. Through economies of scale and bulk tendering opportunities, solar PV solar PV maintains a competitive advantage over many other renewable-based power generation methods, including onshore wind. Modular deployment options, such as rooftop solar, make it ideal for tapping into far wider range of opportunities than other options.

The competitive choice of solar PV over other technologies is reinforced by the relative and consistent trend in costs.

Average Cost of Solar PV vis-à-vis other Select Clean Energy Technologies



Source: IEA

Solar PV stands out for its significant unexplored potential, unlike its closest competitors, wind and hydro, where opportunities are either nearly saturated or constrained for further development. Both utility-scale and rooftop/residential solar PV segments possess substantial untapped commercial potential. Recent estimates indicate that the African and Middle East regions host the best locations for solar radiation, followed by others in Asia-Pacific. However, realizing this potential depends on overcoming the constraints, such as land, regulations, infrastructure connectivity, and more. The push by European developers for Middle Eastern solar projects and power transmission connectivity underscores the growing interest in expanding these frontiers.

Trends and Drivers

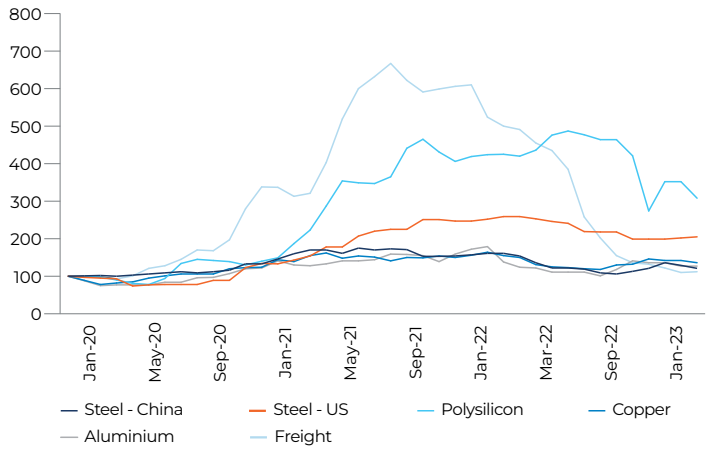
Cost Pressures in the Business

Due to the inflationary pressure on commodities and the cost of capital, the levelized cost of solar PV increased by the end of 2022.

A major recent development in solar power cost economics has been the increase in cost levels by end-2022 in most markets. As with other renewable technologies, solar power developers can no longer operate at the historically lower price ranges. Reflecting the inflationary pressure on commodities and the cost of capital, the levelized cost of solar PV rose by the end of 2022. In some markets, this increase was more substantial than others, with the US market reporting a rise in wind and solar PV levelized costs for the first time since 2009.

Despite a drop from last year's peak, commodity prices and freight rates remain high. Furthermore, rising interest rates have increased developers' financing costs. As a result, the global average Levelized Cost of Electricity (LCOE) for solar PV is expected to remain above 2020 levels in 2024. Even with the decline in commodity prices in 2023 from 2022 levels, they remained elevated compared to 2020, when major input prices, including steel, copper, aluminum, and polysilicon rose sharply due to a constrained supply chain and spiked post-pandemic demand. Polysilicon, a key component of crystalline silicon solar PV cells, reached its highest price in 2022, four times its level at the beginning of 2020. Steel, the primary construction material for utility-scale PV plants, increased by 75% in China, 160% in the US, and 270% in Europe, while copper and aluminum increased by 60-80% during the same period. The highest growth was in freight rates, which rose almost six times in 2022 compared with 2020.

Trend in Monthly Commodity and Freight Price Indices



Source: IEA

Yet, such projects, even without subsidies, remain competitive against new-build coal and gas-based power projects. Given various assumptions, it is clear from the levelized cost of energy that new solar PV projects effectively displace the new fossil fuel power projects. Other studies, such as the one conducted by Energy Innovations, indicate that in the case of US markets, new renewable projects (wind and solar) could be a more cost-effective option than operating existing coal-based power plants. In large part, utility-scale solar PV plants play an important role in substituting conventional energy generation. Rising efficiency of the solar modules (a 15%-20% rise in commercial wafer-based silicon modules) and the falling cost of the balance-o- system components (such as inverters and mounting systems) contribute significantly to reducing the costs for a utility-scale PV plant.

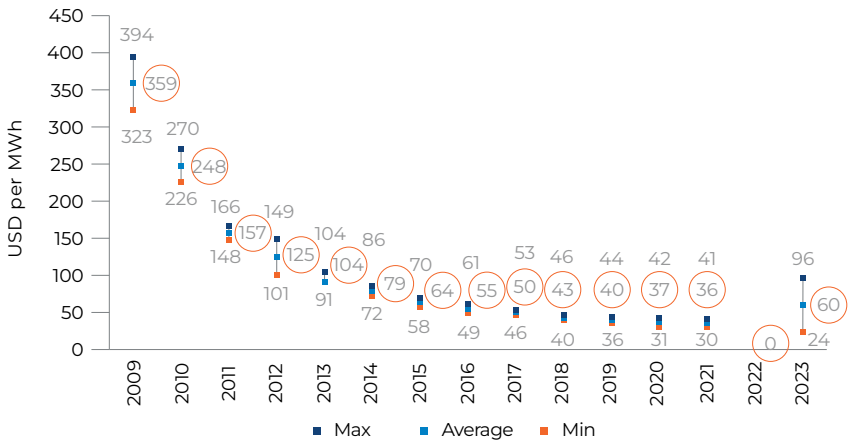
Trends and Drivers

Levelized Cost of Energy in Unsubsidized Solar PV across Configurations

Source: Lazard

The LCOE for utility-scale solar declined at the lower end of its cost range, despite inflation and supply chain challenges. Additionally, there is a growing trend of consolidation in the renewable energy sector, as companies with a larger scale can leverage supply chain economies and other efficiencies to develop new renewable energy assets more rapidly. Between 2009 and 2023, solar's LCOE decreased by 84%.

Long-term Trends in Levelized Cost of Energy of Utility-scale Solar PV



Source: Lazard

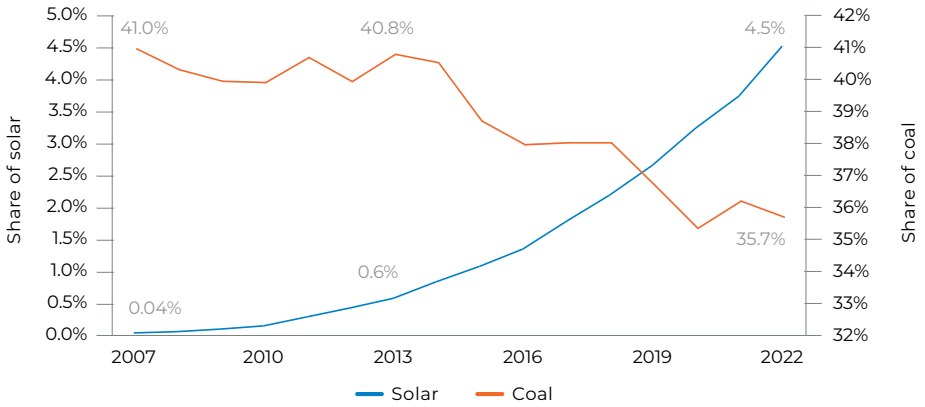
Between 2009 and 2023, solar's LCOE decreased by 84%.

Rising Solar Penetration and New Challenges

Between 2018 and 2022, the relative share of solar power in total generation more than doubled.

Between 2018 and 2022, the relative share of solar power in total generation more than doubled (based on estimates from Ember). This increase in grid-connected supply indicates the accelerating integration of solar in the overall power mix. While the global average provides a broad perspective, several top countries, including Chile, Greece, Hungary, Italy, Spain, the Netherlands, Australia, Vietnam, among others, have significantly higher shares of solar power in their generation, with penetration rates exceeding 8-9% (as of 2021 estimates).

Global Share of Solar Power against Coal in Total Electricity Generation

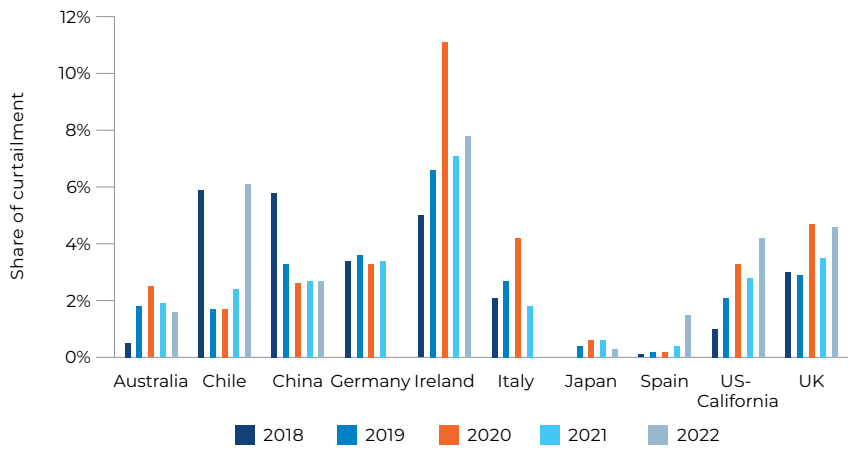


Note: Above data on solar power includes PV and thermal technologies

Source: Ember

The grid integration experiences of leading countries in solar (and overall renewable) energy penetration provide valuable insights into the emerging and likely scenarios. Many of these countries are finding rising instances of grid curtailment. For instance, in May 2023, the Australian grid operator reported a 40% rise in grid curtailment since previous year. Vietnam's outlier growth in renewable capacity (from 500MW in 2018 to 25GW in 2022) led the regulators to pause all new solar (and wind) projects due to grid congestion. The presence of sufficient baseload capacity, mostly coal-based power, is also not a guarantee. The Polish grid operator resorted to curtailing solar and wind power, particularly as the grid management system was ill- equipped to reduce the conventional baseload share. In other cases, seasonal low-demand conditions similarly triggered curtailment, as was observed in Czech where Easter-induced low demand prompted the disconnection of solar generation to prevent excess supply/injection.

Grid Curtailment Share of Renewable Energy in Select Countries of High Penetration



Source: IEA

The expansion of grid connectivity is just one way to enable higher offtake of power.

Faced with the integration challenges, various corrective measures are under gradual implementation. Expanding grid connectivity is just one way to enable higher offtake of power. Deeper changes involve a re-design of the power markets, departing from traditional practices. Changes in market design enable greater participation for renewable projects, whether utility-scale solar or rooftop residential/ commercial. Some examples include reducing the imbalance settlement period, lowering the gate closure time, and increasing the geographical granularity of the power market. Some regulations also allow renewable developers to participate in the intra- day/balancing markets.

The most notable example of the energy system's shortcomings in accommodating rising solar penetration surfaced in Europe during May 2023. The region had several countries reporting negative power prices in wholesale power markets during daylight hours. The relatively low summer/springtime power demand was in direct contrast with an abundance of solar power generation in grid. A negative price in such cases denotes the incentive for wholesale consumers to absorb surplus power, helping to balance the grid. This situation primarily affected central and north-west Europe, where a substantial amount of solar power was being generated. While the operators have known brief phases of negative prices to clear the markets, remains an anomaly that signals a lack of flexibility or adaptability towards rising solar power penetration.

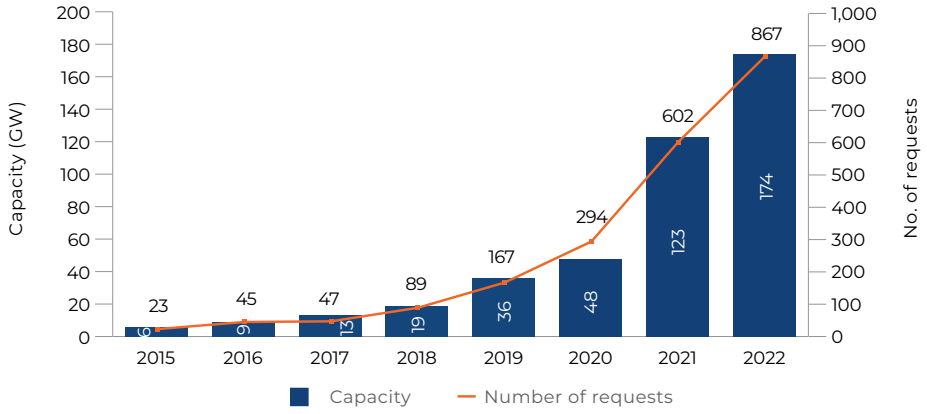
Trends and Drivers

Co-located Storage for Better Commercials

A trend that has lately gained traction is the rising number of upcoming utility-scale solar PV projects being paired with battery storage.

A rising number of upcoming utility-scale solar PV projects are paired with battery storage, representing a trend that has gained momentum in recent times. In such configurations, developers combine battery-based storage with the PV-based generation plant to enhance grid dispatchability and can cater to specific timeslots, such as peaking power needs.

Grid Interconnection Requests for Solar PV with Storage in the US



Note: Data on grid interconnection requests just indicative of developers' interest but does not imply actual capacity addition

Source: NREL

Policy support helped strengthen the case for such projects. The incentives available under the US Inflation Reduction Act tipped the balance in favour of many storage and clean energy projects. Additionally, the tax credits that storage projects have garnered in the US offer added benefits. One indication of the interest in such projects is the nearly fivefold increase in grid interconnection requests between 2018 and 2022. The Western region of the US is particularly in focus due to its abundant solar resources and project portfolio. With improving commercials for battery storage projects, co-location with solar PV provides attractive opportunities for grid price arbitrage. Batteries can discharge during hours of higher prices while using cheaper solar power for charging during other time slots.

To be sure, the growth in this sub-segment depends on the commercialization in the battery storage business. The US market's growth reflects the same. In other markets, such as in Europe, it has been slow to pick up. In Spain (which also has high solar PV penetration), the government offered grants in December 2022 worth €150 million for energy storage projects co-located with renewable generation. In March 2023, a solar-plus-storage project was commissioned in Germany and was the first of such capacity under the recent innovation tenders in the country for co-located storage projects. Other countries are similarly prioritizing this. As of May 2023, The Serbian government established a working group to devise a tendering plan for selecting an EPC developer/contractor for a potential 1GW worth of solar PV capacity co-located with 200MW of battery storage capacity.

Most of these projects involve a fair degree of complexity as the business model is impacted by the regulatory framework of the power market. Local norms and incentive structures are thus important. Consequently, the growth and depth in the battery storage market and their business models to monetize grid-related functionalities are critical for the solar-plus-storage sub-segment.

Trends and Drivers

The Post-Subsidy Market Orientation

A gradual but definite realignment of business is underway with the phaseout of subsidy support. Projects are thus exploring avenues in competitively bid auctions, corporate power purchase agreements (PPAs), direct offtake agreements, energy certificates, and merchant power projects. As IEA's estimates indicate, about a fifth of the total power procurement in utility-scale wind and solar power is expected to follow market-based routes during 2023-2024. Regional considerations play an important role in this case. In China, which holds a world-leading share in capacity and procurement, projects receive fixed tariffs and premiums set by the provincial authorities after feed-in tariffs were phased out. Excluding the Chinese market, total power procurement based on market-based allocation for 2023-2024 stands at 36%.

Over the years, competitive bidding has been the most important enabler among the market orientation measures undertaken by policy and regulatory authorities. The capacity allocation done in this route yields the price discovery of utility-scale PV generation vis-à-vis the prevalent energy mix connected to the grid. Competitive bidding or auction-based allocation is the most prevalent form of policy-led push in Europe and India, followed by the US, South Korea, UAE and Brazil. Some of the key factors driving the auction-based allocation are climate mitigation targets, utility-based procurement, and economic attractiveness.

Over the years, competitive bidding has been the most important enabler among the market orientation measures undertaken by policy and regulatory authorities.

Recent Solar PV Auctions Announced / Planned

Country	Capacity (MW)	Description
Argentina	500	First tender since 2019 for both utility-scale and small-scale projects.
Albania	300	Third auction in the series planned for targeted 1GW allocation.
Serbia	50	First auction announced for projects to be supported through 15-year Contracts for Difference
Greece	200	Planned auction by end of 2023 for solar projects up to 1MW.
Germany	1,611	Planned solar PV auction, which may accept proposals for projects of up to 100MW size

Source: News reports, press releases

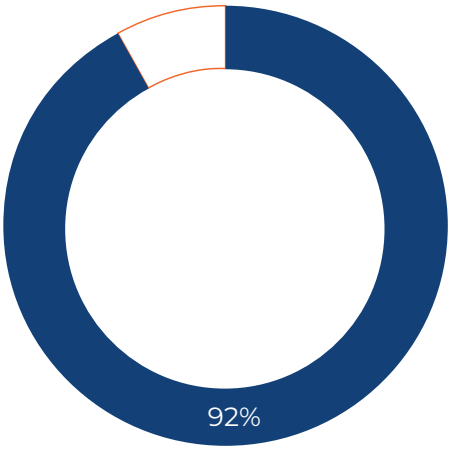
Trends and Drivers

The volatility in the energy wholesale markets during 2022, together with other challenges such as the rise in inflation rate, interest rates, and equipment costs, impacted the auctions. Many of them closed under-subscribed. Lower ceiling prices in the auctions, especially when compared to the corporate PPAs or the merchant segment, make the incentives weaker. A recent example in point is the Spanish auction, which as of November 2022, went largely unsubscribed for 3,000MW worth of solar PV capacity on offer. Yet, it appears that the dampened sentiment in auctions may gradually turn a corner. In June 2023, Germany's solar PV auction was marginally over-subscribed, with final average price at $0.077/kWh. France similarly reported an oversubscribed 172MW worth of auction-based allocation in January 2023.

The volatility in the energy wholesale markets during 2022, together with other challenges such as the rise in the inflation rate, interest rates, and equipment costs, impacted the auctions.

Even as the predominance of competitive bidding continues, PPAs and merchant plants are the other two key segments supporting the market-led shift in solar PV business. As with other renewable energy projects, solar PV developers progressively face greater volatility through exposure to the merchant power segment. Volatility, however, is not the only factor to consider. Merchant PV power (in terms of direct sales in electricity market or through PPAs) enables developers to tap into attractive prices and circumvent the constraints of tendered bidding contracts (time, restrictive conditions, volume). Even with a minor share in the overall procurement scheme, developers are gradually increasing their participation in merchant plants.

Share of Surveyed respondents Anticipating Higher Merchant Market Exposure in Next Five Years



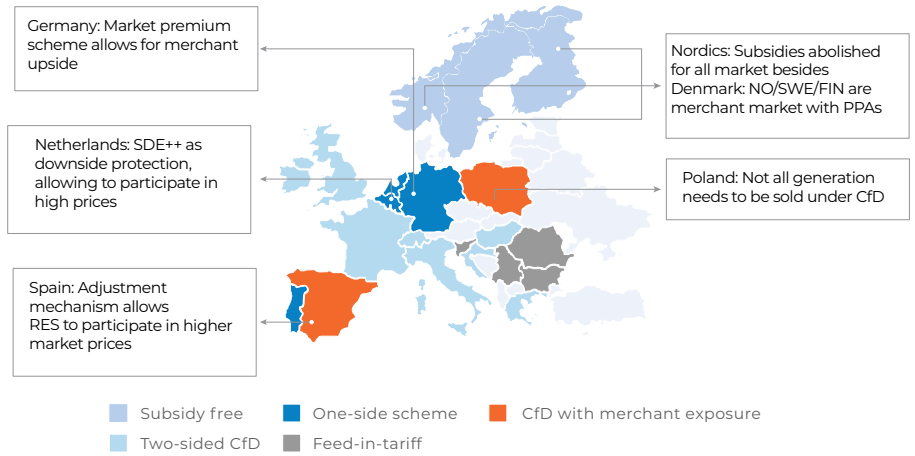
Note: Data refers to Renewable Industry Survey Report 2023, covering 543 renewable energy sellers across 65 countries

Source: Solar Quarter

The European market, primarily driven by the policy-led growth in capacity and the related support structures, also accommodates the potential for the merchant power segment. Select markets such as those of the Nordics are examples of prominent merchant PPAs due to the elimination of subsidies. In contrast, other markets have CfDs, which could act against the incentives for PPAs and may, effectively, displace the capacity that would otherwise be allocated through merchant or other direct offtake-based PPAs.

Trends and Drivers

Market Support and the Room for Merchant Exposure in European Countries



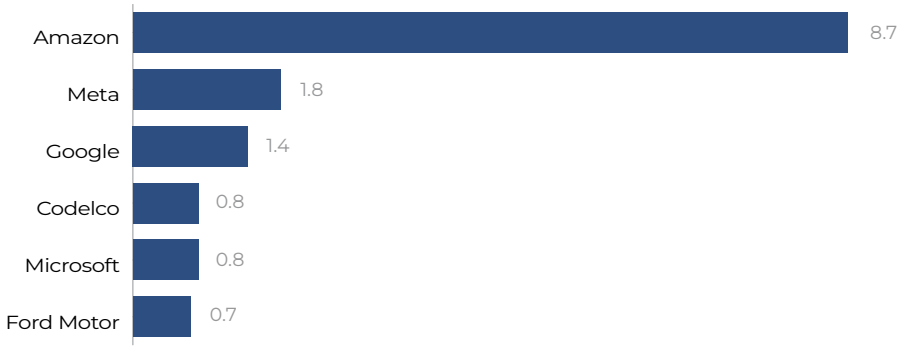
Source: PV Magazine

The corporate PPA segment plays an increasingly important role in market-based procurement of solar PV

The corporate PPA segment plays an increasingly important role in market-based procurement of solar PV.

The corporate PPA segment plays an increasingly important role in market-based procurement of solar PV It has become a well-established trend, with energy-intensive enterprises, led by technology (data centers) to corner a predominant share of PPAs in clean energy. Over time, solar PV came to account for a major share in this context. The US is an important market for such a model, where many of the enterprises have adopted a virtual PPA route (transactions at a pre-agreed price through a tradeable certificate instead of actual physical delivery).

Top Enterprises in Solar-based Corporate PPAs during 2022 (GW)



Source: Electrek

04

Outlook

4.0

Solar PV Outlook

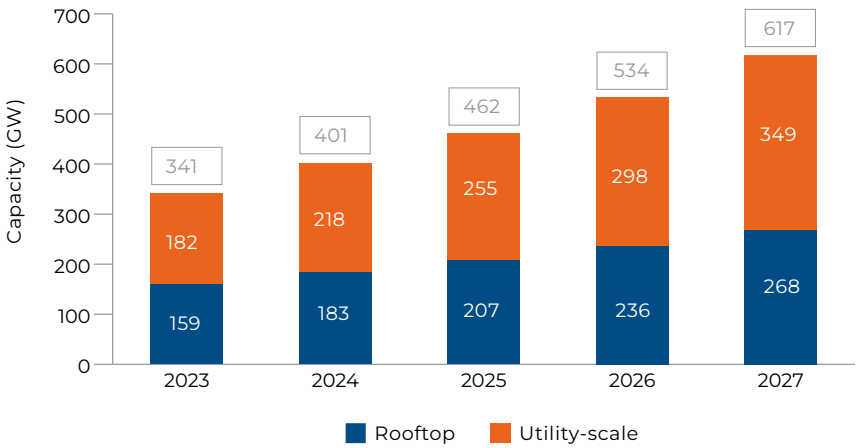
Projected Solar PV Capacity

Most industry studies point to a massive build out in solar PV-based capacities globally. The projected scale varies across studies for assumptions in the pipeline, policy trajectory, methodology, etc. But there is a consensus about solar PV's instrumental role in global renewable capacity growth For example, the International Energy Agency's estimates as of June 2023 suggest that solar PV will account for approximately two-thirds of the new renewable energy capacities in 2023, with a similar leading role projected for 2024.

The scope is bigger than what the projections indicate. BNEF's estimates on the net zero transition phase till 2050 indicate that the solar installations must rise at least three-fold by then, in conjunction with other technologies. The US-based National Renewable Energy Laboratory's (NREL) workshop in early 2023 put forth 75TW in global solar PV requirement. Notably, the same group's 2018 projection had anticipated 1 TW of capacity by 2023, a target that was met by the end of 2022. An acceleration in the rate of capacity addition is a critical need to have a reasonable chance of transitioning to a net-zero scenario.

According to IEA, about 100 million rooftops globally could find solar PV deployment, compared to the 25 million at present.

Globally Projected New Solar PV Build



Note: Rooftop solar would typically include grid-connected capacities in commercial and industrial segments

Source: Solar Power Europe

The utility-scale solar PV segment, while vital for achieving scale and reducing unit costs rapidly, may not be the sole growth driver as in previous years Recent experiences in major solar PV markets, such as China, reveal that the rooftop solar segment could assume a central role in accelerating PV capacity additions. The commercial and industrial consumers are driving such a demand. Residential consumers too play an important role, though often it is in the off-grid (or behind-the-meter) realm. About 100 million rooftops globally could accommodate solar PV installations, compared to the 25 million at present (IEA).

Outlook

Emerging Capacity Configurations

Solar plus battery hybrid projects attracted significant attention, especially in the US market.

The upcoming solar PV capacities are likely to be based on more than one technological configuration. In many solar markets, hybrid capacities are in serious consideration by developers and investors alike. Solar plus battery hybrid projects are one such option that garnered significant attention, especially in the US market, as battery storage developers sought to make take advantage of the investment tax credit on offer. The tax benefits have since been rationalized and the US IRA provides for incentives towards standalone batteries. Nevertheless, the significance of such projects is not lost. Co-located batteries with solar PV projects are important for their role in grid management services, such as arbitrage between the peak and off-peak prices, frequency management, among others.

With subsidy support waning across the markets, and greater exposure to market volatility, co-locating battery storage with solar PV makes a stronger case than before. This is one reason why many projects are also opting for retrofitting existing commissioned power generation projects with energy storage. About 60GW of battery-based energy storage could be commissioned by 2030, with a significant to be linked to renewable, and especially solar PV projects.

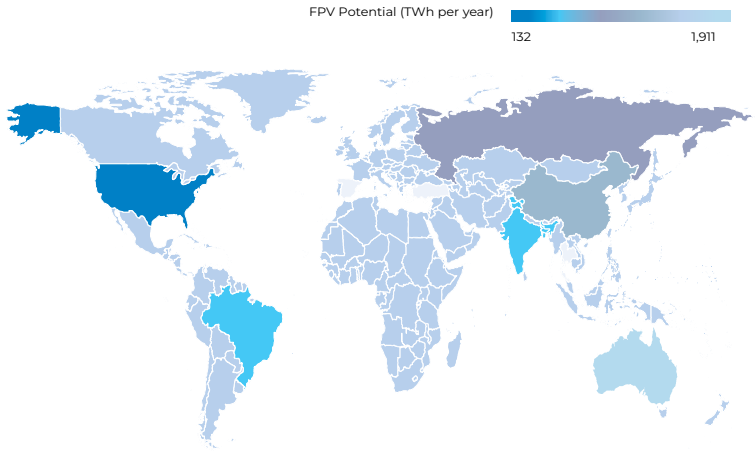
Energy storage is not the only avenue amongst prevalent hybridization options. Another one taking roots is the combination of solar and wind power generation projects. In December 2022, the world's largest wind-solar hybrid (450MW, of which 420MW is solar-based) was commissioned in the Indian province of Rajasthan by Adani Green Power. Earlier in the same year, Iberdrola commissioned a similar project in Australia. Many others are in active consideration.

Some of the considerations in favour of such projects include reduced cost of land and transmission infrastructure and higher capacity utilization factors than those in the standalone wind or solar projects. The push for hybridization has been extended to hydro power projects as well. In June 2023, the world's largest wind-hydro hybrid project was commissioned in China, with 1GW of solar PV capacity and 3GW hydropower generation. An added advantage of hydro and solar hybridization is the ability to combine hydropower's peaking facility with cost-effective solar-based power generation.

The quest for cost-effective solar power generation has also motivated a rising new form of solar PV capacity known as floating solar PV. This refers to solar PV generation based on floating platforms situated on water reservoirs (including dams of hydropower facilities). In March 2023, an international group of researchers published their research findings on untapped energy potential from floating solar PV. It revealed an annual generation potential worth 9,434TWh from global reservoirs, with only 30% of their area covered. The top four countries in this regard are the US, China, Brazil and India. Significantly, the study demonstrated that in 40 countries, the potential generation from floating solar PV exceeds their total existing power demand.

Outlook

Floating Solar PV Potential Globally



Source: PV Magazine

According to IEA, an average annual investment of $600 billion is required by 2030 in the bulk power transmission networks globally to enable the net zero energy transition process.

Issues and challenges ahead

The projected increase in solar PV capacity is subject to constraints of the global PV supply chain. It's evident how utility-scale solar projects slowed down in the face of rising costs of material inputs, interest rates and the uncertainty in supply. To address this, a more diverse supply chain is necessary, given the current dominance of Chinese suppliers. Policies like the US Inflation Reduction Act incentivizing local manufacturing, along with similar efforts in European countries, aim to mitigate the concentration risk and enhance supply chain resilience.

There is a flip side to the ongoing global policy efforts aimed at localization (led by the US IRA). Global capital flow, which seeks maximum return, could be skewed by upfront government incentives. In the process, it risks an imbalance in global capital allocation. Many European countries, for instance, had to respond to the US IRA subsidy package after prominent investors seemed to make decisions solely based on available benefits. It is yet to be seen how and to what extent this stabilizes, as there is a wide range of investments that can be considered for subsidy allocation criteria. Nevertheless, localization remains a priority for the long-term viability and stability of the solar PV industry supply chain.

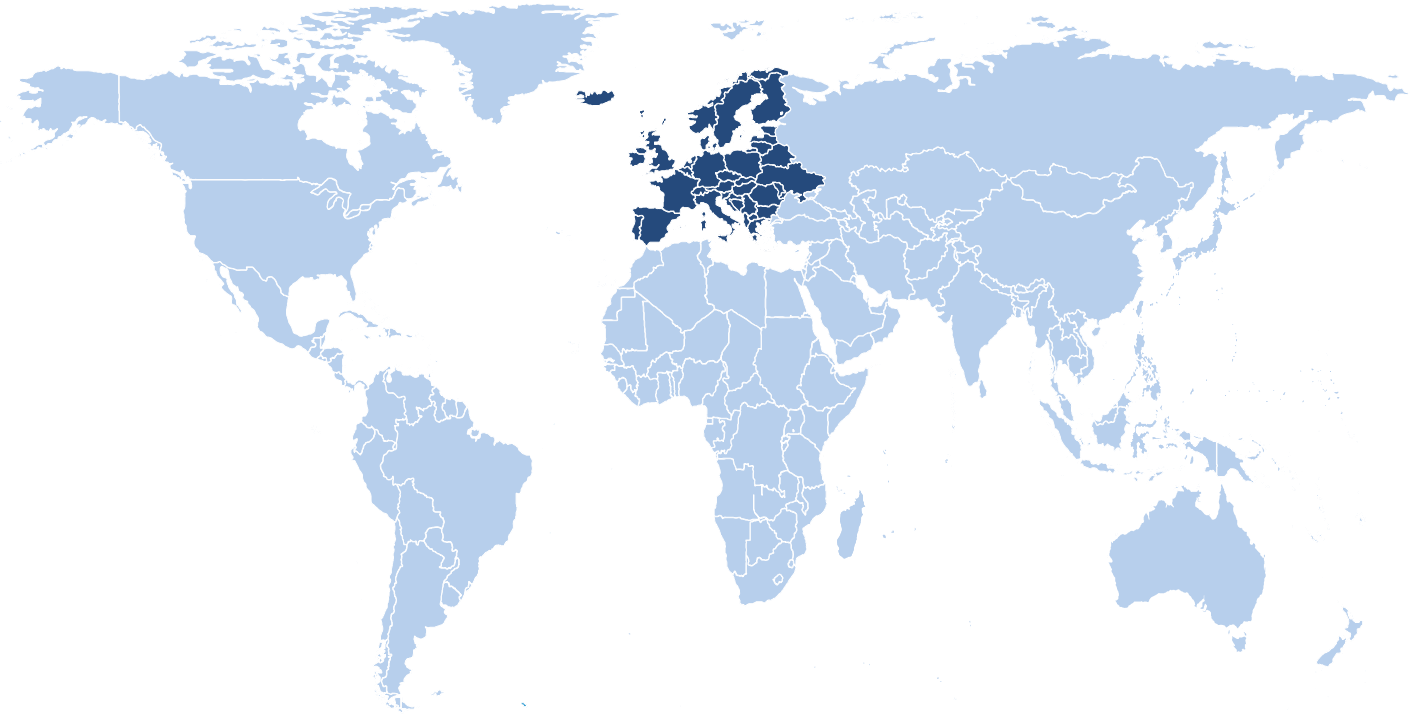
The projected investment requirements in solar PV also demand an expansion of grid infrastructure. IEA's study (September 2022) indicates an average annual investment requirement of $600 billion by 2030 in the bulk power transmission networks globally to enable the net zero energy transition process. This is roughly double the present investment levels. Furthermore, the requirement in emerging markets or developing economies could be far higher, possibly requiring triple the current investment levels. The grid curtailment experience of some of the leading solar markets, including China's, is sufficient proof of the upcoming challenges in integrating solar PV generation in the overall grid dispatch. The impact could be on project returns, as utility-scale PV projects are likely to be pushed towards low utilization levels when the grid connectivity is either inadequate or restricted compared to coal and other baseload fossil fuel power generation.

05

Key Regional Markets

5.1

Key Regional Markets - Europe



5.1.1

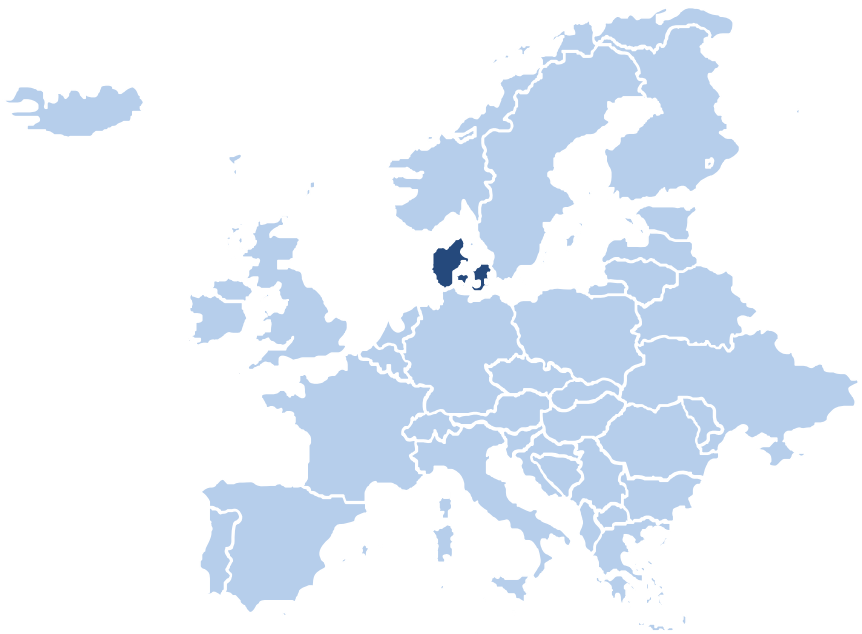
Denmark

Prior to 1973, over 90% of Denmark's energy supplies were derived from imported fossil fuel. The 1973 oil crisis marked a turning point in the country's energy policies, forcing it to diversify its energy sources. Since then, in order to be self-sufficient, Denmark developed a long and hefty tradition of developing and using renewable energy.

According to Danish Energy Agency (DEA) data, although, Denmark's energy consumption dropped by 1.5% in 2022, renewable energy consumption increased by 5.3%. Wind and solar PV production reached record levels, with 21.2TWh generated in 2022 versus 17.3TWh in 2021. This growth represents a 22% increase, accounting for nearly 60% of the nation's electricity. Green electricity exports from Denmark also significantly increased in the first half of 2022, with Denmark exporting about 9.2TWh, marking a 19% increase from the same period in 2021.

GDP (Current Prices) USD (2022)	390.68bn
GDP Growth Forecast (constant prices) (2023-2027)	1.08%
Currency	Danish Krone
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	11.7GW
Solar PV Share in Renewables (2022)	21%
Renewable Energy Target	2030 target of reducing GHG emission by 70% from 1990 level along with renewable energy share to be 100% in electricity generation and 55% in overall consumption

GDP Source: IMF WEO, S&P and IRENA



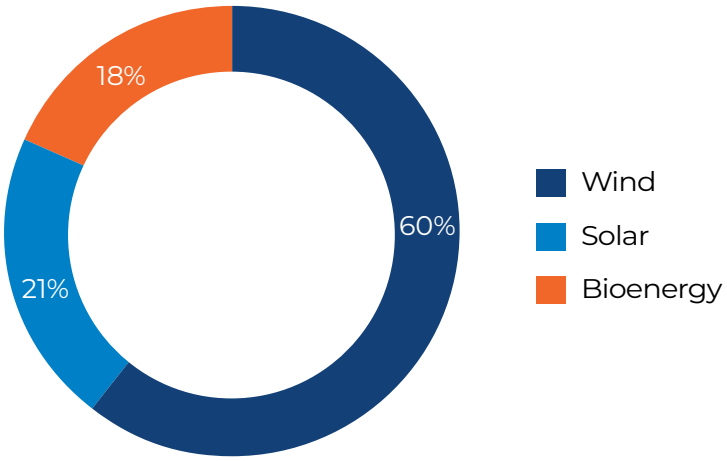
2.49GW Solar PV Capacity

- ✓ Promotion of renewable electricity through premium tariff and net-metering scheme
- ✓ Robust funding and decarbonization strategies put forward to encourage the extensive use of renewables
- ✓ Significant growth experienced by utility-scale solar PV systems attributable to subsidy-free projects
- × Upcoming producer tariffs are expected to result in significant cost increases for renewable energy plants
- × Shortage of grid connections standing out to be a substantial barrier to solar energy expansion

Denmark

Renewable Energy Mix

Current Renewable Energy Mix

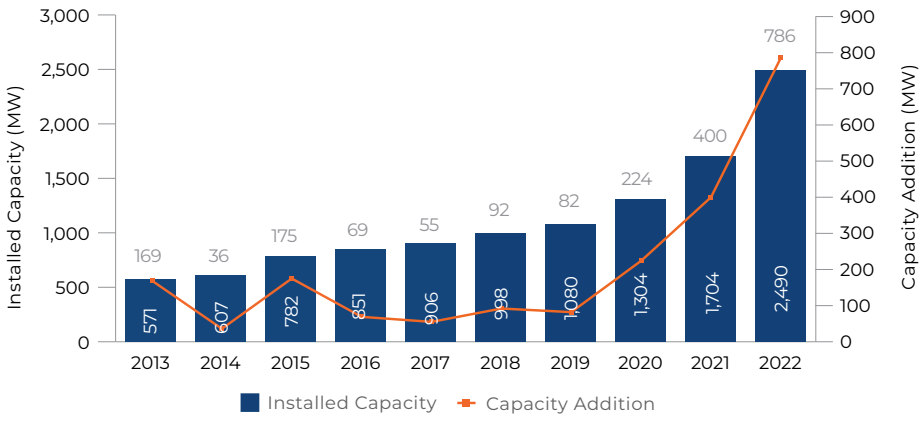


Source: IRENA Renewable Capacity Statistics April 2023

Wind energy has been the dominant renewable source in Denmark, accounting for 61% share in the renewable mix in 2022. However, the share of wind energy went down 7% compared to 2021, which was offset by an increasing share of bioenergy and solar PV. In the case of solar energy, a modest growth rate was observed in the country. In 2020, the share of solar energy in the renewable mix was 13%, which rose to 16% in 2021 and to 21% in 2022. The increasing level of solar radiation and adoption in Denmark paired with a decreasing cost of installation and operations has paved the way for a profitable future in the sector in coming years.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Although the main PV market in Denmark is in BAPV (Building Applied Photovoltaics) and BIPV (Building Integrated Photovoltaics), the utility-scale solar PV systems in the country have experienced significant growth because of subsidy-free projects financed through merchant revenues and bilateral contracts in last few years.

Between 2013-2022, the cumulative solar PV capacity of Denmark grew at a CAGR of 16%, with the highest annual addition of 786MW taking place in 2022. The annual capacity additions experienced a robust growth in 2022 with total solar PV capacity in Denmark reaching 2.5GW, marking a 46% year-on-year growth over 2021. Furthermore, the recent Russia-Ukraine conflict will boost solar PV growth since nearly 75% of Denmark's gas imports are supplied by Russia via a pipeline through Germany. In a move to ensure Denmark's long-term energy security, the Danish government has pledged to increase the number of solar PV and onshore wind farms by 2030.

Denmark

Demand Drivers

Denmark promotes renewable electricity through a premium tariff and net-metering, contributing to the successful development of renewable projects, particularly in the commercial and industrial sectors. However, it is supported by the Danish Climate Agreement for Energy and Industry, which promotes a market-driven expansion approach for solar power and onshore wind. The agreement includes the allocation of DKK 2.5 billion in subsidies for electrification and energy efficiency improvements in the industry, as well as DKK 2.9 billion for low-carbon gases. Additionally, it increased taxes on fossil used for heating buildings and introduced tax incentives for using renewable electricity. These measures are all part of the 2020 Climate Act, which sets a target to reduce Denmark's greenhouse gas emissions by 70% in 2030 compared to 1990 levels and climate neutrality by 2050. In 2021, the act was amended to include the emission reduction target for 2025 of 50-54%.

Recent years have seen a rapid proliferation of unsubsidized utility-scale PV projects in the country. Unsubsidized solar PV represented the lion's share of all PV systems deployed in 2022, followed by commercial and industrial installations. Corporate bilateral PPAs are the foundation of this segment. Few notable deals that took place in the market involve large conglomerates like Telia, Telenor, Toms Group and Carlsberg signing deals to offtake considerable amounts of renewable electricity thereby facilitating the construction of PPA solar plant projects.

In Denmark, the government is increasingly putting forward robust funding and decarbonization strategies to encourage extensive use of renewables. The Danish parliament and the government reached three agreements in June 2022 covering a green investment fund, an enhanced unified carbon tax, and a renewable energy package that will quadruple solar and onshore wind energy production by 2030. The fund covers €7.2 billion in investments from 2024 to 2040, prioritizing larger and longer-term investments in climate, green energy and the environment.

The carbon tax emphasises the government's intention to decarbonize the economy, particularly the commercial and heavy industrial sectors at a cost-effective pace. The proposed agreement introduces an increased CO2 tax at a rate of DKK750 per tonne of emitted CO2 for companies not covered by the EU Emissions Trading System (ETS), DKK375 per tonne for companies covered by ETS and DKK1,125 per tonne for companies who are large emitters and exempted from both agreements. Mineralogical companies receive a charge of DKK125 per tonne emitted. The charge will be increased over time, from DKK350 in 2025 to DKK750 per tonne in 2030. This reform is expected to reduce Denmark's CO2 emissions by 4.3 million tonnes, making it the most significant single contribution to Denmark's 2030 climate goals since the adoption of the Climate Act.

Another reason for the high volume of utility-scale installations in 2022 is probably the upcoming tariff scheme for grid connection that will significantly increase grid connection costs. The scheme will introduce a per-MWAC grid connection charge between €17,600 and €329,000 depending on connection voltage (from 10 kV at DSO level to 400 kV at TSO level) and geographical zone (production dominated vs. consumption dominated).

Market Opportunity

The electricity sector in Denmark has successfully met long-term demand while keeping costs down by fostering competition. At the same time clean energy has always been prioritized. Supporting the same cause, in H2 2021, European Commission approved the Danish aid scheme of EUR400 million to produce electricity from renewable energy sources including solar PV. This aid will be provided under competitive tendering, creating an opportunity for the projects to present themselves and receive funds. The process will continue until 2024 and aid can be paid out for a maximum of 20 years after the renewable electricity is connected to the grid.

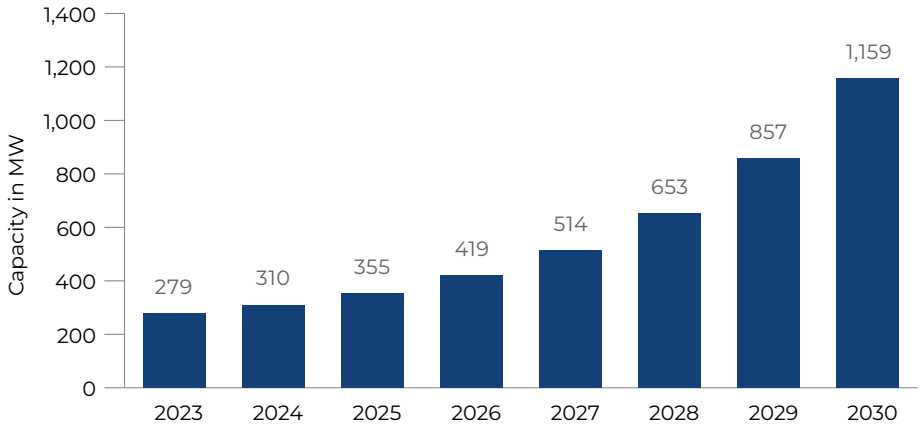
The achievement of grid parity by solar PV and the stability of LCOE for PV plants have made the construction of solar parks without subsidies a more viable option. Danish renewable energy developer, European Energy, has been an active participant in the Danish solar sector, accounting for significant market activity. On the other hand, another renowned developer, Better Energy, announced a new solar PPA with 12 Danish companies in the beginning of 2022, seeking to build subsidy-free solar plants.

Considering the dominance of wind power in the country, growth opportunities for the PV sector also lie in new high-power mixed wind-PV systems. Hybrid systems offer a plethora of benefits such as maximizing land and infrastructure use, increasing plant utilisation and reducing grid connections costs. More cost-efficient ways like the upgrade of Denmark's enormous pool of pre-existing wind farms to PV-hybrid plants also presents new venues to accelerate further growth. In January 2023, Danish renewable company GreenGo Energy announced plans to develop a 4GW hybrid solar and wind energy park in western Denmark.

Denmark

Outlook

Denmark's Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

Insights from the International Energy Agency (IEA) indicate that Denmark's renewable electricity capacity will double during 2022-2027, primarily driven by wind and solar PV. The unsubsidized utility scale solar projects are expected to drive the solar market in the coming years, while real-time self-consumption models and community solar projects will play supporting roles. According to a study by Norwegian research company Rystad Energy, the Nordic region has the potential to add 12.8GW of PV capacity by 2030. Denmark is predicted to be the leader in the region, adding 9GW, or three-quarters of the total projected capacity.

While the present balance of achievements in the country's renewable agenda is positive and the ambitions for the future are high, there are also significant challenges ahead.

One of the challenges lies in Denmark's plan to introduce producer tariffs from 2023, which will result in significant cost increases for renewable energy plants. The new tariff model will require renewable energy producers to pay for grid connections in accordance with their geographical location. This will increase the overall grid cost by more than 50%, thereby rendering most PV projects in the pipeline as uncompetitive due to unplanned charges according to the new geographical zoning principle. Energinet and several other grid companies have already developed and submitted tariff models which are awaiting the Danish Utility Regulator's approval. Despite recent progress in solar energy, producer tariffs may prove to be a substantial barrier to further expansion.

Market operators are betting on cable pooling to tackle shortage of grid connections. The solution aims for infrastructure sharing, allowing power plants to use a single connection to feed the electricity they generate into the grid. This helps in the optimisation of existing grid connection points, reducing investors' costs and the investment needs of power grid operators.

The Danish renewable sector is currently undergoing a significant transformation, with unsubsidized large-scale PV projects steadily gaining market share in a market traditionally dominated by wind power. Over the past two years, almost 95% of the total capacity deployed has been utility-scale solar. This shift is primarily driven by corporations' willingness to purchase green electricity under bilateral PPAs. These PPAs, signed by corporations, are signed at a slightly higher price than grid electricity. However, corporations and conglomerates sign PPAs above grid prices to ensure future price protection and increase the share of renewable energy in their final consumption. A decline in government support for solar technology will lead to an increase in PPA-backed utility-scale solar deployment in the future.

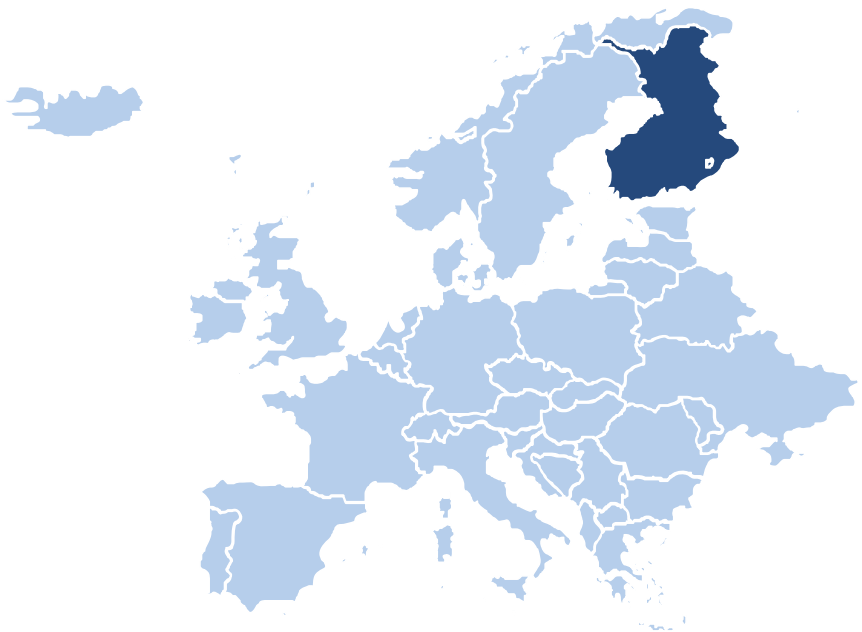
5.1.2

Finland

Finland's energy system is experiencing rapid transformation primarily due to changes in regulatory landscapes, consumer preferences and technological advancements. The country's total energy consumption from renewable sources has steadily increased over the past decade, reaching 41.8% in 2022. On June 30, 2022, Prime Minister Sanna Marin's Government presented the latest National Climate and Energy Strategy to the Finnish Parliament. The plan outlines Finland's plans for meeting the EU's climate commitments for 2030 and achieving the targets set up in the Climate Change Act, which calls for reducing greenhouse gas emissions by 60% by 2030 and becoming carbon neutral by 2035. The emphasis on renewable energy is thus significantly high. It is in this context that solar PV assumes significance.

GDP (Current Prices) USD (2022)	281.05bn
GDP Growth Forecast (constant prices) (2023-2027)	1.04%
Currency	Euro
Country Credit Rating (S&P)	AA+
Renewable Energy capacity (2022)	12.1GW
Solar PV Share in Renewables (2022)	5%
Renewable Energy Target	Reducing greenhouse gas emissions by 60% by 2030 and becoming carbon neutral by 2035

GDP Source: IMF WEO, S&P and IRENA



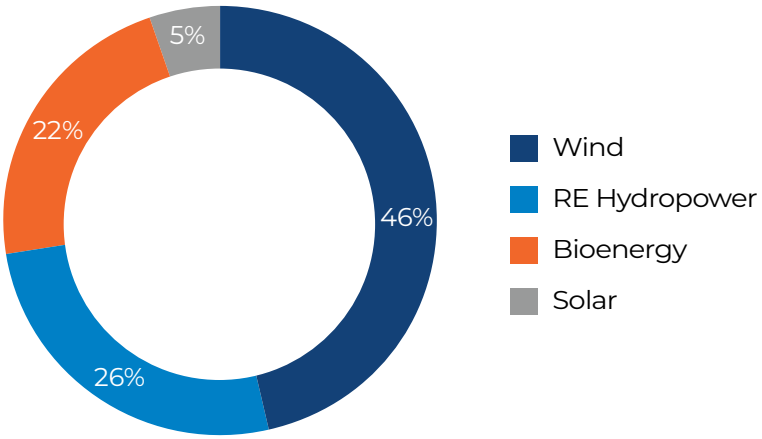
0.59 GW Solar PV Capacity

- ✓ Commitment to stabilizing regulation and setting ambitious carbon neutrality targets to generate significant traction in the solar sector
- ✓ An influx of foreign investment observed, along with a shift in public opinion towards more support for renewable technologies
- ✗ Power transmission connectivity is not adequately placed to meet the upcoming renewable energy capacities
- ✗ The major setbacks for solar technology over the years have been the absence of government strategies and objectives

Finland

Renewable Energy Mix

Current Renewable Energy Mix

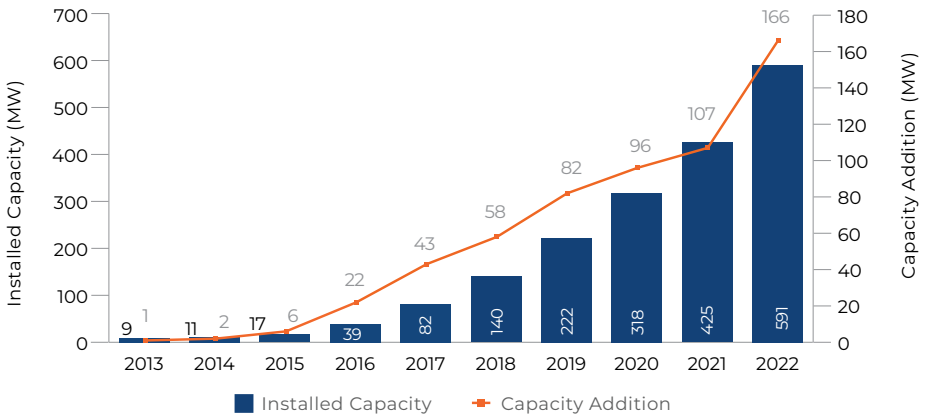


Source: IRENA Renewable Capacity Statistics April 2023

Finland's energy mix continues to be dominated by hydropower and wind. A low solar energy share in Finland's renewable energy mix is due to intermittent solar energy availability (day-night and summer-winter cycles). Therefore, the market relies heavily on wind, hydropower, and bioenergy to generate renewable electricity. The share of wind power has increased by 12% in 2022, displacing hydropower and bioenergy, while the share of solar power has marginally increased by 1%.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Finland's total solar installed capacity has been on the rise since 2016. Currently, 591MW of solar capacity is connected to the Finnish main grid. From 2016-2022, solar PV installed capacity has increased by a 57% CAGR, primarily due to small-scale solar projects (mainly rooftop residential) which have pioneered PV deployment. More recently, there has been an uptick in corporate interest as they are increasingly adopting the technology on an industrial and utility scale.

Finland

Demand Drivers

Finland's climate policy outlines ambitious goals, including achieving a nearly emission-free electricity sector by 2030. Enforcing such a policy roadmap would require a focus on solar as one of the renewable power generation options. There are various support measures also in place. Most important among them is investment subsidies granted by the Ministry of Employment and the Economy and Business Finland. A total of €82.3 million in investment subsidies were granted for 632 PV installations in 2022. Traditionally, subsidies have been 15% of total project costs for conventional technologies, and 19-20% for new technologies. PV systems installed by agricultural companies are also eligible for investment subsidies of up to 35% from Centres for Economic Development, Transport, and the Environment. Individuals are eligible for a tax credit covering the labor component of PV system installation, with the credit amounting to up to 40% of the total labor cost, including taxes. This effectively reduces the total cost of the PV system by approximately 10-15%.

The Finnish energy transition primarily focuses on the decentralised electrification of energy-intensive sectors, such as heating and transportation This approach enhances energy independence, a critical factor today and a likely driver of green electricity demand in the future. Solar panels are becoming more frequent, as they are being installed in grocery stores, offices and public buildings.

The Finnish government has encouraged traditional industrial companies and new technologies, such as data centres, to use more renewable energy. Consequently, corporate PPAs are experiencing a strong boom, driven by sustainability concerns. The PPA market, however, is dominated mainly by wind and hydropower projects due to PV's small share of the energy mix Nevertheless, solar PPAs are poised for growth due to their accessibility and proximity to consumption points.

Solar PV research and development activities are gaining momentum across various universities and research institutes. The research and development work at universities and research institutes is mainly funded by the Academy of Finland and Business Finland, which also provides financing for company-driven development and demonstration projects. Universities across the country are actively researching multi-junction silicon solar cells based on III-V semiconductors, perovskite solar cells, organic photovoltaic (OPV) and atomic layer deposition (ALD) technologies. Among the best examples of this is VTT Technical Research Centre of Finland, which is active in integrating solar energy into buildings and energy systems. In addition to developing roll-to-roll printing and coating processes for photovoltaics, VTT is exploring new applications for perovskite solar cells and organic photovoltaics.

Market Opportunity

Compared to its Nordic peers, enjoys a more advantageous geopolitical location for solar PV installations. This advantage primarily stems from its low atmospheric temperature, which makes solar PV cells more efficient. Moreover, the economic competitiveness of solar power has improved over the last few years and is projected to maintain this positive trend.

Investors and the developers are finding significant opportunities in the Finnish solar power market, even as it competes with wind energy. In a major development, renewable company OX2 has acquired the project rights for the solar power project in Huittinen, Finland, from the Finnish solar power developer SAJM Holding Oy. The planned capacity will be 475MW, making it one of the largest solar farms in Finland.

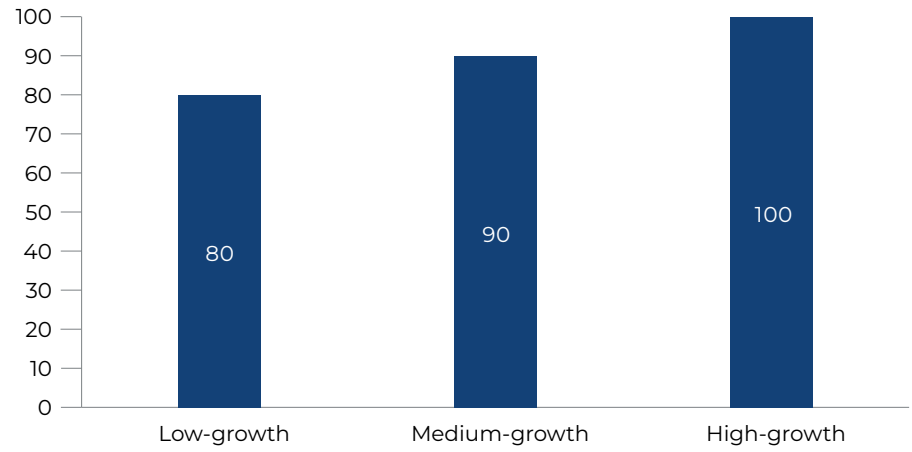
Off-grid systems dominated the Finnish PV market for a long time. Approximately 22MW of off-grid PV capacity was installed in more than 55,000 homes by the end of 2021. However, the number of grid-connected PV systems has steadily increased since 2010, and the installed grid-connected PV capacity has almost doubled in 2020-2021. The number of companies preparing multi-megawatt PV plants has also increased over the past few years. A key example would be that of renewable firm Helen, which has acquired a turn-key 206MWp solar power plant located in Kalanti, Uusikaupunki, in south-west Finland. Businesses are currently interested in plants being implemented on land that is difficult to repurpose, such as decommissioned peatlands. There is an increasing interest in combining PV with wind power production to reduce the variation in power production, use a common infrastructure, and reduce project costs. Furthermore, the integration of power storage in PV plants is also being heavily considered. In an innovative technology breakthrough, Finnish companies Polar Night Energy and Vatajankoski have built the world's first operational "sand battery", which provides a low-cost and low-emissions way to store renewable energy.

There are multiple solar development associations in Finland, which not only promote the development of solar energy, but also provide financial support for PV deployment. A case of this is the Finnish solar power developer's association, Auringosta Energiaa, which plans to invest more than €10 billion in solar energy in Finland over the next few years.

Finland

Outlook

Finland Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

One of the major setbacks for solar technology over the years has been the absence of government strategies and objectives. As a result, solar PV is viewed as an energy technology that can be used to enhance the energy efficiency of buildings by generating electricity for self-consumption. However, Finland's commitment to stabilizing regulation and setting ambitious carbon neutrality targets is generating significant traction in the solar sector. As a result, grid-connected PV systems have gradually become more popular in recent years.

An influx of foreign investment has been noticed, along with a shift in public opinion towards more support for renewable technologies. Currently, there are fewer than ten industrial-scale solar power plants in Finland with numerous pending projects, mainly in southern Finland. According to Fingrid, solar energy production capacity in the country will increase more than tenfold by 2030, reaching approximately 7GW.

Despite market optimism, some factors could potentially impede to growth. For instance, power transmission connectivity is not adequately placed to meet the upcoming renewable energy capacities. To address this, the country's transmission system operator (TSO), Fingrid, is planning to expand its capacity in bulk power transmission assets. The TSO's Grid Development Plan, 2022-2031, shows a planned investment spending of €2 billion for both new capacity and upgrades of existing ones.

Apart from implementation challenges, the future of the Finnish solar PV sector will also be shaped by the relative competitive position of renewable energy technologies. The commercial feasibility of solar PV against other renewable technologies would be key in this regard.

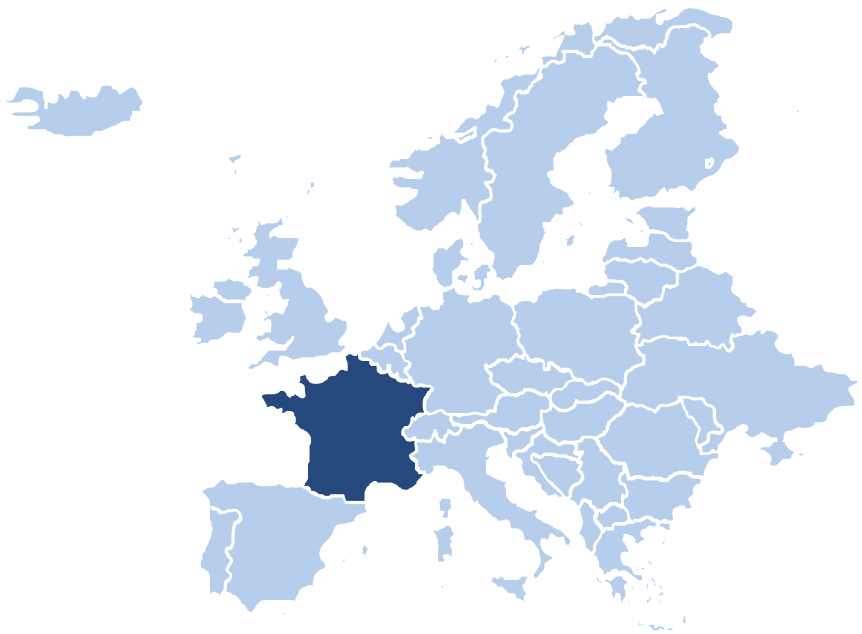
5.1.3

France

Despite introducing eco-friendly laws and targets earlier than most of its peers, France has lagged in deploying solar modules in the past and is still struggling to reach its true potential due to the political and economic crisis. However, the French government has taken the initiative to promote renewable energy and reduce the dependency on nuclear/fossil energy. In its Multi-Annual Energy Programme (MAEP), the government has set the objective to achieve cumulative PV capacity of up to 35GW-44GW by 2028 and 100GW by 2050. Their ambition is strongly anchored on emerging technologies such as storage and applications like agrivoltaics, which are set to enhance solar's momentum in France.

GDP (Current Prices) USD (2021)	2,957.42bn
GDP Growth Forecast (constant prices) (2022-2026)	1.64%
Currency	Euro
Country Credit Rating (S&P)	AA
Renewable Energy capacity (2022)	65.4GW
Solar PV Share in Renewables (2022)	27%
Renewable Energy Target	"Producing 33% of its energy needs from renewable sources by 2030 Achieving 100GW of solar PV capacity by 2050"

GDP Source: IMF WEO, S&P and IRENA



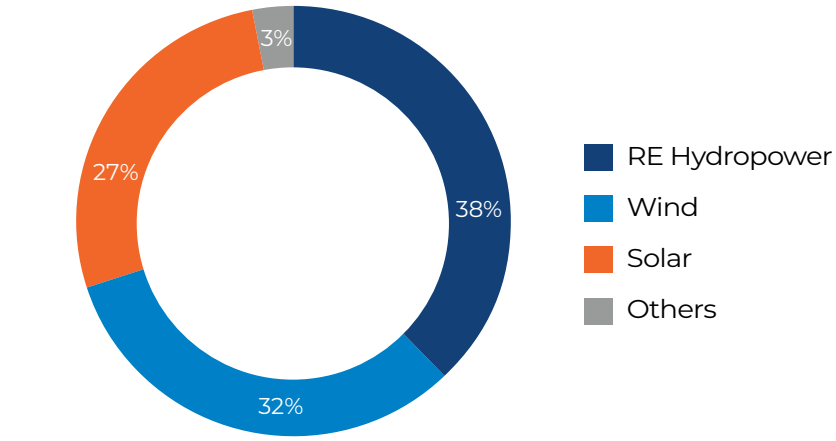
17.4GW Solar PV Capacity

- ✓ Favorable policy measures adopted by the French Legislators aim at simplifying procedures and reducing the deadlines applicable to renewable energies, thereby accelerating the development of renewables
- ✓ The private investment is strengthening in the French solar market with the entry of new players as well as the expansion of projects under existing players
- × Time lag between the proposed plant and its implementation remains one of the major challenges faced by investors
- × Recent tender round for commercial and industrial rooftop installations remained largely undersubscribed

France

Renewable Energy Mix

Current Renewable Energy Mix

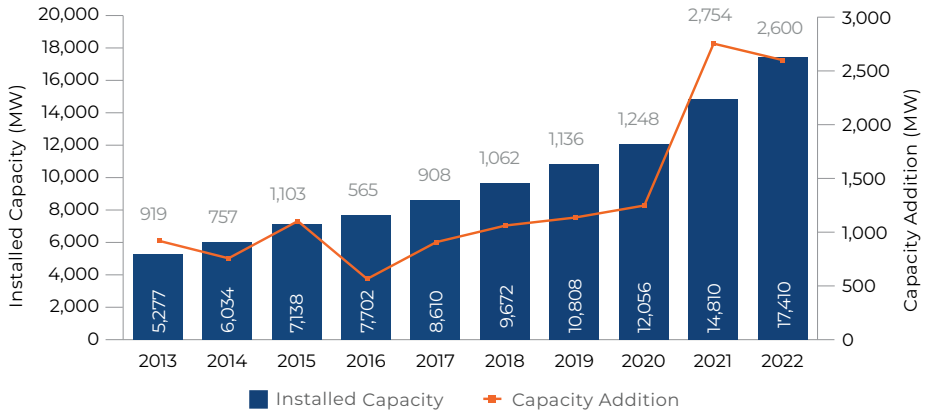


Source: IRENA Renewable Capacity Statistics 2023

The share of renewables in France's total installed power capacity increased to 44.6% in 2022 from 42.6% in 2021. While wind and renewable hydropower are better represented than solar, accounting for a combined share of c.70% in the renewable energy mix in 2022, solar energy is expanding at a steady rate in the mix, showcased by its growth from 18% in 2017 to 27% in 2022.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics 2023

The 2050 goal of carbon neutrality set by the French government serves the as the base for growing renewable energy adoption in the country. Solar PV capacity in France maintained a steady growth trend during the last five years. However, in 2022, there was a slight decrease in capacity additions, with 2.6GW of new capacity installed compared to the record installation of 2.8GW in 2021. More than half (53.3%) of the cumulative solar capacity in 2022 came from installations above 250kW. Nevertheless, there has been a noticeable increase in the number of PV self-consumption installations as well.

Installations under 36kW represent the second largest section of the market, accounting for 18.4%.

To support the renewable sector, in the second half of 2021, the European Commission (EC) approved a French aid scheme with a provisional budget of €30.5 billion. This scheme provides grants to renewable operators (including ground mounted and rooftop solar PV), awarded via competitive tenders for a cumulative new renewable capacity of 34GW that would be organised between 2021 and 2026. The scheme is estimated to mobilize a total of €5.7 billion till 2026.

France

Demand Drivers

Favourable policy measures along with fiscal incentives have been the primary driver for renewable deployment in France. The Renewable Energy Acceleration Bill adopted by the French Legislators in February 2023 aims at simplifying procedures and reducing the deadlines applicable to renewable energies, thereby accelerating the development of renewables. Besides launching the identification of renewable energy "acceleration zones" and setting short timeframes for authorities to examine projects applications therein, the bill includes measures to promote the installation of agrivoltaics and a mandate to install solar panels on parking lots larger than 1500m2 on at least 50% of their surface. The latter measure is expected to add 11GW of solar to the country's energy mix, doubling its existing solar capacity.

The calls for tenders play a significant role in achieving solar growth targets. Therefore, the French government has chosen to initiate two additional tender rounds in June 2023, aimed at allocating 2.3GW of solar capacity. This capacity will be split into a 1.5GW procurement exercise for ground-mounted projects and an 800MW tender for rooftop installations. The new capacity will compensate for the high failure rate of the previous tender round for large-scale ground-mounted solar plants, which only had seven winners, for an allocated total of 115MW. Notably, the tender criteria have been modified in 2022 to include Agri-PV projects, either in the form of agrivoltaic canopies above crops or ground- mounted projects on uncultivated agricultural land of more than 5 years, or land that is hosting livestock.

In terms of fiscal benefits, the government extended its support by increasing the fixed feed-in tariff (FIT) threshold for from 100kW to 500kW in Autumn 2021. This is meant to make procedures easier for the mid-sized rooftop market segment, where projects were previously limited by tendering procedures. Also, a new FIT scheme will be introduced in 2023 for ground-mounted projects under 1MW installed on degraded land.

Solar PPAs have emerged as another important driver and France is actively promoting the PPA space. The country's Nouvelle-Aquitaine region has announced aid to support the growth of solar PPAs. Companies are eligible for two types of aid: a subsidy for technical and legal feasibility studies (to a maximum of 70% of costs), or funding assistance in the form of a loan or guarantee. Recently, many big developers have signed a Corporate Power Purchase Agreement for solar electricity. Some notable mentions are PPA signed between Q Energy and French retailer Les Mousquetaires, The Iliad Group and Engie, Toyota Material Handling and Alight.

Market Opportunity

In order to reduce the dependence on nuclear power for electricity generation, the French government has initiated several strategies to expedite the expansion and development of renewable power, particularly solar PV. As part of the France 2030 national investment plan, the government will invest €1 billion in renewable energy innovation projects to encourage local production of solar panels and other renewable technologies.

So far, renewable energy tendering has proved to be a tool to expand the project base. However, contrasting results were observed in the two latest auctions conducted in January and April 2023. While the January auction was oversubscribed, allocating 173MW of solar PV capacity, 33MW more than the planned 140MW, the April 2023 tender round for commercial and industrial rooftop installations remained largely undersubscribed with only 58MW allocated of the 400MW originally planned. This discouraging result is mainly due to multiple bidders failing to comply with the financial security requirement. However, auctions are going to continue to provide investment opportunity in the sector as the government has already announced plans to hold a 1.5GW tender for ground-mounted PV and another tender for 800MW of rooftop capacity, in order to compensate the failure in the latest tendering round.

Agri-solar and floating solar are the two areas that are experiencing increased activity in the recent times. For example, in the Haute-Saône region, TSE inaugurated its first agrivoltaic demonstration site on field crops in Amance. Energy developer Iberdrola also won its first floating solar power project in France, with a total capacity of 25MW, set to be completed in early 2024.

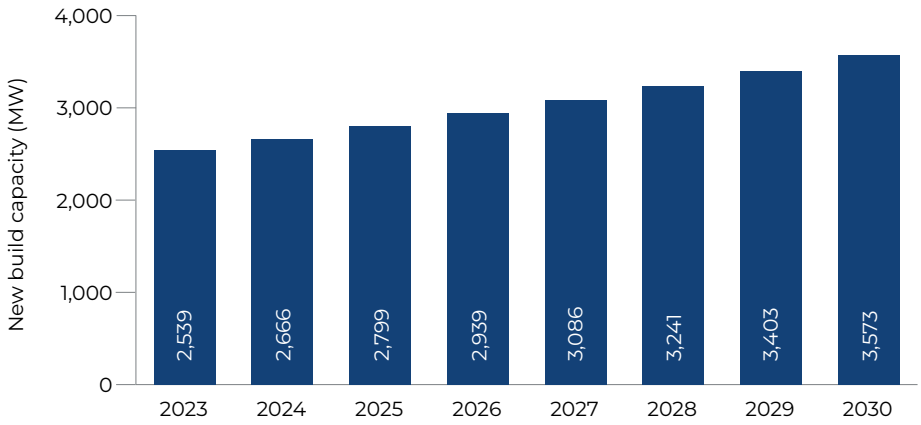
Private investment is gaining momentum in the French solar market with the entry of new players as well as the expansion of projects under existing players Among notable deals, Macquarie Asset Management led consortium is in the process of acquiring French solar developer Reden Solar from infrastructure companies Infravia and Eurazeo for €2.5 billion.

To facilitate faster deployment of renewable energy to counter the ongoing energy crisis, the government has made amendments to several tenders launched under CRE4 and PPE2 to fast-track more than 3.4GW of wind and 2.7GW of solar PV capacity to come online.

France

Outlook

France's Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

The outlook of the French solar PV sector is shaped by the country's ambitious long-term target of achieving 100GW of solar PV capacity by 2050, which translates into more than 5GW of capacity every year. While solar PV capacity in France is expected to continue growing steadily, with a projected annual capacity addition of 3.5GW by 2030, these forecasts fall short of the long-term target. Achieving this target will require a substantial injection of investments and strong regulatory measures.

One of the major challenges faced by investors, in this regard, is the time lag between the proposed plant and its implementation. Pervasive permitting difficulties are causing delays in the project's progression. The ongoing energy crisis has aggravated this as many large-scale solar projects have had to be set aside temporarily and some of the non-bankable projects were abandoned. Moreover, unlike the rooftop solar segment, the utility-scale segment has always been neglected in terms of receiving favourable regulatory norms.

Some positive steps have already been initiated, such as with the amendments done to the CRE4 and PPE2 tenders to facilitate faster deployment of renewable energy facilities across the country. The amendments entail 13 specification changes with respect to solar PV tenders, applicable to ground-mount and rooftop projects, as well as self-consumption arrays and installations without storage. Notably, through PPE2, France seeks to allocate almost 29GW of renewable power generation capacity by 2026, including c.10GW of ground-mounted PV capacity and 5.1GW of rooftop capacity.

Overall, France has showcased a more focused approach in recent years to achieve its true solar potential. However, to achieve the 2050 decarbonization goal, it is imperative that administrative procedures and architectural planning are streamlined and simplified in all market segments. This should be accompanied by grid development initiatives at both transmission and distribution levels to accommodate a high share of renewables towards 2050.

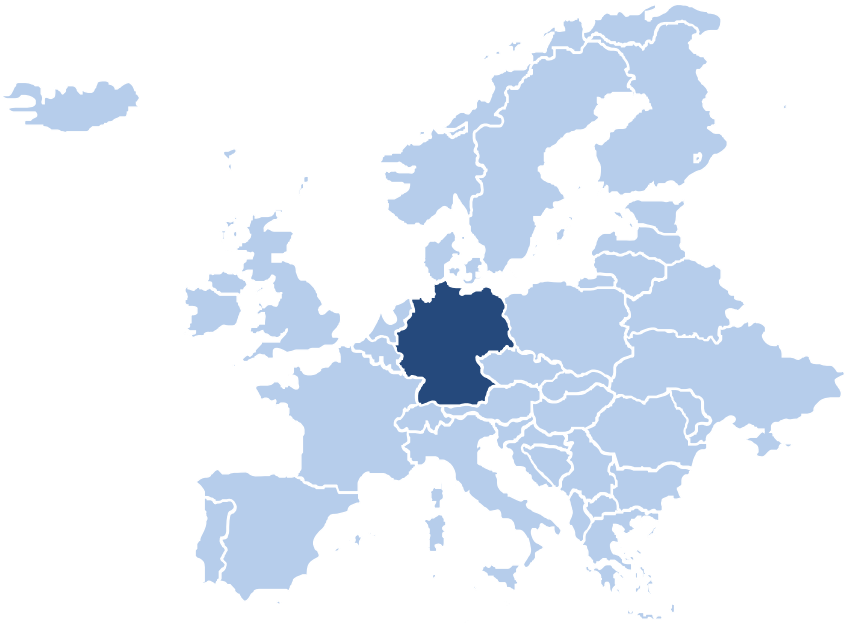
5.1.4

Germany

Germany is one of the largest renewable energy producers globally, with wind and solar energy dominating the renewable energy mix in the country, contributing a 45% share equally in 2022. Germany continues to hold on to its spot as the largest solar market in Europe, with a total installed solar PV capacity of ~66.6GW, producing about 62TWh of solar power in 2022. Since the end of 2021, the new coalition government has been making significant efforts to accelerate the deployment of renewables to keep the country on track with its 2030 targets to achieve 80% share of renewable in power generation.

GDP (Current Prices) USD (2022)	4,075.40bn
GDP Growth Forecast (constant prices) (2023-2027)	1.22%
Currency	Euro
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	148.4GW
Solar PV Share in Renewables (2022)	45%
Renewable Energy Target	2030 targets to achieve 80% share of renewable in power generation

GDP Source: IMF WEO, S&P and IRENA



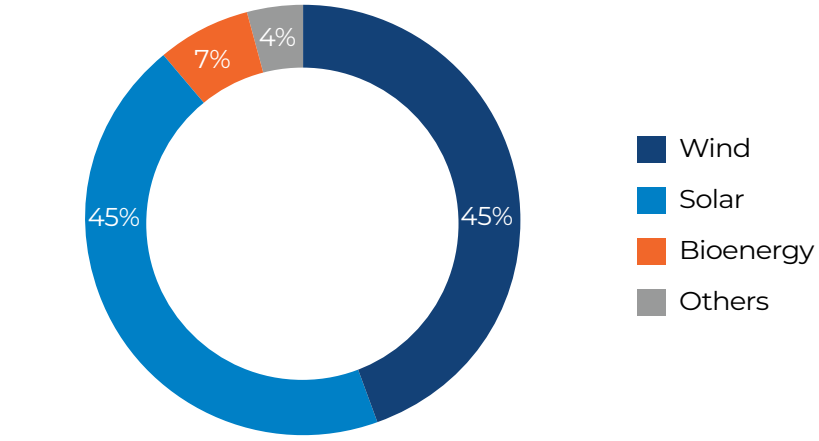
66.55GW Solar PV Capacity

- ✓ Increased price caps for the auctions for onshore wind and solar energy in an effort to make renewable energy tenders more attractive
- ✓ Rooftop solar, both residential and C&I segments, is expected to make the largest contribution
- × Distorted costs for grid connections, and sluggish permission and grid connection processes
- × Lag in terms of deploying front of the meter battery storage

Germany

Renewable Energy Mix

Current Renewable Energy Mix

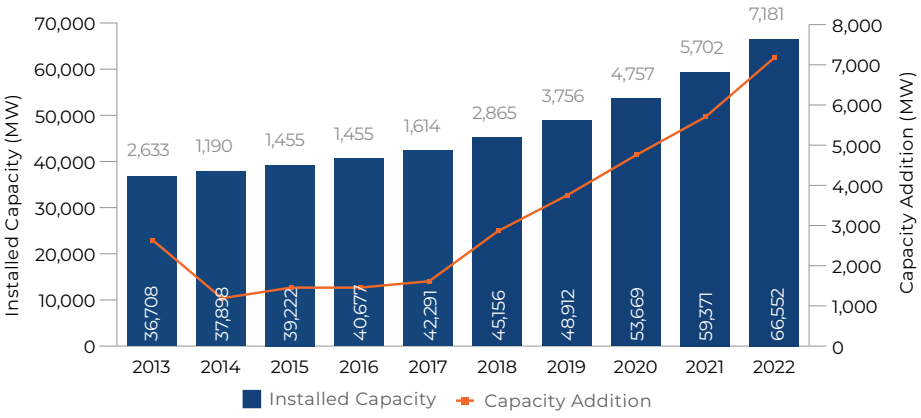


Source: IRENA Renewable Capacity Statistics 2023

In Germany, wind and solar share an equal percentage of the renewable energy mix. The solar sector saw a 3% increase, contributing 45% in 2022 compared to the previous year's 42% in 2021. The new coalition government has revised its target to achieve an 80% share of renewable in power generation by 2030, which was previously set at 65%. The current government's climate plan and the European energy crisis accelerated the demand for solar power installations in 2022, with increasing appetite from the residential sector in solar PV adoption.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics 2023

In 2022, capacity additions of Solar PV increased by 26% annually, with 7.2GW of new installations added to the grid, reaching a cumulative total of ~66.6GW. This growth can be attributed to the significant increase in roof-mounted installations for the residential segment, which rose by 40% to nearly 3GW. However, installations on commercial building roofs declined to just over 1.2GW. Additionally, large ground-mounted installations increased by 70% to 2.4GW for projects supported under the Renewable Energy Act (EEG) and by 22% to 0.8GW for installations built under power purchase agreements (PPA) outside the EEG support scheme.

The pace of capacity expansion in Germany has fallen short of meeting the country's net-zero obligations for the coming years. To achieve its targets, Germany would need to triple its annual expansion volumes, reaching a total capacity of 215GW by 2030. This would translate to adding 22GW per year, including annual solar installations of 7GW in 2022, 9GW in 2023, 13GW in 2024, 18GW in 2025, and 22GW from 2026 onwards(as suggested in the Easter Package by the government in line with energy independence and security concerns caused by the Russian war on Ukraine).

Germany

Demand Drivers

Germany's efforts towards renewables were further spurred by the fossil fuel crisis in the aftermath of Russia's Ukraine invasion. There is a strong push on the policy side too The draft "Easter Package," released in July 2022, includes proposed reforms to the Renewable Energy Act (EEG), amendments to energy industry law, and measures to expedite power transmission grid development. It also aims to increase tender volumes for wind and solar projects and introduce contracts for difference (CfD The adoption of EEG 2023 incorporates several provisions to facilitate faster deployment of solar energy. The adoption of EEG 2023 incorporates several provisions to facilitate faster deployment of solar energy. For instance, it encourages full rooftop utilization for solar PV by allowing rooftop PV system owners to choose a smaller feed-in tariff while using some of their rooftop-generated power themselves or receiving additional remuneration on top of the standard feed-in tariff if they feed in 100% of their rooftop power. Households that decide to export all solar electricity to the grid will receive the full feed-in bonus of €0.048/kWh, raising total remuneration to €0.134/kWh.

The amended remuneration scheme has been particularly attractive to the investors with little or no self-consumption needs and in turn encourages them to have maximum usage of available roof space. The law also revoked the limitation to sell electricity to the grid for mid-size rooftop PV systems, implemented by the earlier government. The new government also presented a new package that included an increase in solar capacity, to be allocated through tenders, and the mandatory installation of PV systems in all commercial buildings. The solar obligation for commercial buildings stems from several German states deciding to require solar installations for new buildings. As of 1 January 2022, North Rhine-Westphalia (NRW) and Baden- Württemberg are the first two German states to implement a solar-PV obligation for certain construction projects. The states of Berlin, Hamburg, Rhineland-Palatinate, Bavaria, Schleswig-Holstein, and Lower Saxony have adopted similar laws introducing the solar PV obligation from 2023 onwards.

Support in terms of tax benefits for small-scale solar is also in place. For example, under the Annual tax Act 2022, operators of PV systems with an output of up to 30KW on a single-family home or commercial property will no longer have to pay income tax on the electricity yield from the beginning of 2023. This tax exemption also applies to multi-family houses and mixed-use properties owning a PV system with an output of 15kW. In addition, the value-added tax (VAT) will no longer be due on the purchase, import, and installation of PV systems and energy storage systems.

Germany's Federal Network Agency "Bundesnetzagentur" has increased the price caps for the auctions for onshore wind and solar energy in 2023 in an effort to make renewable energy tenders more attractive and draw stronger interest following the sharp drop in bids observed in 2022. As a result, the country's first solar auction of 2023 was oversubscribed with 347 bids, totalling 2.87GW submitted for a tendering quantity of 1.95GW of ground mounted and non-building solar systems.

Market Opportunity

The renewable sector of Germany received a major boost when European Commission approved the German government's €28 billion support scheme for renewable energy in December 2022. This scheme is designed to accelerate the adoption of wind and solar power and will replace an existing renewables support scheme, running until 2026. Notably, the country has a broader plan to spend up to €200 billion in subsidies to shield consumers and businesses from soaring energy costs.

In Germany, the growth of solar PV installed capacity is anticipated to be primarily driven by rooftop solar installations, encompassing both residential and commercial and industrial (C&I) segments. Additionally, ground-mounted facilities such as Agri-PV and residential battery storage get increased importance. A study by the transport and infrastructure ministry (BMVI) estimates that an additional 150GW of solar capacity can be installed in buildings in the country.

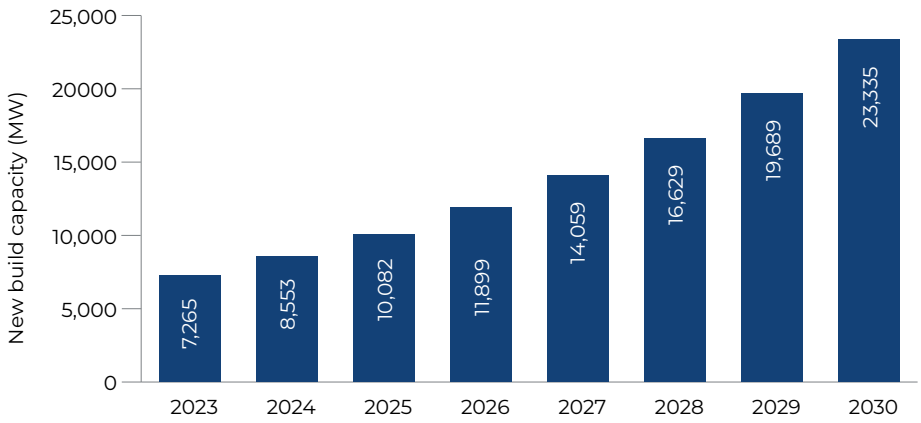
Germany, being the largest importer of Russian gas before Ukraine war, has been at the epicentre of the energy crisis in Europe. It is now leading the charge in the energy transition in Europe to meet the energy demand of its massive industrial sector. Big companies are investing in the latest technologies to ramp up the adoption of Solar PV. Meyer Burger is looking to commercialize solar panels using perovskite tandem cells as it ramps up production in Germany as these cells increase efficiency and generates more power.

The German government is also planning to use CfD (Contracts for Difference) as a funding tool to reduce industrial carbon dioxide emissions. The draft plan proposes that companies committed to cutting carbon dioxide emissions by more than half using innovative technologies could be eligible for 10-year CfDs.

Germany

Outlook

Germany Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

The government's vision to exit coal and nuclear-based power generation by 2030 from the previous target of 2038 led to multiple policy framework alterations. As the leading segments in the renewable energy sector, wind and solar will lead the way towards a zero-emission target. However, the pace of capacity expansion has been inadequate. In order to make a strong stride towards meeting the country's long-term ambition, barriers such as distorted costs for grid connections, and sluggish permission and grid connection processes need to be addressed first.

A top priority among these is to expedite the approval process. The solar parks need around 30 different permits before construction. Thus, clear guidelines for solar expansion need to be drafted for a rapid deployment of the technology.

Similar support measures are required for the C&I sector as well. These would include removing funding caps and investment barriers for an accelerated expansion of the segment.

While Germany may have lagged behind some of its European peers in terms of deploying front-of-the-meter battery storage, especially in comparison to countries like the UK and France, the residential sector in Germany has consistently demonstrated strength. Homeowners in Germany have shown a growing interest in backing up their residential PV systems, especially in response to high retail power prices. Over the next 5 years, Germany is expected to continue to be the key European market for home batteries.

Additionally, the PPA market is anticipated to experience strong growth in the coming years. Given the active participation of utilities, large investment funds, and private investors in this segment, PPA-based projects hold significant importance for the development of solar energy in Germany. The steep decline in solar power makes fixed-price PPAs an attractive proposition for offtakers, especially as conventional energy prices continue to be high and volatile.

5.1.5

Italy

Italy is one of the major renewable markets in Europe. Solar PV has always played a crucial role in shaping the country's renewable sector. In order to adhere to the targets set at European level by the "Fit-for-55" measures' package, renewable energy in Italy will need to cover at least 65% of end consumption in the electricity sector by 2030, compared to the 55% initially set in the National Integrated Energy and Climate Plan (PNIEC), for a total of 70GW of additional power.

This translates into an annual capacity addition of 10GW from now until 2030, marking a substantial increase from the roughly 3GW installed in 2022. A major portion of this capacity will be generated from the country's wind and solar assets, which are the most mature of all other technologies. The projects planned by grid operator Terna would make a significant contribution to achieving this goal.

GDP (Current Prices) USD (2022)	2,012.01bn
GDP Growth Forecast (constant prices) (2023-2027)	0.96%
Currency	Euro
Country Credit Rating (S&P)	BBB
Renewable Energy capacity (2022)	59.9GW
Solar PV Share in Renewables (2022)	44%
Renewable Energy Target	Increase the share of renewable energy in the country's total energy mix to at least 30% by 2030 and 55% in electricity generation

GDP Source: IMF WEO, S&P and IRENA

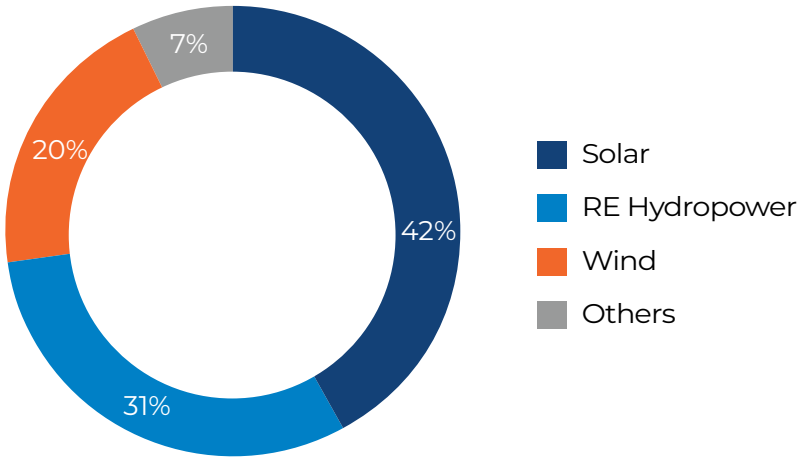
25.07GW Solar PV Capacity

- ✓ Ambitious targets by the National Energy Strategy (NES)
- ✓ Notable growth in recent clean energy auctions in terms of the number of tenders received and expanded investment value
- ✗ Slowdown of solar deployment in the residential segment due to discontinuation of tax relief scheme
- ✗ Insufficient grid infrastructure hindering the solar PV sector from growing to its full potential

Italy

Renewable Energy Mix

Current Renewable Energy Mix



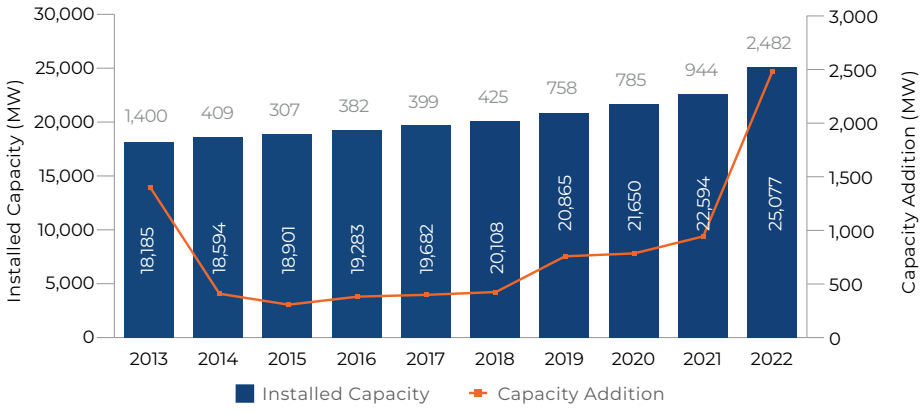
Source: IRENA Renewable Capacity Statistics April 2023

According to TERNA the year 2022 brought considerable market activity following an average growth period. The share of solar PV in the renewable energy mix increased by 2% year over year, diminishing the share of hydropower. According to TERNA, the maximum capacity that came online was in Q4 with 844MW, up from 627MW, 634MW and 377MW in the three preceding quarters, respectively. Solar systems were mostly installed in the northern regions of the country, while systems in the center and south are struggling, despite high levels of solar radiation.

The five most solar rich regions are Lombardy, with 3.2GW cumulative installed capacity (having installed 438MW in 2022), followed by Puglia with 3.1GW, Emilia Romagna with 2.5GW, Veneto with 2.5GW and Piedmont with 2.0GW.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Italy finally returned to Europe's GW Club in 2022 with the installation of 2.5GW of new PV systems. The capacity installation matches with 2010, when the country's solar market was the world's strongest following the introduction of the second feed-in tariff (FIT). A 164% increase in solar PV installations was reported in Italy at the end of last year, from 944MW in 2021 to 2.5GW in 2022, taking Italy's cumulative solar PV capacity to 25.1GW. Official statistics from TERNA show that the total number of built PV plants connected to the grid amounts to 1,221,045, of which 205,806 were built in 2022 alone.

The hike in capacity additions can be directly related to government efforts, specifically the Superbonus 110 tax relief scheme which radically facilitated solar deployment in the residential segment. In 2022, Italy's residential (PV systems below 12kW) deployment proved to be the major market driver with around 1,103MW of new capacity, representing 49% of the total PV installed capacity. Commercial and industrial (C&I) systems ranging in size from 20kW to 1MW accounted for 28%, or 678MW, while utility scale plants more than 1MW accounted for 23% or 571MW, representing a 467% increase on an annual basis.

Italy

Demand Drivers

The Italian government has been proactive in promoting renewable energy, with the National Energy Strategy (NES) setting ambitious targets. A commitment to reach 71.2GW of solar capacity by 2030 has fuelled the growth of the solar industry and attracted investor interest. With the DL Energia decree, the Italian authorities introduced new provisions aimed at reducing energy bills for households and businesses. As part of these new provisions, permits for installing commercial rooftop PV systems with a capacity between 50kW and 200kW are simplified significantly, which can be operated under Italian net metering, called "Scambio sul posto." A further €267 million ($294 million) has been allocated by the Italian government to assist small and medium-sized enterprises in deploying solar panels for self-consumption.

Investor sentiment is boosted from the notable growth observed in recently held clean energy auctions in terms of the number of tenders received and expanded investment value. The state-owned energy service system operator Gestore dei Servizi Energetici (GSE) awarded 94.2MW of solar capacity across 15 locations with PV projects ranging in size from 2.2MW to 15.8MW. The developers received discounts ranging from 2% to 2.12% off the auction ceiling price of €0.065 ($0.070)/kWh. The GSE awarded 294MW of solar capacity in September with discounts ranging from 2% to 2.50% from the auction ceiling price of €0.065 ($0.063) per kWh.

There is a growing demand from the corporate sector for renewable electricity offtake. Unsubsidized solar PV projects are becoming easier to finance thanks to the growth of solar PPAs, which are becoming more common. In a significant development, Enfinity Global signed a 10-year solar power purchase agreement with Statkraft in January 2023. Under this agreement, Enfinity will procure 191GWh of clean electricity annually, sourced from a 112MW utility-scale solar power portfolio comprising three power plants located in the Viterbo province.

Market Opportunity

The increasing adoption of solar PV technology presents an appealing opportunity for the domestic manufacturing of solar equipment. There is a growing need for panel manufacturing in order to reduce dependence on Chinese imports. In a noteworthy development, Enel, an Italian energy company, unveiled its intentions to expand the capacity of its 3Sun solar panel manufacturing facility in Sicily. It currently has a production capacity of 200MW, which will be increased to 3GW by July 2024. A total investment of €600 million will be made, including €188 million as grants received from the European Commission through the pandemic recovery fund.

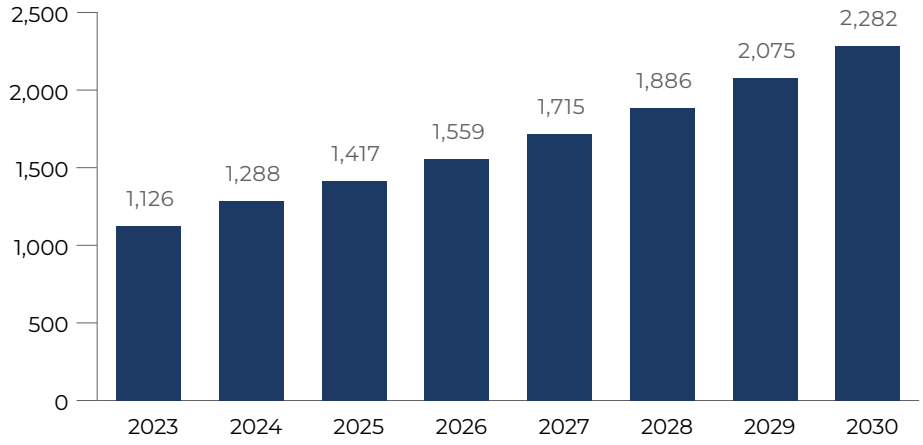
There is substantial development in the technology side as well. In addition to bifacial solar panels, the gradual shift to TopCON N-Type, PERC P-Type, and HJT technologies is reducing costs and enhancing power output. N-type and P-type PERC cells offer efficiency over 25%. Estimates indicate that N-type solar modules will account for 20% of the market in 2023. It is expected that solar cells based on silicon and perovskite will improve performance further, as they have been tested to have a revolutionary conversion rate of 32.5%. These advancements are contributing to the growing adoption of solar technology among Italians.

Italy is also exploring ways to combine solar energy production with agriculture in order to increase solar capacity and maximize land use efficiency. With around 50 - 70 thousand hectares of usable agricultural land, the development of agri-voltaics is bound to have a considerable expansion effect. In 2022, the Italian Ministry of Agriculture, Food and Forestry Policies facilitated a €1.5 billion measure to support solar in the agricultural sector, which involves installing 375MW of PV panels on buildings in the sector, including agro-industrial sites. Enel Green Power, an Italian renewable energy company, will begin construction of a 170MW agri-voltaics solar PV plant in March 2023.

Italy

Outlook

Italy Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

According to Italia Solare Forum, Italy is expected to significantly overcome the historical permission bottleneck for solar PV power plants in the coming two years, potentially pushing installations to 4GW in 2023 and 8GW in 2024. A major portion of this growth will be attributed to the C&I and utility segments after the slowdown of the residential market due to discontinuation of Superbonus 110. On another positive axis, renewable energy will also benefit from the deployment of over €200 billion of European spending power that could radically improve growth and investment prospects.

The sector will gain further traction through agri-voltaics. As of February 2023, there is a backlog of 19GW of Environmental Impact Assessment requests for agri-voltaic plants over 10MW. Notably, NextEnergy Group company Starlight has initiated a ground-breaking agri-eco-voltaic project in Italy called Land of the Sun. It is currently in the advance stages of development and, when completed, will cover around 140 hectares with an installed capacity of 87MWp. However, there are challenges for the agri-voltaic sector to develop as the deployment of agri-voltaics could be stalled by cost factors, since agri-voltaics are 25% more expensive than traditional PV arrays in the case of permanent crops, and 60% more expensive in the case of arable crops.

Energy-storage coupled with solar PV technology is expected to play a crucial role in Italy's aim to become independent of Russian gas by the second half of 2024. Thanks to generous incentives and rapid growth in the residential solar sector, energy storage in Italy has boomed because of its ability to reduce the need for gas-fired power plants as must-run capacity, thereby reducing reliance on imported energy. As of September 2022, approximately 1,59,274 storage systems were installed, for a total power of 949MW and a maximum capacity of 1,816MWh. Most units are connected to a photovoltaic plant, 97% of which are residential.

The biggest obstacle in Italy's solar PV sector to reach its full potential is the insufficient grid infrastructure of the country. In a countermeasure the Ministry of Energy Security has approved 22 projects for adapting and upgrading smart grids, making the grid resilient to integrate and manage new PV capacities. Simultaneously, Terna has presented a 2023 Development Plan, outlining its intentions to invest over €21 billion in the next 10 years, which represents a 17% increase from the previous plan. This plan is designed to promote the integration of renewable energy sources, develop international interconnections, enhance the security and resilience of the electricity system, and invest in grid digitalization.

5.1.6

The Netherlands

In the Netherlands, the de-carbonization goal of 2050 is the primary catalyst behind the massive renewable energy deployment in the recent years. The 2019 Climate Act set legally binding targets to reduce greenhouse gas emissions by 49% by 2030, and 95% by 2050, compared with 1990 levels, and to generate 100% of electricity from renewable sources by 2050. By 2030, the government plans on generating 70% of its electricity from renewable sources, primarily solar and wind power. As part of its efforts to reduce dependence on Russian energy imports following its invasion of Ukraine, the government has also initiated several fossil fuel phase-out policies with strict deadlines.

GDP (Current Prices) USD (2022)	993.68bn
GDP Growth Forecast (constant prices) (2023-2027)	1.37%
Currency	Euro
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	32.8GW
Solar PV Share in Renewables (2022)	69%
Renewable Energy Target	Generate 70% of electricity from renewable sources, primarily solar and wind power by 2030

GDP Source: IMF WEO, S&P and IRENA

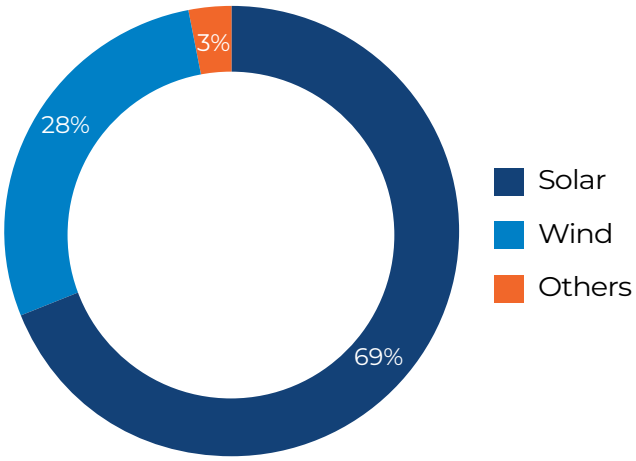
22.59GW Solar PV Capacity

- ✓ Promotion of renewable development through competitive auctions to award operational subsidies
- ✓ Substantial progress made by floating solar deployments and technologies
- ✗ Decline in annual capacity additions anticpated as fewer auctions per year is prescribed by subsidy scheme
- ✗ Lack of grid capacity at the middle and high voltage levels expected to lead to long delays and possibly non-realization of the projects

The Netherlands

Renewable Energy Mix

Current Renewable Energy Mix

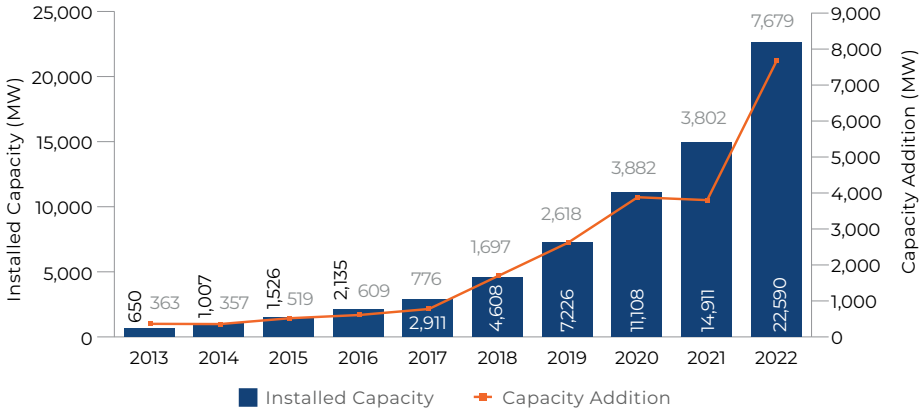


Source: IRENA Renewable Capacity Statistics April 2023

The Dutch energy mix now has a 16% share of renewable energy, compared with 11% in 2020, when it missed a 14% target it had agreed with the European Union. Over the past few years, solar PV has steadily increased its share in the renewable energy mix, more than doubling from 30% in 2016 to 69% in 2022. The 7% year-over-year increase in solar PV capacity has resulted in wind energy's share being decreased considerably. Cumulative PV capacity is now standing at nearly 2.5x of wind capacity.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

There was a record amount of solar capacity added in 2022, with around 7.7GW deployed. The residential segment contributed the lion's share of this growth thanks to an attractive net-metering policy. The C&I segment, on the other hand, has lost some traction due to decreasing subsidies from the SDE++ scheme and increased logistics and technology costs.

Still, the Dutch market retains a good balance among its different segments, which is why it ranks first in Europe in terms of solar capacity per capita. Netherlands reached this remarkable milestone in 2022, when it installed more than 1,000 watts of solar power per capita, 28% more than in 2021. This has widened the distance to Europe's powerhouse, Germany, which had 816W/capita installed at the end of 2022.

In 2022, electricity production remained unchanged compared to the previous year whereas 40% of total electricity production came from renewable sources, up from 33%. Statistics Netherlands (CBS) reported that in 2022, electricity production from renewable sources increased by 20% year-on-year to 47 billion kWh and production from fossil sources fell by 11%. Solar power production increased by 54%, while wind power production was up by 17%.

The Netherlands

Demand Drivers

An important instrument to promote renewable development is the Stimulering Duurzame Energietransitie (SDE++) support scheme that uses competitive auctions to award operational subsidies to new renewable energy projects. SDE++ was implemented after the expansion of SDE+ in 2020, which was designed for large-scale renewable technologies, but did not cover other technologies such as carbon capture and storage. During the period 2011 to 2020, the precursor SDE+ allocated up to €60 billion in subsidies, which are paid over 15 years based on renewable energy production. For the 2022 SDE++ program, the budget was €13 billion, the highest budget for the program to date. Among the largest projects funded by SDE subsidies in 2022 is a 136MW solar farm in Haarlemmermeer, which is 100% locally owned. The project is expected to be finished in 2023 and was developed in co- creation with local citizens.

This SDE++ tendering scheme is the primary driver of the commercial and utility-scale solar energy markets in the Netherlands. Under the scheme solar energy competes with other renewable energy projects and CO2 reducing technologies such as CCS. A total of 2.3GW in solar projects applied for subsidy in the 2022 round, of which 1GW were ground-mounted, 38MW were floating, and 1.3GW were large rooftop installations.

Net metering is another important mechanism for solar growth in the country, which is key to the residential solar market. The Netherlands' net metering system, set up in 2004, allows households with solar panels to offset their green electricity production against their consumption. With the support policy, more than 2 million homes are currently generating renewable energy. However, a proposal by the Dutch solar sector to gradually phase out net-metering with 9% reductions every year until 2031 is awaiting a vote in parliament. This degressive approach is based on a seven-year payback period for the prosumer, assuming 30% self- consumption and optimal system conditions.

Over the past few years, there have been growing concerns from the insurance sector related to rooftop solar installation causing fires, which had a negative impact on the rooftop solar market. Consequently, the Dutch government conducted an independent study in November 2021 that proved there were limited fire risks. Additionally, a code of conduct was developed, which has been in place for a year now, resulting in higher insurability, thereby enhancing commercial solar installations.

Market Opportunity

Netherlands is one of Europe's leading markets for corporate power purchase agreements. Over the period 2014-2022, BNEF has tracked 2,381MW of corporate renewable energy PPAs in the Netherlands. Local companies with high electricity demand and sustainability objectives also contribute to this success.

With available farmland being limited, industry operators have been experimenting with innovative solutions to find space for solar farms. This includes exploring ways to make solar plants work alongside agricultural production. One such project involves growing strawberries and raspberries below a solar panel roof, replacing the plastic cover traditionally used by farmers. In an innovative attempt to utilize land, Dutch solar developer TPSolar installed 23,000 solar panels on a landfill site in Armhoede capable of producing 8.9MW of green electricity.

SCE (Subsidy Cooperative Energy Production 2021) has been successfully supporting the development of cooperative projects among organized citizens and will continue to do so. Additional methods of participation, financial or otherwise, have also been implemented and will be included in the solar sector's Code of Conduct. This ensures a level playing field for commercial project developers and residents.

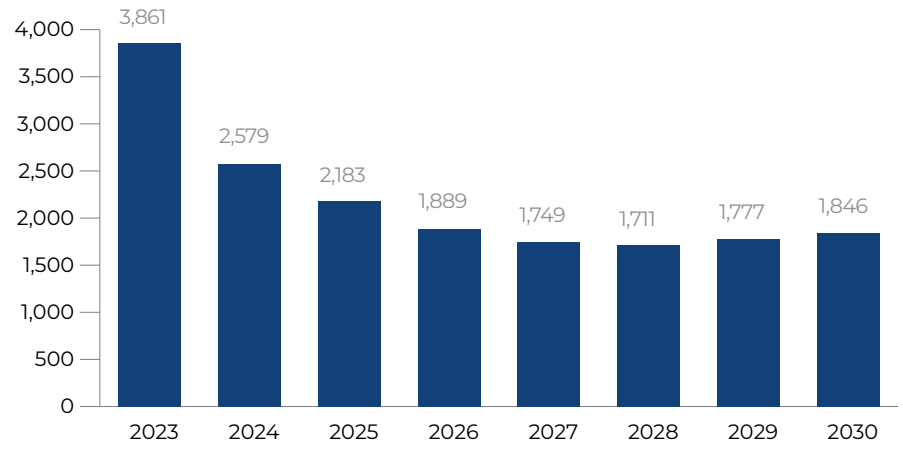
In addition, floating solar deployments and technologies have made substantial progress in the country, thanks to the country's abundant water resources, covering approximately 20% of its surface area. Several solar power developers have taken advantage of this by building farms on artificial lakes. Dutch company GroenLeven has installed more than 500,000 solar panels on Dutch waters. Furthermore, the Netherlands has deployed an innovative floating solar farm that tracks the sun's path through the sky, maximizing energy production. The farm was developed by the Portuguese company Solaris Float that can be installed on lakes, reservoirs and in coastal areas, potentially solving many issues plaguing solar technology.

There has been a growing appetite for large-scale battery energy storage systems in the country, primarily to tackle the shortages of renewable capacity on the grid caused by grid constraints and procedural delays. The storage requirement is estimated to be 10GW by 2030. Naturally, movement in the battery storage market has picked up over the last 12 months. The largest operational system in the country was brought online in October last year by GIGA Buffalo, followed in quick succession by the largest under-construction projects being launched by Rolls-Royce and Alfen in November 2022 and February 2023, respectively.

The Netherlands

Outlook

The Netherland Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

There has been a decent level of ambition demonstrated by the newly formed government on the issue of climate change. However, annual additions may decline because the Netherlands' subsidy scheme now prescribes fewer auctions per year and the requested SDE++ budget subsidy for solar PV in 2023 is halved compared with 2022. The government is announcing new actions to support solar development, but they are not yet in place. Examples include deploying additional support for solar on "unsuitable" rooftops and defining solar-prepared building standards.

Based on preliminary studies conducted by the Dutch Foundation for Applied Water Research (STOWA) and the Netherlands Organisation for Applied Scientific Research (TNO), the country has the potential to generate 11GW of solar energy. Furthermore, green electricity demand is anticipated to grow by 10-20TWh by 2030, resulting in the possible continuation of the SDE++ scheme in 2023-2025 for solar and wind projects. It is planned that the new round of SDE++ 2023 will be launched in September this year, with phase 1 to be held on September 5, 2023. Subsequent phases up to 5 will be conducted by October 2, 2023, depending on the subsidy intensity.

The limited capacity of the Dutch power grid could pose a significant obstacle to solar deployment. Lack of grid capacity at the middle and high voltage levels is expected to lead to long delays and possibly non-realization of the projects. Furthermore, the utility-scale segment faces the challenge of securing suitable land for solar installations. Land availability concerns often coexist with concerns about public acceptance when it comes to the use of agricultural land for solar projects. As part of its efforts to address these issues, the industry seeks to ensure a quota of local participation in renewable energy projects and create a biodiversity label for large-scale projects. However, the Dutch government is currently examining ways to alter site planning and financial support to encourage the build-out of more solar farms with better landscape integration.

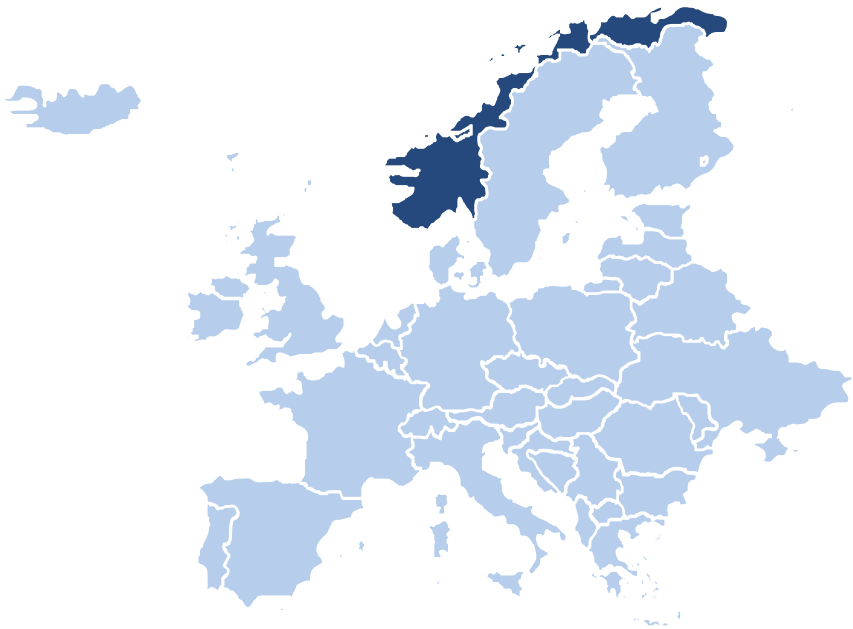
5.1.7

Norway

Norway has been expanding its renewable energy base over the years to achieve the ambitious target of carbon neutrality by 2050. The energy sector programs of the country are generally aimed at promoting renewable energy and increasing energy efficiency, resulting in almost entirely renewables-based electricity system, with renewable resources accounting for 98% of generation in 2020 itself. A low solar irradiation level and heavy reliance on an established hydropower market result in solar energy having a limited contribution to renewable energy generation. However, investments in the sector have recently gained momentum, especially in the residential and commercial sectors.

GDP (Current Prices) USD (2022)	579.27bn
GDP Growth Forecast (constant prices) (2023-2027)	1.87%
Currency	Norwegian Krone
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	39.7GW
Solar PV Share in Renewables (2022)	1%
Renewable Energy Target	Targeting 2030 as its carbon-neutrality year

GDP Source: IMF WEO, S&P and IRENA



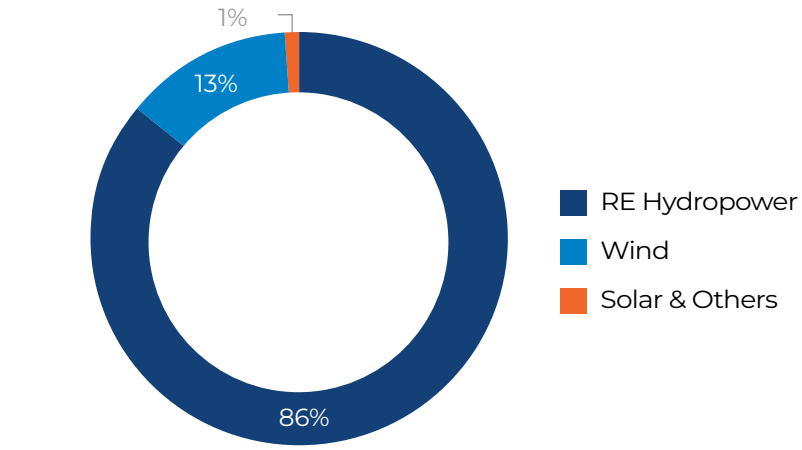
0.321GW Solar PV Capacity

- ✓ Increased support for residential PV installations through the implementation of rebate scheme
- ✓ Ever-growing demand for rooftop solar segment, supported by boosted incentivized efforts by the government and strong manufacturing industry
- × A low solar irradiation level and heavy reliance on an established hydropower market result in solar energy having a limited contribution to renewable energy generation
- × Utility-scale solar segment remains somewhat underdeveloped and stagnating

Norway

Renewable Energy Mix

Current Renewable Energy Mix

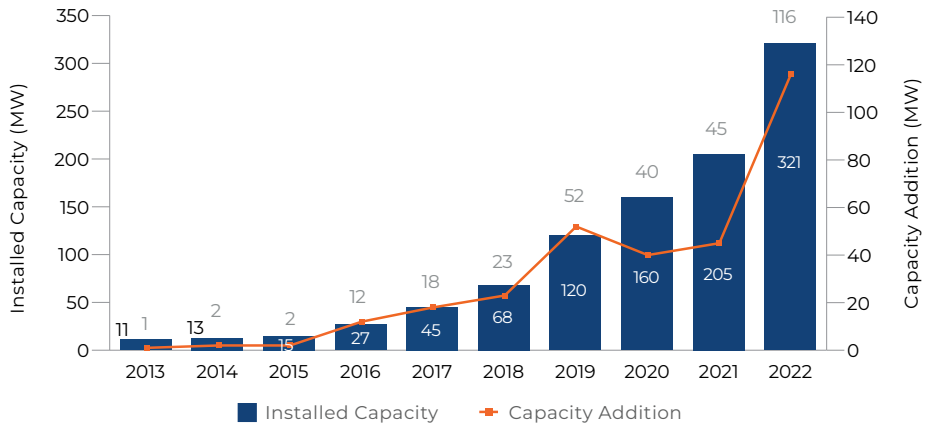


Source: IRENA Renewable Capacity Statistics 2023

Norway's renewable energy mix is dominated by hydropower, accounting for 86% of the energy mix, with wind power slowly gaining more importance. Although the solar industry is growing, it has accounted for only 1% of Norway's renewable energy mix due to a less favourable environment. Various support measures have been included in Norway's programmes for the implementation and expansion of solar energy in the future.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Installed solar capacity in Norway peaked at 321MW in 2022, adding 116MW of new capacity. A continuous growth trend can be observed since 2020, in which the country doubled its installed capacity.

Despite a dip in 2020 due to the Covid-19 outbreak, the solar market has proven its resiliency with a growing capacity, driven by electricity deficits and the need for local energy security.

Installation volume increased dramatically in 2022 due to exceptionally high electricity prices throughout the year. Additional government supports are also made available for the development of solar technology, materials, and solutions.

Norway

Demand Drivers

Norway, being one of the largest producers of oil and gas, relies heavily on the oil and gas sector for its economy and finances. However, the oil & gas sector is also one of the major sources of emissions and the government is continuously trying to find solutions to reduce and prevent greenhouse gas emissions. This is where renewable comes into play as it has a crucial role in reducing overall emissions. Renewable energy plays a crucial role in achieving emission reduction goals, and as a result, the government has implemented a range of regulatory measures to support renewable energy options. It has also pledged to increase the carbon tax to $200 per tonne by 2030, with a yearly increase of 21%. However, despite all government support, the shift towards green energy would be gradual in Norway.

A national PV policy is being implemented to increase the solar potential in the region through its energy sector programs. It is possible for owners of small-scale PV installations to register as prosumers. Prosumers are not subject to the grid connection costs that power providers otherwise incur. It is possible to transfer surplus electricity to the grid at net retail electricity rates (i.e., excluding grid costs, taxes, and fees). A grid connection fee only applies if such installations exceed a limit of 100kW AC electric power feed-in to the grid, excluding own consumption.

To further boost the country's solar market, Norway has increased support for residential PV installations by providing a rebate scheme. The public agency Enova SF increased the maximum PV system size eligible for rebates from 15kW to 20kW and the maximum subsidy amount from NOK1,250 to 2,000 ($226.7) per kW installed. Additionally, the Norwegian government has opened a public consultation for renewable energy systems, including solar, to be exempted from paying grid rent, VAT, and electricity tax.

The three segments of the Norwegian solar PV value chain, downstream national, downstream international and upstream segments are closely interconnected, and knowledge creation and utilisation for experimenting with new or improved solutions is generally strong. Additionally, collaborations between customers and suppliers have been proven to be vital across segments, thereby creating synergy for unlocking new solar development.

Solar energy auction is still an uncharted territory for the country. Solar energy harvesting at the residential level is growing in Norway, but utility-scale installations remain somewhat underdeveloped. Wind and hydropower have been the preferred technologies for PPAs in the country, but solar is still not considered to be the ideal technology for making PPA agreements. Though solar energy has a limited market in the country, Norwegian solar energy developers are increasingly trying to promote and rationalize PPAs within the country and abroad. Norwegian solar developers are expanding the solar market across nations by pairing up with international entities to build international projects.

Market Opportunity

Although the utility-scale solar segment is somewhat stagnating, the demand for rooftop solar segment is ever- growing, supported by boosted incentives from the Norwegian government and strong manufacturing industry. This segment in particular offers attractive investment opportunities.

As part of their efforts to increase solar efficiency in the region, Norwegian developers look for new opportunities to manufacture the latest technologies. REC Solar produces solar silicon using a metallurgical purification method rather than the traditional chemical route to polysilicon based on the Siemens process. NorSun manufactures high-performance monocrystalline silicon wafers with an annual production capacity of 1GW. Research Council of Norway (RCN) and Innovation Norway support investments in solar energy systems pertaining to agriculture, floating solar panels, solar cells, silicon ingots, wafers, and solar panels. Over its duration (2017-2025), the center will spend NOK240 million (USD24 million). In the coming years, Norway is poised to become an important hub for solar technological research and production thereby opening new avenues for investments in the country.

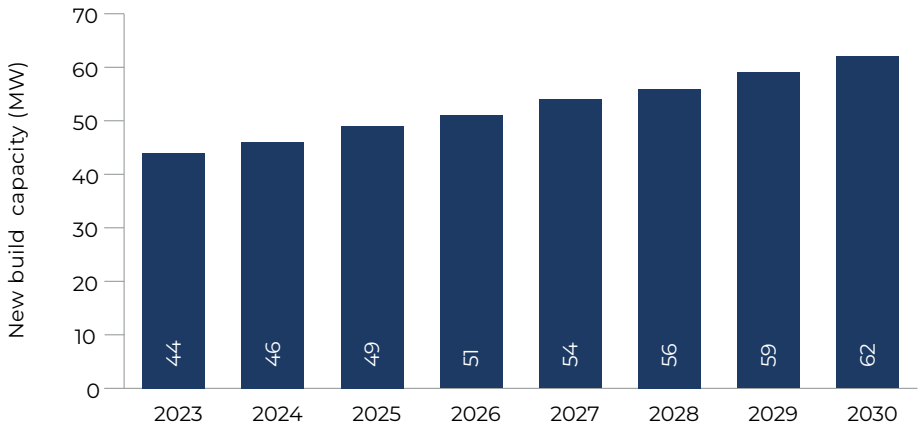
Floating solar provides enormous potential in the sector and offers attractive investment opportunities. It can generate power from coastlines and hydropower reservoirs, freeing up land for other uses. With its expertise and experience in the maritime, offshore, and energy sectors, Norway is ideally positioned to drive technological advancement in this field. Norway's Ocean Sun is one of the companies that specializes in floating solar. The company has developed a patented new technology inspired by the aquaculture industry and will be delivering a floating solar plant for Statkraft's Banja reservoir in Albania.

Norway is actively involved in research efforts aimed at advancing energy storage technology. One of the areas of focus is phase change materials (PCMs) as part of a heat storage system, often referred to as a bio-battery. The ZEB laboratory, operated by the Norwegian University of Science and Technology (NTNU) and SINTEF in Trondheim, uses the latest technological advancement of bio-batteries. Solar energy from the laboratory's solar panels is stored as heat in the bio-battery and can be used to heat the building, especially during the winter.

Norway

Outlook

Norway Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

A primary factor for solar adoption in Norway is its affordability and diverse applicability, since hydropower plants are capital-intensive to build.

Furthermore, hydropower alone cannot meet the soaring demand for electricity during winter, causing the country to turn to fossil fuels to meet electricity needs. Therefore, it is evident that the country's untapped solar potential will be crucial going forward to attain energy security and reduce carbon emissions.

Rooftop solar continues to be a preferred option, supported by favourable government initiatives. On the other hand, the utility-scale solar segment has not been able to gain traction in the country due to the lack of supportive regulatory policies and mechanisms. However, this segment is poised to grow further to meet increasing electricity demand, rising from the emergence of energy-intensive businesses, such as data centres. Moreover, due to Norway's geography and concentration of population in cities in the south, the country requires significant investments in new generation sources and grid expansions to eliminate network congestion problems, which would also reduce the large electricity price differences between regions.

Rising PV system efficiency, growing social acceptance of solar, and regulatory changes for new zero-emissions buildings will turn out to be the driving forces behind future solar expansion. According to data from Germany-based EUPD Research, between 2023 and 2026, the country could add 285MW of residential capacity, 360MW of commercial arrays, and 640MW of large-scale projects.

5.1.8

Poland

Lately, Poland has demonstrated significant growth in its solar energy capacity, owing to a growing adoption of the technology and corporate demand, helped by favourable policy regimes. As a result, in 2022, Poland emerged as Europe's third-biggest solar market. However, its renewable share in the power mix is still insufficient to attain the 2040 target of an emission-free electric system that has a significant percentage of energy generated from fossils and gas. To accelerate the growth of solar energy in Poland, the government has implemented effective policies at both the residential and utility-scale levels, creating an environment conducive to private investments in the solar sector.

GDP (Current Prices) USD (2022)	688.30bn
GDP Growth Forecast (constant prices) (2023-2027)	2.60%
Currency	USD ($)
Country Credit Rating (S&P)	A-
Renewable Energy capacity (2022)	21.2GW
Solar PV Share in Renewables (2022)	53%
Renewable Energy Target	Zero-emissions sources account for 74% of the installed capacity and cover around 73% of Poland's electricity demand by 2040

GDP Source: IMF WEO, S&P and IRENA

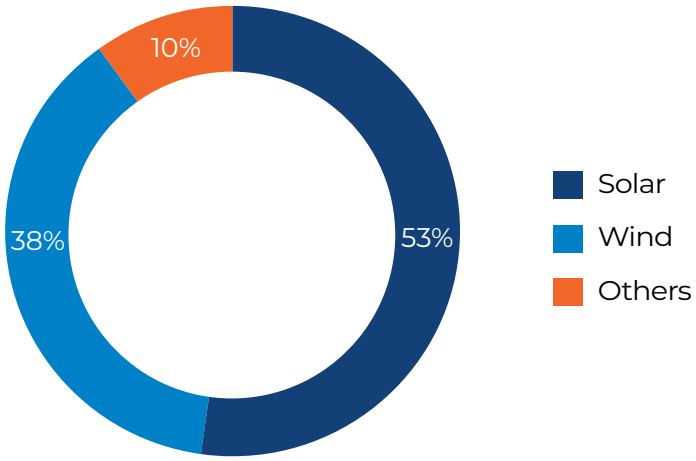
11.16GW Solar PV Capacity

- ✓ Significant progress towards a shift to renewable energy through fiscal support in terms of subsidies, tax benefits and revised clean energy targets
- ✓ The strong PPA activity has enhanced the competitiveness of the solar market, with unsubsidized projects leading the way
- ✗ Net metering scheme has hurdled capacity installation growth and is expected to halt installation by prosumers further
- ✗ Undersubscribed auction ignited by the volatile energy prices and changing regulatory environment

Poland

Renewable Energy Mix

Current Renewable Energy Mix

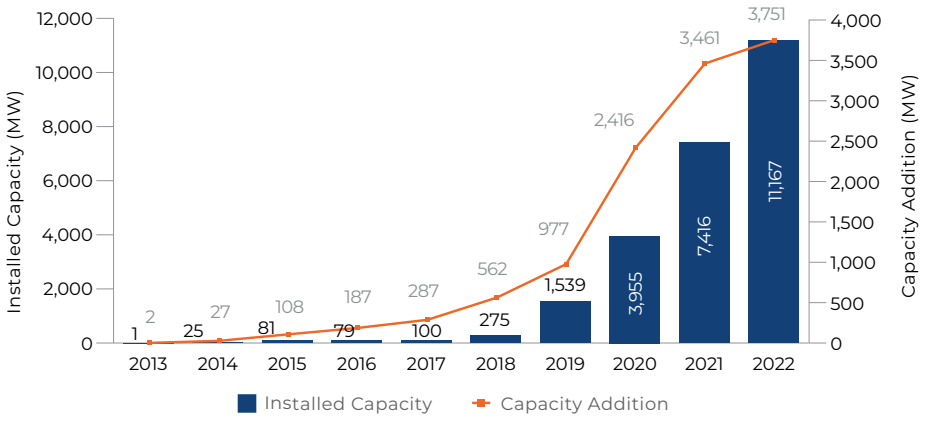


Source: IRENA Renewable Capacity Statistics 2023

Solar energy has become the primary driver of renewable energy growth in Poland, comprising 53% of the renewable energy mix in 2022. This remarkable increase is in stark contrast to the minimal contribution it made in the earlier part of the decade. Over the past five years, the solar energy sector has seen a cumulative growth rate of 108%, largely fueled by the widespread adoption of home solar installations backed by favourable policy support. In line with solar, wind accounts for 38%, and Renewable hydropower and Bioenergy stand at 5%. Despite such contributions towards a green economy, Poland is still vastly reliant on coal for its power generation, and renewable energy accounts for only 36.2% of the total electricity mix (IRENA). This showcases the urgent need for a strong policy-level push to repel the contribution of coal by 2040.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

The solar PV sector in Poland has been recording an exponential growth in capacity addition since 2018, with a CAGR of 92%, taking the cumulative installed capacity to over 11GW by the end of 2022, where distributed- generation PV systems account for around 9GW and ground-mounted solar plants contribute c.3GW. The Polish Government engineered this exponential growth with increased regulatory backing that stimulated sectoral activity, as even during the pandemic, the country recorded remarkable numbers in installations.

The main contributor causing this steep increase is the residential prosumers due to financial assistance and the government's net-metering scheme for micro-installations.

Poland

Demand Drivers

Despite coal's prolonged dominance, Poland has made significant progress toward a shift to renewable energy buoyed by fiscal support in terms of subsidies and tax benefits and revised clean energy targets. As per the 2023 updated "Energy Policy of Poland until 2040", the Polish Ministry of Climate has unveiled the third scenario, mentioning that zero-emissions sources should account for 74% of the installed capacity and cover around 73% of Poland's electricity demand by 2040, which signifies a substantial increase over the previous energy policy of 23% of renewable energy sources in power generation by 2030.

Solar, as the leading renewable energy source, has a crucial role to play considering its substantial irradiation potential in Poland. On the policy side, a notable amendment was brought in early Q22022, as the net-metering system was replaced by a net-billing system, whereby the amount of electricity injected and retrieved from the grid is balanced in an hourly settlement for micro installations. This modified regime incorporates better dimensioning of PV installations and investments in additional equipment like heat pumps and battery storage systems to enable the use of surplus solar energy. Another regiment, the Mój Prąd (My Electricity) scheme was remodified at the end of Q42022 to provide additional benefits to rooftop solar and energy storage systems. Now residential rooftop solar installation can benefit from the 50% increase in subsidy from the previous PLN4,000 and storage installations can enjoy more than 2x increase in rebates of the prior PLN7,500.

Poland has not only focused on supporting small-scale PV systems but has also taken significant steps to promote utility-scale solar projects. In 2022, the Polish Council of Ministers introduced a new auction scheme, recognizing the success of auctions in driving the utility-scale solar market. The government plans to allocate around 9GW of new solar capacity in procurement exercises to be held up to 2027. However, Russia's invasion of Ukraine and the related energy crisis resulted in a disappointing uptake in the latest auction, causing it to be minorly unsubscribed, as in the Q42022 renewables auction, only 336MW of solar capacity could be awarded from a planned allocation of 486MW. Despite this setback, the series of auctions scheduled until 2027 will continue to provide opportunities for Poland to fulfill its climate commitments.

Market Opportunity

With the advent of the geopolitical issue and pressure of decarbonization, the Polish government has been attempting to deploy investments from international institutions to assist the renewable industry. In 2022, the European Bank of Reconstruction and Development (EBRD) made significant investments of approximately €792 million in Poland's green projects. Out of this funding, around €126 million was directed towards renewable energy developers, with €45 million specifically allocated for solar projects. These investments are aimed at enhancing Poland's energy security by promoting the development of sustainable alternatives to Russian gas.

Financial aid provided by international institutions is an indication of the attractiveness of the Polish solar sector, which has resulted in rampant activity taking place in recent times. In association, the Polish government publicized in Q12023 the launch of a PLN1 billion to support investments in renewable energy sources and energy storage in rural areas. Under the same, farmers and energy cooperatives can seek co-financing grants for renewable installations as a subsidy of a maximum of PLN20 million or a loan of up to PLN25 million. Also, financial assistance provided by the state-owned Polish Development Fund has enabled Polish renewable energy investor Lewandpol Group to secure a loan worth PLN90 million for a 200MW solar and wind energy project. Such aids instigate investors to implement ambitious energy projects to accelerate the green transition.

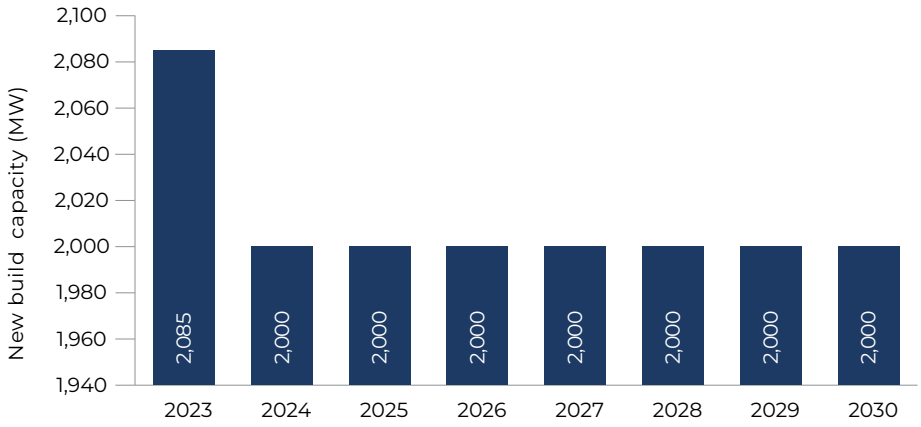
The strong PPA activity, especially due to the higher demand from the corporate sector, has enhanced the competitiveness of the solar market in Poland, with unsubsidized projects leading the way. Notably, Poland's largest solar plant, the 204MW solar park in Zwartowo by Goldbeck Solar, went online in September 2022. The project was able to secure financing with an intelligent combination of CfD, PPA and merchant revenues. In another notable development, Qair Polska signed a PPA to supply 2TWh of renewable energy from its wind and solar plants to a big international company operating in Poland. The company is negotiating contracts with leading brands, which would grow its portfolio to 5TWh.

Moreover, as energy and raw material prices are soaring, Poland is focusing on self-sufficiency to reduce supply-chain bottlenecks, such as in the efforts of companies like the Unimot group, which is actively tripling its PV manufacturing capacity. This can drive substantial investments in the sector.

Poland

Outlook

Poland Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

As per BNEF forecasts solar PV builds are expected to rise sharply in 2023 and maintain a steady pace thereafter.

This growth is attributed to several factors, including the increased production of in-house solar PV modules, the expanded use of floating solar projects, and the potential replacement of coal plants with renewable energy sources.

However, there are quite a few downsides to rapid growth. One such is the country's key deployment scheme of net metering, which after the transformation, has hurdled capacity installation growth and is expected to halt installation by prosumers further. Moreover, the freezing of electricity prices hurts residential PV installation more. On the contrary, a growing demand on the C&I side could be recorded as the electricity prices have not been frozen for them, and companies are pressured to decarbonize under RE100 initiatives. Therefore, the C&I solar segment stands ready to pick up the slack considering the prospects for healthy investments.

Despite uncertainties due to regulatory altercations, utility-scale projects can boom as market prices march towards recovery. However, large power grid investments are needed to enhance the capacity of the grid network to accommodate new utility-scale PV capacities. Another concerning factor is the undersubscribed auction ignited by the volatile energy prices and changing regulatory environment. This, however, has made the PPAs more attractive, which facilitates the merchant solar segment.

In summary, the solar sector has experienced impressive growth in Poland's renewable energy mix. However, it will require a coordinated effort from the public, private sector, and local communities for the sector to play a decisive role in Poland's energy transitions.

5.1.9

Portugal

Portugal's energy mix has historically been dominated by imported fossil fuels. However, imports have been severely affected due to the Russian-Ukrainian war, jeopardizing energy security. Thus, the country has focused heavily on renewable energy, mainly wind and solar, which has helped lower its energy import dependence to below 80%. As Portugal develops its renewable energy base, its dependence on fossil fuels is expected to decline to 65% by 2030. Over the last few years, this sector has grown through a well-structured incentive system and the adoption of ambitious targets.

GDP (Current Prices) USD (2022)	252.38bn
GDP Growth Forecast (constant prices) (2023-2027)	1.72%
Currency	USD ($)
Country Credit Rating (S&P)	BBB+
Renewable Energy capacity (2022)	16.3GW
Solar PV Share in Renewables (2022)	16%
Renewable Energy Target	Aims to generate 80% of its annual electricity usage from renewable sources by 2026

GDP Source: IMF WEO, S&P and IRENA

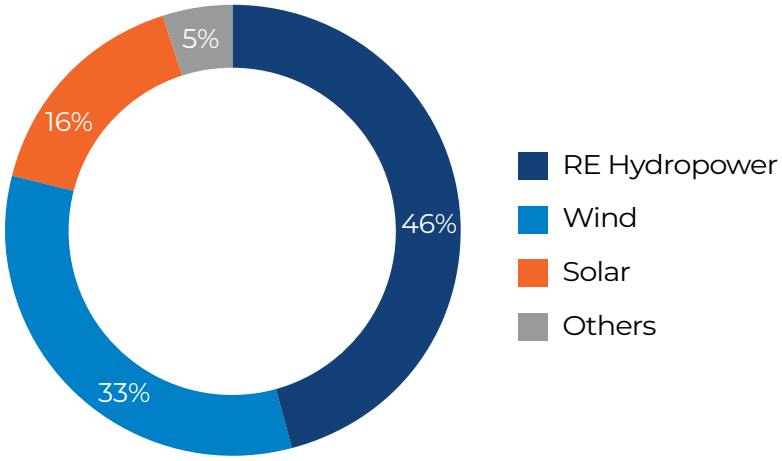
2.53GW Solar PV Capacity

- ✓ Fast tracked the 2030 target of 80% renewable electricity by 2026
- ✓ Government's Plans to mobilise €25 billion in the next 10 years to expand its renewable capacity
- × Permitting hurdles delaying project
- × Grid capacity limitation for utility scale projects

Portugal

Renewable Energy Mix

Current Renewable Energy Mix



Source: IRENA Renewable Capacity Statistics April 2023

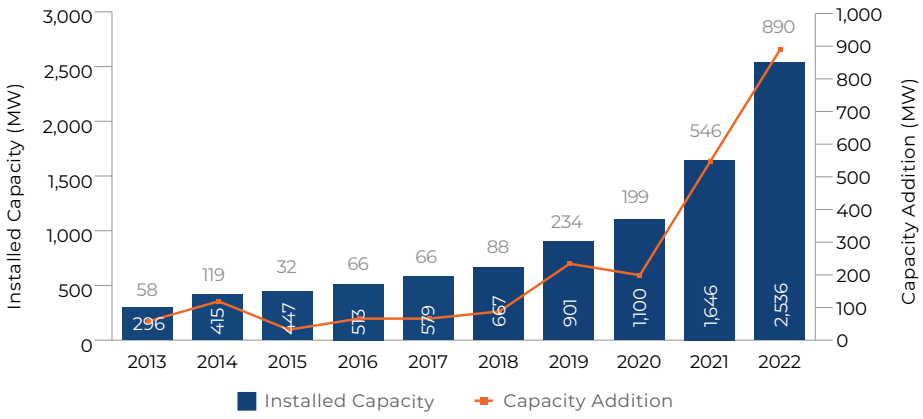
Portugal's new national energy and climate plan for 2030 and roadmap to carbon neutrality by 2050 plays the most important role in decarbonizing the energy sector. A robust push for renewable development was evident when the country fast-tracked its 2030 target of 80% renewable electricity by 2026 through solar energy licensing, wind tower renovation, hydrogen support, and offshore wind development.

Based on the progress made regarding public transportation, hydrogen, and ending coal-fired power stations, Portugal is on track to achieve carbon neutrality by 2045 instead of 2050.

Portugal's renewable energy mix is dominated by renewable hydropower, holding a 46% share, closely being followed by wind power at 33%. Solar PV represented a 16% share in the mix in 2022, growing 4% YoY. The wind and solar sectors are poised to increase their share in the energy mix, replacing slashed hydropower capacity due to droughts.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Solar PV installed capacity has seen slow growth over the years up to 2018, after which capacity additions started to increase, reaching peak in 2022. The government's recovery plan for 2020 aimed to contain the decline in renewable energy overall, thereby generating positive momentum. During the period 2020-2022, capacity additions grew at a CAGR of 52%, indicating a strong market momentum.

Between January and September 2022, Portugal installed approximately 700MW of new solar PV capacity, setting a record. By the end of 2022, Portugal added 190MW of additional solar capacity, bringing its total to 2.5GW.

The growth was primarily driven by three factors, which include the 2019 and 2020 utility-scale auction projects reaching completion and grid connection, rising self-consumption market and the influx of floating solar segment.

Portugal

Demand Drivers

Portugal's long-term goal to generate 47% of its gross final energy consumption from renewable sources by 2030 is the primary demand driver for solar deployment. The country now aims to reach 9GW of solar by 2026, which translates to roughly 1.6GW of capacity addition every year. To achieve this, the country introduced a long-term plan called 'Roadmap to Carbon Neutrality 2050'. In 2022, the government also announced that it plans to mobilise €25 billion in the next 10 years to expand its renewable capacity.

With the European Commission's proposal to promote solar PV installations in buildings, Portugal's decentralised solar PV capacity could grow significantly. To promote the deployment of decentralized solar PV systems on residential rooftops, the Portuguese government offers two financial incentives. One of them is the "Vale Eficiência" programme (efficiency voucher programme), which will distribute 100,000 "efficiency vouchers" of €1,300 + VAT by 2025 to economically vulnerable families, reducing energy poverty and strengthening the renovation of buildings, including solar panels. The other programme is the "Apoio Edifícios + Sustentáveis" (Support + Sustainable Buildings programme) which has a contribution rate of 85% up to €2,500 for the installation of PV panels, with or without storage.

Among other things, auctions have been a strong driver for solar deployment. The auction model was used to ensure compliance with proposed targets in the most cost-effective manner. So far, 2.3GW have been auctioned for injection points to connect power plants where there is still grid availability or where expansion is planned. Besides that, the Decree-Law No. 15/2022 published at the beginning of 2022 introduced two new modalities that will allow the optimisation of the connection point: repowering (until 20% of the injection capacity) and hybridisation. It is expected that several wind farm operators will install solar PV power plants in the following years to maximize the amount of electricity they put into the grid.

Historically, physical PPAs were the most common in Portugal, but financial PPAs are becoming more common lately. Also, merchant solar routes have become increasingly popular in the country, allowing producers and offtakers to negotiate freely. The prior government attempted to define a policy framework for merchant renewables facilities, but the apparent looseness of the permit regime led to a flood of applications. The Direção Geral de Energia e Geologia (DGEG) halted the processing of merchant solar project applications in March 2020, resulting in the benching of a mammoth 253GW capacity. To unlock the held-up potential, Decree-Law No. 30-A/2022 creates a temporary regime that permits power plants to operate without an operation licence or operation certificate if grid injection conditions are ensured by the grid operator. Among notable deals, Statkraft signed a PPA with NextEnergy Capital's solar fund NextPower III ESG in Portugal to procure electricity from 210MW of solar PV plants currently under construction.

Market Opportunity

Portugal has a greater capacity waiting for permits than it has installed so far. There are 1.1GW of production permit requests in the country and another 3.2GW of solar PV awaiting an operating permit. These figures provide insight into the withheld capacity that will be unlocked, offering a plethora of opportunities to investors and operators. The investment injected by Portuguese government in support of international institutions is broadening the spread of the solar activities in the country. In June 2021, European Commission (EC) endorsed Portugal's €16.6 billion recovery and resilience plan, of which 38% will be allocated to the climate objectives.

Also increasing at a promising rate is the capacity of decentralised solar PV, mostly for self-consumption. The first big jump occurred in 2019 when Portugal installed 110MW, bringing the total to 429MW, up from 176MW in 2015. The years 2021 and 2022 were the most productive for decentralised solar PV, with 210MW and 296MW being added respectively, aggregating to 1GW. In the next few years, decentralised solar PV is anticipated to grow at a rate of 250MW per year on average, following the pattern seen in 2021 and 2022.

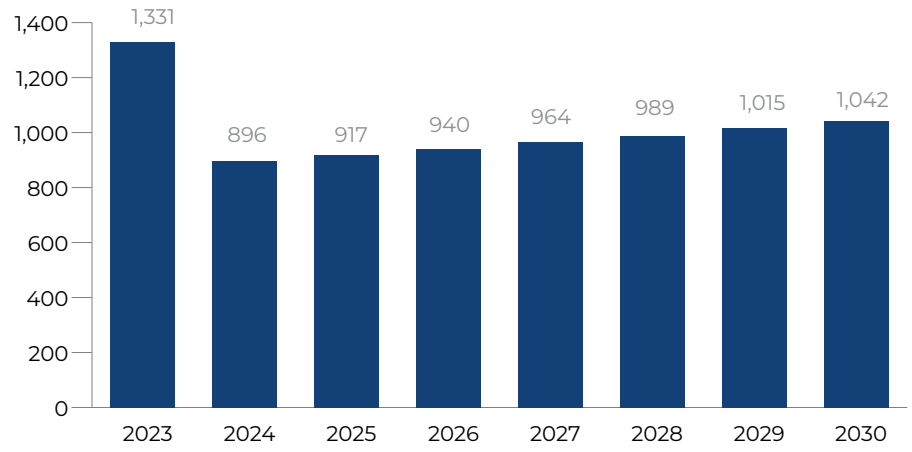
According to the national energy-saving plan, the country aims to add 2.6GW of new solar capacity by the end of 2023. In this context, energy storage will prove pivotal if the country hopes to achieve its solar installation goals. Along with this, the booming hydrogen sector would also provide significant investment opportunities in renewable technologies since most of the electricity used for electrolysis will come from wind and solar power.

Floating solar systems are perfectly suited for the country's dams and other water bodies, and researchers from Évora University have found that the installed capacity may exceed the 7GW target outlined in the country's National Energy and Climate Plan 2030. In May 2023, the Empresa de Desenvolvimento e Infraestruturas do Alqueva (EDIA), controlled by the Ministry of Agriculture of Portugal, launched an international tender for the construction of 5 floating PV plants to capitalise on the untapped potential. A total of €4.3 million will be invested in the five projects, which will have a combined capacity of 4.5MW.

Portugal

Outlook

Portugal Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

In recent years, the solar segment in Portugal has experienced strong growth thanks to the streamlining of permitting processes, increased focus on identifying and resolving grid connection issues, and enhanced policy support. Floating solar generation and decentralised PV will play a critical role in enabling future development. As of now, Portugal is on track to meet its 2026 goals. It is, however, important to adjust those targets to the development of hydrogen and hybridisation potential.

There are some procedural challenges as well. Although significant progress has been made on the long-running environmental impact assessment study, few permitting hurdles remain. It is largely because of a lack of digitalisation and inter-organisational communication, which needs to be streamlined. Grid capacity limitations also create uncertainty for larger solar projects. If grid development does not accelerate, Portugal might not be able to unlock its large solar PV potential. Furthermore, self- consumption remains a limited market, owing to the lack of attractiveness of the government support system.

Despite these challenges, solar PV is rapidly gaining traction in the country and, although rooftop solar has grown rapidly, utility-scale solar will continue to dominate new installations. According to SolarPower Europe's medium scenario, Portugal is poised to add 10.3GW of new PV between 2023 and 2026. In the high scenario, additional solar capacity could reach 15.7GW with subsidy-free solar activity and new renewable hydrogen projects. However, a cohesive strategy including setting higher auction volumes and accelerating deployments is needed to boost investor confidence.

Based on BNEF's forecasts, the solar PV sector is expected to grow overall between 2022 and 2030. After the highest solar PV builds expected to take place in 2023, the activity is projected to dip in 2024. However, from then until the end of the forecast period, PV builds are predicted to grow slowly but steadily. Solar PV builds will be lower by 2030 as compared with 2023, according to projections.

5.1.10

Spain

Spain is one of the renewable energy leaders in Europe, with a cumulative installed capacity of 68GW as of 2022. The Spanish government has made a major commitment to green energy for the next decade and beyond, planning to achieve 160GW of total installed renewable capacity by 2030. The government has also taken a comprehensive approach to phase out coal energy by 2025, decommission Oil-based power plants by 2030, and eliminate nuclear energy by 2035. In 2020, the government submitted its 2030 National Energy and Climate Plan (NECP), which outlines a 23% reduction in greenhouse gas emissions from 1990 levels, a 42% share of renewables in energy end use, a 39.5% increase in energy efficiency and a 74% share of renewables in electricity generation.

GDP (Current Prices) USD (2022)	1,400.52bn
GDP Growth Forecast (constant prices) (2023-2027)	1.78%
Currency	Euro
Country Credit Rating (S&P)	A
Renewable Energy capacity (2022)	67.9GW
Solar PV Share in Renewables (2022)	29%
Renewable Energy Target	Achieve 42% of final energy use from renewables, and 74% of electricity supply from renewable energies by 2030, rising to 100% renewable by 2050.

GDP Source: IMF WEO, S&P and IRENA

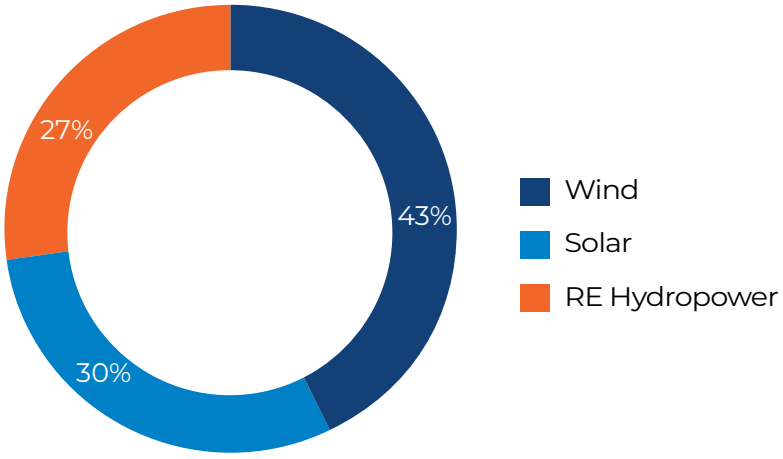
18.21GW Solar PV Capacity

- ✓ Elimination of building permits and simplification of administrative barriers to self-consumption make self-consumption segment more common and accessible
- ✓ Commitment to decarbonization and enhanced energy security lay the foundation for future growth prospects
- ✗ Renewable auction largely undersubscribed as it failed to consider the increased costs of new renewable energy projects
- ✗ Law requiring plants under development to speed up permitting procedures puts heavy pressure on the administrative authorities

Spain

Renewable Energy Mix

Current Renewable Energy Mix

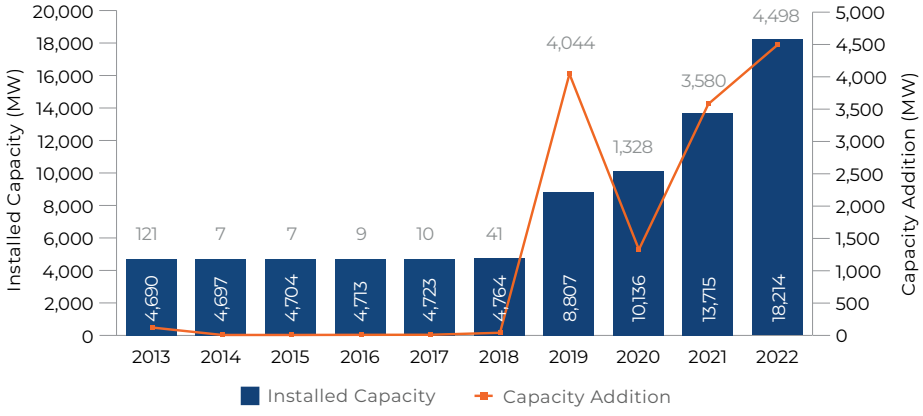


Source: IRENA Renewable Capacity Statistics April 2023

The Spanish government has done an admirable job of ramping up renewable energy in its electricity mix. According to Red Eléctrica, 2022 marked 42.2% of the electricity generation coming from renewable sources. Wind and solar had a banner year, generating 61,176GWh and 31,988GWh, respectively, representing 1.1% and 24.5% year-on-year growth over 2021. Solar power managed to surpass the renewable hydropower, currently positioning itself as the second most renewable power generating technology accounting for 30% of the renewable mix.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

In 2022, Spain added 5.9GW of renewable energy capacity, an increase of 9% over 2021. The increase in installed renewable power has been mainly attributed to solar power, which contributed 4.5GW, or 76%, of the new power installed, marking the largest growth ever recorded. Installed solar PV capacity increased by 29% year-on-year in 2022, driven mainly by the self-consumption segment.

This breakthrough can be largely ascribed to Spain's decentralised government system, high coordination between their local and state level counterparts, and strong supporting policies and tax credits. Furthermore, Spain's geographical advantage of receiving more than 3,000 hours of sunshine per year contributed to accelerated solar deployment.

Spain

Demand Drivers

Since the cancellation of the 'Sun tax' on self-consumption in 2018 and the finalization of the current framework in 2020, rooftop solar capacity increased from 596MW in 2020 to 2.5GW in 2022. The growth was further motivated by high electricity prices, energy uncertainty caused after the invasion of Ukraine, as well as the promotion of the aid contemplated within the Government Recovery Funds. Additionally, eliminating building permits in autonomous communities and simplifying administrative barriers to self-consumption are creating a positive synergy to make self-consumption more common and accessible. According to Spain's Roadmap of Self-Consumption, approved in December 2021, its self-consumption segment could install between 9GW and 14GW by 2030.

Furthermore, the Spanish Government simplified approval procedures through Royal Decree-Law 6/2022. The decree set provisions to conduct self-supply capacity auctions in nodes and provided regulations for floating solar PV plants, thereby unlocking new avenues for PV development. In 2022, the Spanish energy ministry approved changes to environmental planning rules which will fast-track permitting of solar projects with capacities up to 150MW. The streamlined process will remain in place until 2024 and will only apply to projects with a low or medium environmental impact.

A major part of the government's plan to develop renewable energy in the country is through renewable energy auctions, one of the primary tools under the Renewable Energy Economic Regime (REER). Following several successful auctions, the fourth renewable auction in November 2022 was largely undersubscribed. The main reason for its failure was banked upon the fact that it failed to consider the increased costs of new renewable energy projects. However, to renew investor and developer interest, the Spanish government expects to hold the next renewable energy auction in October 2023.

Failure of the latest auction is somewhat offset by the growing corporate PPA market. In 2022, developers signed 8.4GW of PPAs in Europe, where Spain held the largest share with around 3.2GW of disclosed capacity across 31 deals. PPA markets in Spain are driven mainly by post-pandemic manufacturing booms and reduced logistical challenges. Additionally, the gradual decline in inflation, although compensated for by higher interest rates, has given developers greater transparency into their capital expenditures, thereby reducing uncertainty in their PPA calculations. Price drops are expected in Q2 due to an influx of solar supply, putting downward pressure on PPAs. According to the Ministry of Ecological Transition, 132 solar PV projects were approved in January 2023, further confirming the hypothesis that prices will decline. Additionally, the drop in natural gas and wholesale electricity prices is forcing developers to decrease their PPA prices to remain a competitive option for buyers.

Market Opportunity

The Spanish Parliament approved the Climate Change Act in May 2021, setting a dual target for renewables by 2030. Spanish National Climate and Energy Plan (NECP) envisions a solar PV capacity of 39.2GW in 2030 to meet the targets. Furthermore, this plan may be revised upwards in 2023, with new targets for solar PV capacity possibly increasing to 50 to 65GW, since the country has already achieved about 50% of its 2030 goal.

A supportive ecosystem for hydrogen development will also encourage solar development in the region. Through its abundant solar and wind resources, Spain aims to become one of Europe's top producers of green hydrogen. In October 2020, the Spanish government announced a green hydrogen roadmap, which calls for the installation of 300MW to 600MW of electrolyser plants by 2024, and at least 4GW by 2030. Spanish companies have already begun investing in renewable hydrogen projects. Spanish energy company Cepsa has announced plans for a 200MW solar PV project to supply power to a green hydrogen plant in Andalusia. In May 2022, Iberdrola inaugurated the Puertollano Green Hydrogen Plant which is powered by a 100MW solar power plant and 20MWh BESS.

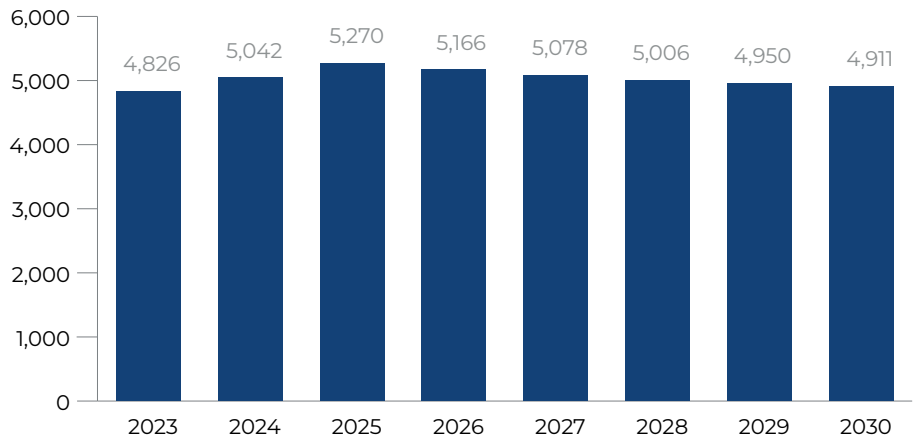
European Investment Bank (EIB) has extended support to the Spanish renewable sector by signing climate action and environmental sustainability financing in Spain totalling record €5.18 billion in 2022, more than half of the total project signatures in Spain. Among notable projects, Iberdrola secured €550 million loan from EIB for the construction of a portfolio of projects with a total capacity of close to 1.8GW.

Spain recorded significant activity in mergers and acquisitions, making it one of the largest sectors in Europe for renewable transactions. In addition to M&A operations, several companies are considering going public, highlighting the strong potential of Spanish solar companies. As of LTM June 2022, a total of 93 M&A deals were announced in Spain resulting in a total deal value of over $27.4 billion.

Spain

Outlook

Spain Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

Growth prospects for the renewable energy sector, particularly solar energy, look promising. A commitment to decarbonization, enhanced energy security, and untapped solar potential lays the foundation. 2023 is a key year for the ecological transition in Spain, where renewable energies could contribute 50% of the nation's electricity generation. As per UNEF, 40GW of renewable power has obtained the Environmental Impact Declaration in January 2023, which will become operational in the next three years.

As for Solar PV build, data projections indicate steeper growth until 2025, when it peaks. In subsequent years, however, annual PV build starts declining, although at a slower rate, until the forecasted year of 2030. As the October 2023 auction approaches, there is certainly a possibility of a change in the slowdown scenario, which will result in a considerable amount of capacity being allocated and built.

Investing in renewable energy in Spain offers a wide selection of plans tailored to investors' risk profiles. However, there is a certain amount of scepticism as renewable energy investors have lost billions in subsidies promised by the Spanish government. Legal claims over the past solar boom in Spain have reached €8 billion; if not addressed, these claims will seriously jeopardize the country's ability to attract new investments in the future.

In addition to reflecting Spain's solar potential, the PV targets set out in the NECP address the persistent challenges of PV deployment in the country. Under the Royal Decree 23/2020, plants under development are obligated to speed up their permitting procedures, which puts heavy pressure on the administrative authorities, who are struggling to deal with the volume of applications. There have also been cases of resistance from certain local communities against utility-scale renewable plants. Therefore, ensuring regulatory stability and streamlining administrative procedures and network access are crucial, especially for smaller PV plants and self-consumption projects.

The government has taken vital steps to address at least one of the key areas, i.e., adequate grid infrastructure to ensure security of supply. In March 2022, the Spanish government approved the 2021-2026 plan for the development of the electricity transmission network. The plan entails an investment of €7 billion, within which nearly €1.9 billion is earmarked for the integration of renewables and mitigating technical restrictions that prevent renewables from being absorbed.

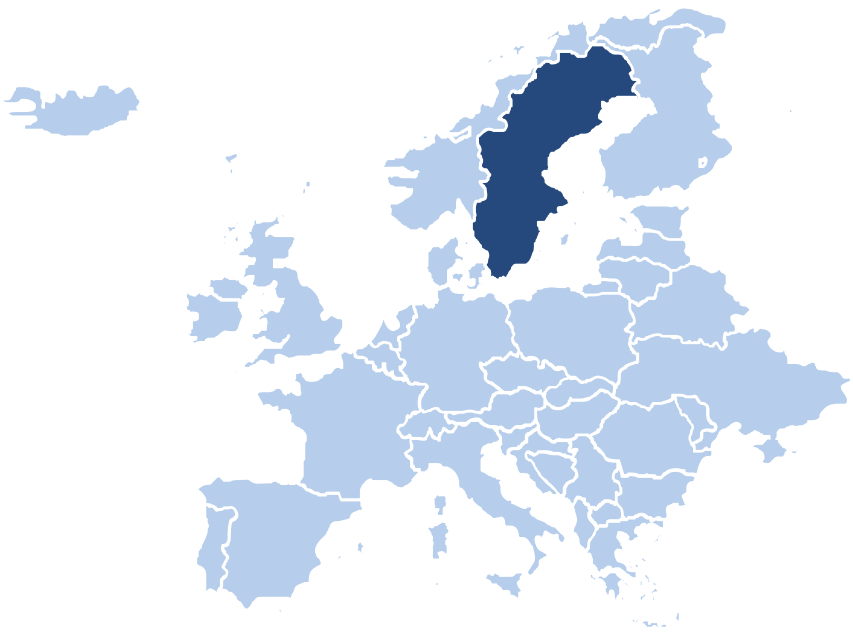
5.1.11

Sweden

Sweden is one of the key renewable markets in Europe. Its renewable sector has progressed primarily due to favourable government policies. In the long term, Sweden aims to source 65% of its generation capacity from renewables by 2030 compared to 23% presently, rising to 100% by 2040. It was the largest electricity exporter in Europe for the first three quarters of 2022, selling over 20% of its total generation to neighbouring countries. Huge, planned expansion of generation capacity will enable it to continue being a powerhouse for Europe, exporting clean and cheap power.

GDP (Current Prices) USD (2022)	585.94bn
GDP Growth Forecast (constant prices) (2023-2027)	1.56%
Currency	Swedish Krona
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	38.04GW
Solar PV Share in Renewables (2022)	7%
Renewable Energy Target	Source 65% of generation capacity from renewables by 2030 and 100% by 2040

GDP Source: IMF WEO, S&P and IRENA



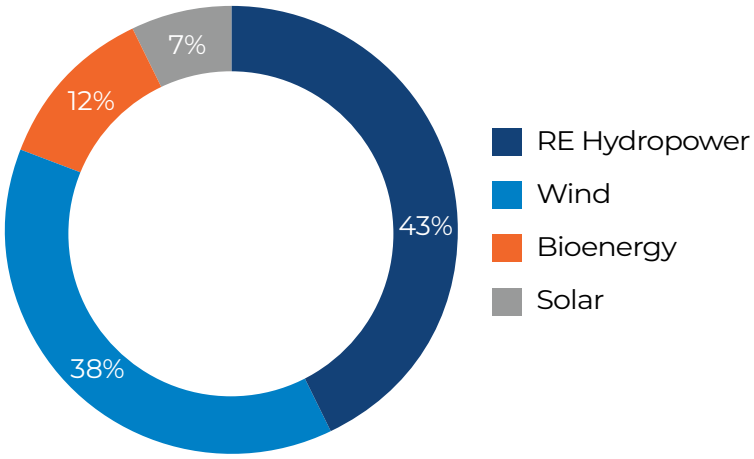
2.6GW Solar PV Capacity

- ✓ Gradual rise in subsidy-free merchant-based utility-scale capacities as developers are getting directly into power sales deals with consumers, thereby accelerating solar projects build out
- ✓ Favourable tax incentives and grants greatly enhance the deployment of solar panels
- × Absence of favourable support mechanism for the utility-scale segment
- × Unsubsidized solar capacity faces delays and cancellations in obtaining permits from local authorities

Sweden

Renewable Energy Mix

Current Renewable Energy Mix



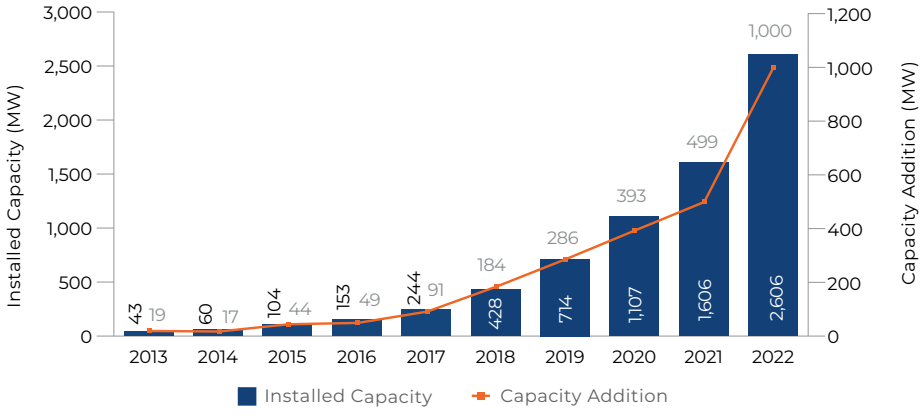
Source: IRENA Renewable Capacity Statistics 2023

The bulk of the renewable energy generation in Sweden is attributed to hydropower and wind, which cumulatively hold an 81% share. Despite holding a minor share in the mix, the solar sector has shown moderate growth over the years, reaching 7% in 2022 from a mere 1.5% in 2018.

The country is tapping into solar energy to address power shortages in the energy market. Along with wind and hydropower, solar is filling the part of the void left by the closure of two nuclear reactors in southern Sweden, which houses the biggest cities and industries. The evident shift from nuclear to more renewable energy is opening a broad scope for potential investors and developers to explore. Additionally, there is a gradual rise in subsidy-free merchant-based utility-scale capacities as developers are getting directly into power sales deals with consumers, thereby accelerating solar projects build out.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Capacity additions have accelerated rapidly since 2018 because of strong government policies. in 2022, Sweden deployed 1GW of new solar PV capacity, marking its entry into Europe's gigawatt scale market. By December 2022, Sweden's PV capacity had reached 2.6GW. The growing interest in solar has also led to a 162% annual increase in requests for grid connection, with 94,700 applications in 2022 compared to 36,200 in 2021.

There have been numerous subsidy-free solar projects built across the country in the last few years. Furthermore, favourable tax incentives and grants have greatly enhanced the deployment of solar panels. Most of the capacity growth is attributed to small-scale systems deployed for residential and commercial/industrial consumer segments. The residential market currently accounts for about 50% of solar capacity installed, followed by the C&I segment at 35-40%, and the utility-scale market at 10-15%.

Sweden

Demand Drivers

The residential segment leads the market, with subsidies primarily directed towards residential solar. After the solar Rebate Scheme got closed for new applications in July 2020, homeowners can now take advantage of a tax deduction policy that encourages the installation of solar panels. The investment cost for installation and material costs are reduced by 15% for PV installations, and by 50% for energy storage connected to PV and EV chargers. Also, for small prosumers there is a tax deduction of 60 öre/kWh (5.5 EUR cents/kWh) for exported electricity, as a light version of net-metering. Starting from July 1, 2022, micro-producers are allowed to generate more electricity than they consume without getting charged for overproduction by the grid company, making it more profitable to install larger PV systems. This excess power is bought at attractive rates by various market participants.

Swedish homeowners have been at the fore front in embracing energy transition. So far nearly 140,000 Swedish small house owners have invested over SEK 8 billion in green technologies. With the help of the government's green deduction grant, they have received almost 2 billion in tax deductions for investing in charging boxes, batteries, and solar systems. Approximately 49% of the deduction went to the installation of charging boxes, while 43% went to solar PV installations.

The closure of nuclear plants, combined with rising energy import prices in Europe due to the Ukraine war, has raised concerns related to energy security and thus has necessitated the need for new power generation facilities. In this regard, energy storage has become crucial and there has been a gradual rise in combining storage to new solar PV powerplants. For example, in December 2022, Alight and Tekniska Verken added 2MW/2MWh battery storage to a 12MW solar park in Sweden making the site the largest solar- plus-storage plant in Sweden. Grants are being provided to standalone storage projects as well. For example, the Swedish Energy Agency granted SEK 2.8 million to a project by Dalarna University, Halmstad University, and Absolicon, for a seasonal storage facility that can store energy from summer to winter. Notably, Elevio Energy Solutions is building Sweden's biggest Energy Storage System (BESS) of 10MW.

PPA-linked large-scale solar PV projects are gradually gaining traction. Stakeholders and organizations are now advocating a rapid expansion of large-scale solar PV farms, especially in Sweden's southern region. A 10-year PPA was signed by Centrica and re:cap global investors for two solar parks in Sweden developed by SunSpark, with a total installed capacity of 9.2MW. In another agreement, Alight and Neoen signed the largest PPA in Sweden selling power to H&M from a 90MW solar project, which is expected to be commercialized by 2025.

Market Opportunity

Investment in the Swedish renewable sector is steadily increasing both from foreign and domestic players due to favourable market dynamics. The merchant power segment is also slowly finding traction. Recently, UK solar company Eco Energy World Limited (EEW) sold its first 42MWdc project to a large Swedish developer. In Sweden, EEW has a pipeline of more than 1GW of solar and battery energy storage systems. Furthermore, Danish developer European Energy plans to build a 128.5MW solar park in Svedberga, southern Sweden. This facility will be capable of producing 175GWh annually when completed in 2023.

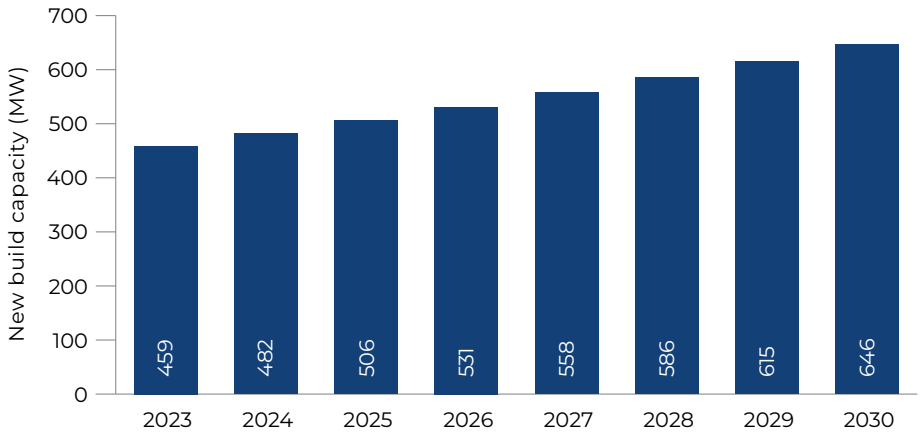
A growing number of startups are also contributing to the generation of solar power. They are actively participating in fund raising rounds to intensify organizational expansion and accelerate energy transition nationwide. Swedish startup SunRoof raised €13.5 million in new investment to bring solar power to homeowners in domestic and international markets.

Accelerated deployment of solar PV parks, coupled with the massive influx of energy-intensive establishments, ranging from data centres to steel manufacturing, has created an urgent need for expansion of the electricity grid. In this regard, the Swedish power grids have budgeted SEK 14 billion investment to increase electricity transmission. The entire project, including the decommissioning of old lines is projected to be completed by 2036.

Sweden

Outlook

Sweden Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

In the absence of any favourable support mechanism for the utility scale segment, the outlook of the solar PV market of Sweden will be shaped by the rooftop solar systems installed in the commercial and residential sector. The rooftop solar or distributed generation segment is likely to continue to benefit from financial incentives. On the other hand, the fate of the utility scale segment will be decided by the opportunities in the merchant power market. The rise of unsubsidized solar capacity is, therefore, essential for expanding the large-scale project pipeline.

The unsubsidized solar capacity is yet to pick momentum mainly due to multiple challenges, most notable among which is delays and cancellations in obtaining permits from local authorities. For instance, local officials refused the application for Sweden's largest solar park, claiming the property would be better used to preserve the country's food supply. Such uncertainties make it difficult to prepare a financially viable business case that can attract investors. Moreover, the predominance of other renewable sources like wind and hydropower has limited the scope for solar PV in terms of long-term opportunity.

Nevertheless, a number of measures have been proposed by the Swedish government to boost Sweden's renewable electricity production, including investments in solar cells, which will prove to be crucial in the long-term development of the solar PV sector. Additionally, the success of ongoing measures to enhance grid capacity will be a game changer in terms of accommodating new solar PV generation capacities and mitigating the permission bottleneck for the ones under development.

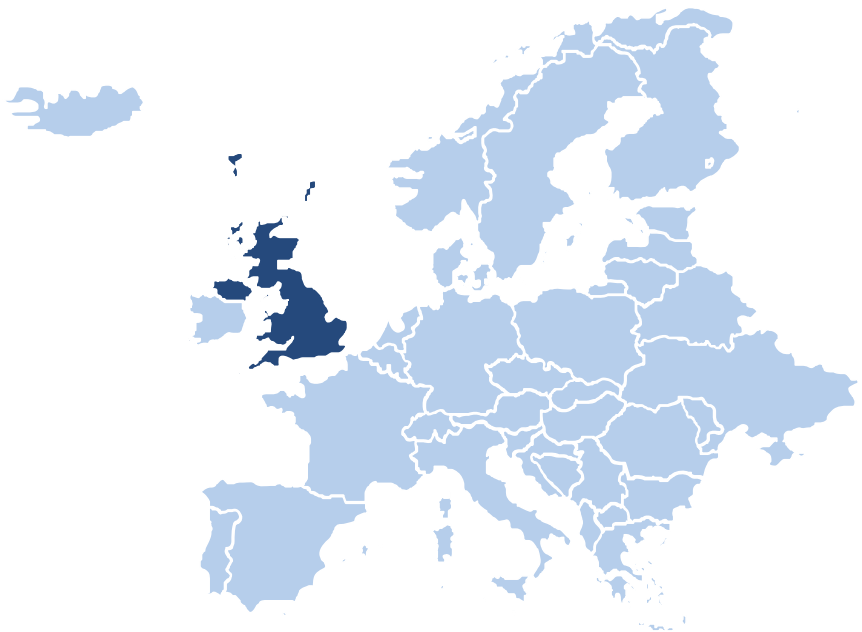
5.1.12

UK

In 2022, the total installed capacity for renewable energy-based electricity in the UK increased by 7.4%, reaching 52.4 GW, up from 48.8 GW in 2021. During 2022, renewables accounted for 48% of the total electricity generated in the country, marking a 1.7% increase compared to the previous year. Wind energy remains the predominant contributor, followed by solar PV.

GDP (Current Prices) USD (2022)	3,070.60bn
GDP Growth Forecast (constant prices) (2023-2027)	1.33%
Currency	Pound Sterling
Country Credit Rating (S&P)	AA
Renewable Energy capacity (2022)	52.4GW
Solar PV Share in Renewables (2022)	27%
Renewable Energy Target	Decarbonising UK's electricity generation fully by 2035, and reaching net zero greenhouse gas emissions by 2050

GDP Source: IMF WEO, S&P and IRENA



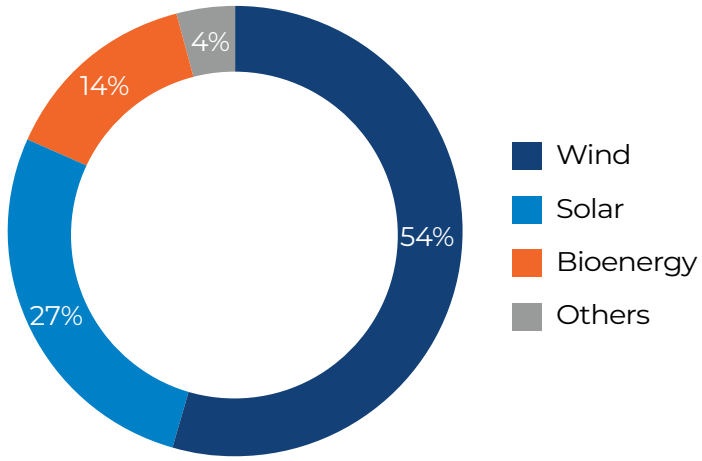
14.4GW Solar PV Capacity

- ✓ Adoption level of storage technology among UK households is growing
- ✓ Subsidized solar contracts through CfD auctions promote expansion in the solar PV project pipeline
- ✗ Delay in existing connection offers for solar projects
- ✗ Issues related to securing the grid and network capacity

UK

Renewable Energy Mix

Current Renewable Energy Mix



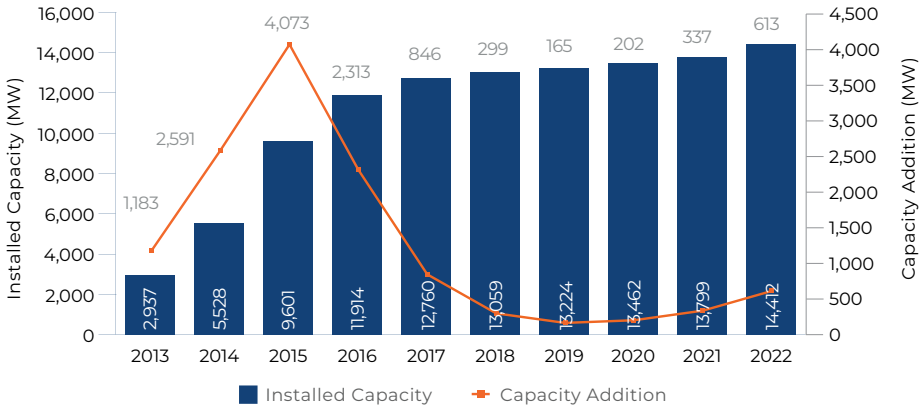
Source: IRENA Renewable Capacity Statistics April 2023

The trend shows a declining contribution of solar PV in the UK's total renewable energy mix until 2021. The fall has been Consistent, from about 34% in 2016 to 27% in 2021. The culmination of several factors, such as premature dilution of government grants, providing less support to private markets, and emphasizing banning of solar projects from farmland have led to this trend. The sector showed signs of recovery in 2022 and solar PV's share in renewable mix didn't fall further.

The shift in the coming years will move towards a more positive trend due to new schemes, grants, and tax exemptions. The rising electricity prices due to the energy crisis have helped the case of solar PV as well by making consumers shift to solar adoption in the region.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Solar PV installed capacity has posted a CAGR of 19% since 2013. Post Covid-19, the market has shown resilience and is growing in capacity addition ever since. High electricity prices due to inflation and a significant dip in the prices of solar panels have helped in the promotion of solar PV usage in the region. The sectoral growth in 2022 is particularly attributed to the Russia-Ukraine war crisis. The energy crisis has propelled the adoption rate of solar PV in order to ensure energy security and reduce dependence on imported coal or gas for energy generation.

Accordingly, there was a spike in solar farm approvals, indicating a possible market recovery. By Q3 2022, the region achieved a milestone with almost 4GW of new solar farm capacity receiving approval, surpassing the 3.1GW that was approved throughout the entirety of 2021.

UK

Demand Drivers

The UK's solar sector is currently undergoing big changes to ramp up capacity addition. While the short-term outlook suggests the annual installation hitting 2GW level during 2023, the government is committed to achieve 70GW of solar capacity by 2035.

The Government's main mechanism for supporting large- scale, low-carbon solar power infrastructure is the Contracts for Difference (CfD) scheme (available for any solar PV project above 5MW capacity), which ensures that eligible technology receives a fixed price for generated power that supports investment from the fluctuating market. In the fourth allocation round, conducted in July 2022 (CfD AR4), a total of 66 solar projects totalling 2.2GW had secured contracts. Developer JBM Solar was the biggest bidder, securing 320MW of contracts, followed by utility ScottishPower and Lightsource bp, which secured 288MW and 130MW respectively.

Contribution in the UK solar sector is coming from all segments of the market, across different rooftop and ground-mount activities. Regulatory requirements have especially helped promote the residential solar segment. As per the latest ECO4 (Energy Company Obligation Scheme), the government allocated a £4 billion budget for 4 years (April 1st, 2022-2026) towards the installation of solar panels. Through this scheme, consumers can save up to £1,600 annually. Additionally, the government has scrapped VAT on solar panels until 2027, post which it will go back to its original level of 5%.

The growth in solar PPA prices in the UK continues the trend seen over the past year, as record high and volatile wholesale power prices make them increasingly attractive. The UK witnessed the biggest increases in solar power purchase agreement (PPA) prices in Europe in Q4 2022, posting a jump of 30% on quarter-on-quarter basis. This steep price increase of PPAs can be attributed to government auctions, as more capacities are being allocated to auctions means less is available for corporate buyers, resulting in demand outpacing supply. Among notable deals, Vodafone signed a ten-year solar PPA with Centrica as the power supplier and MYTILINEOS as the generator. This agreement will cover Vodafone's 44% of annual energy requirements in the UK.

Market Opportunity

Solar-plus-storage systems have emerged as a viable option to reduce price and ensure energy security in response to skyrocketing energy prices, resulting from ongoing geopolitical events. Accordingly, the UK prioritizes battery storage high on its national net-zero agenda. Adoption level of storage technology among UK households is growing, and even big companies are collaborating on solar and battery projects. The British company Amberside Energy and the Copenhagen Infrastructure Partners (CIP) have partnered to develop 2GW of solar and battery storage projects across the UK.

Solar thermal and PV have a substantial role to play in decarbonising the UK's heat supply. Heating currently accounts for around one-third of UK emissions, and solar technologies (including solar thermal) offer an affordable and reliable method for transitioning to clean heat.

The unexplored agri-voltaic sector has high potential in UK as solar power currently covers less than 0.1% of UK land. Approximately 75% of the UK's land is farmland and is best suited for energy generation through solar PV. Necessary backing is available from the government as well since the consensus is that solar and farming can be complementary, supporting each other financially, environmentally and through shared use of land.

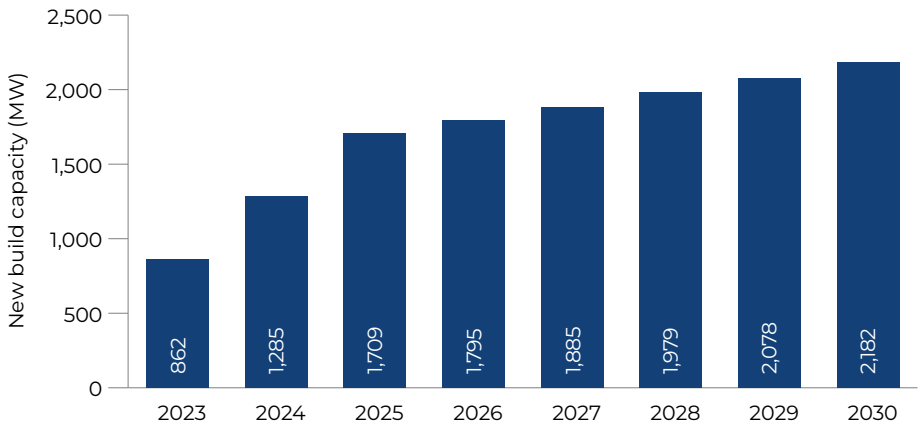
The private sector's interest in the solar PV sector is growing. Low Carbon, the global renewable energy company, is constructing three new large-scale solar farms in Essex, Derbyshire, and Buckinghamshire. The project will receive funding from a multi-bank financing facility of NatWest, Lloyds Bank, and AIB.

The CfD Auction Round Five (AR5) was opened on March 30th, confirming a budget of GBP 205 million for 2023 alone. Continuing the trend of last auction, solar PV projects with over 5MW capacity would compete with other established technologies like hydro and CHP. While the continued participation of solar PV in CfD auctions validates government's funding support for the technology, the subsidized solar contracts through CfD auctions promote expansion in the solar PV project pipeline as well. The steady project pipeline for solar farms in the UK points to the rising investor interest across the spectrum.

UK

Outlook

UK Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

The outlook of UK's renewable sector is primarily shaped by the government's commitment to fully decarbonised electricity by 2035, subject to security of supply and at the same time have among the cheapest wholesale electricity prices in Europe. Alongside other established technologies like wind and nuclear, Solar PV will also have a key role to play in the UK government's objectives, especially because ground-mounted solar is one of the cheapest forms of electricity generation and is readily deployable at scale.

Rooftop as well as ground mounted solar are at equal priority level for the UK government. Rooftop solar is already one of the most popular and easily deployed renewable energy sources in the residential segment. Now the government is looking to facilitate and promote extensive deployment of the technology on industrial and commercial properties. For ground mount solar, the strategy is to deploy across the UK, exploiting brownfield, industrial and low and medium grade agricultural land. A solar government-industry taskforce will be established in this regard and a solar roadmap will be published, setting out a clear step-by-step deployment trajectory to meet the 70GW capacity target by 2035.

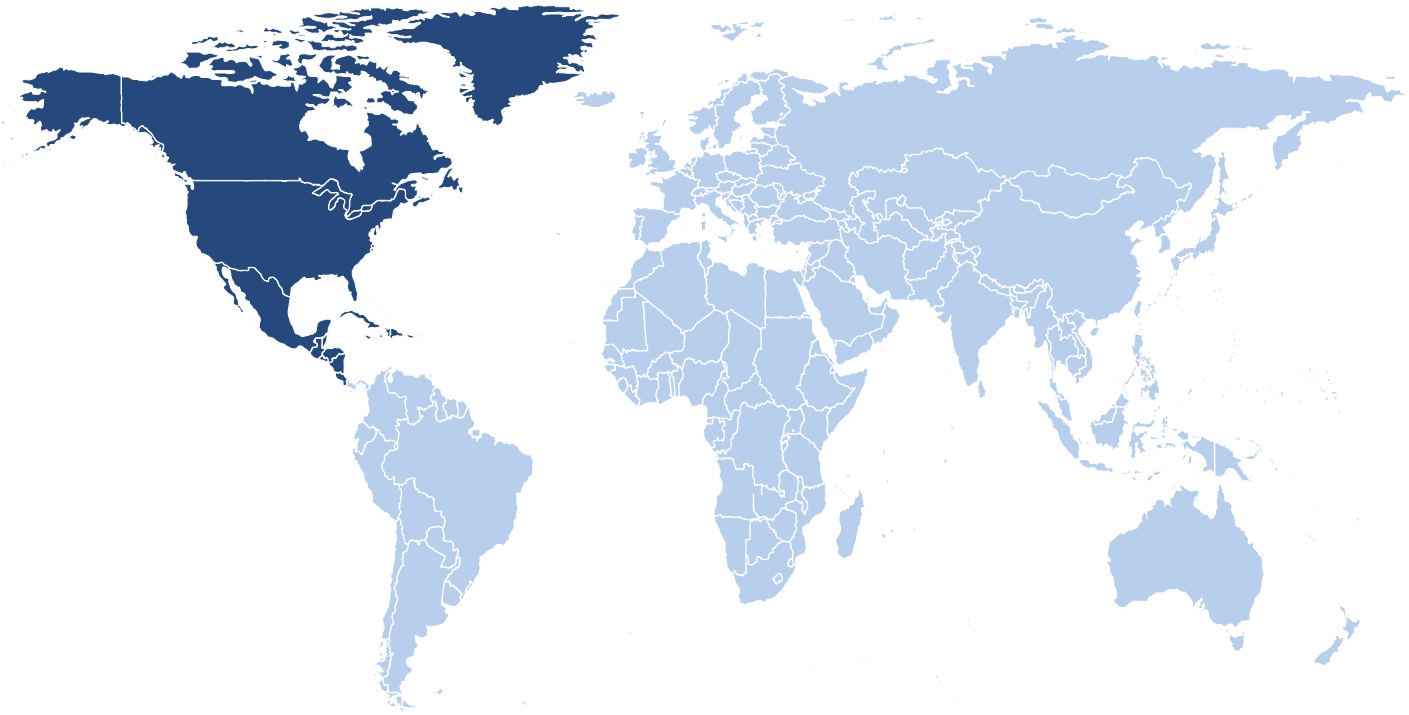
Despite a favourable backdrop and encouraging announcements from the government, the future prospect of the solar PV sector must be weighed by its relative position against other technologies in the renewable mix. Wind energy has always been provided the policy support over the years. Even in the current policy announcements offshore wind receives the first line of support. Furthermore, the funding support for low-carbon energy now also includes nuclear energy.

At an infrastructure level, the government must ensure network infrastructure and grid capacity are in place on a sufficient scale to accommodate new capacities. While recent policy announcements have recognised the need for network reinforcement, the scale of this has not yet been properly acknowledged. There are multiple reports of existing connection offers for solar projects being delayed – sometimes into the 2030s.

For the UK solar PV sector to achieve its true potential, it is imperative to ensure proper resourcing for Network Operators, Local Planning Authorities (LPAs), and Planning Inspectorate (PINS) to help address the issues around securing the grid and network capacity.

5.2

Key Regional Markets - North America



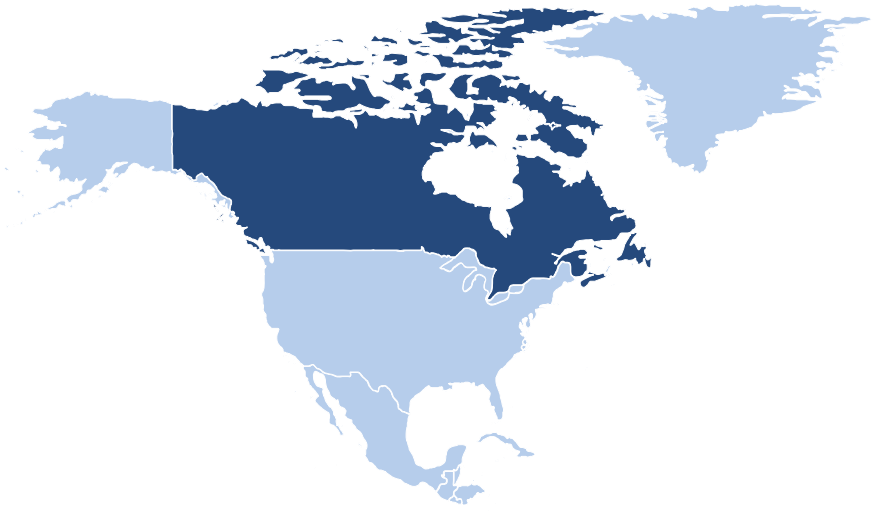
5.2.1

Canada

The solar PV market in Canada is relatively small, and the majority of the country's solar power generation potential is confined to the southern provinces of Alberta, Saskatchewan, and Ontario. Despite considerable challenges posed by the global pandemic, the region's commitment to wind and solar energy continued to grow significantly on the back of favourable policy frameworks to meet its net-zero goal by 2050.

GDP (Current Prices) USD (2022)	2,139.84bn
GDP Growth Forecast (constant prices) (2023-2027)	1.76%
Currency	Canadian Dollar
Country Credit Rating (S&P)	AAA
Renewable Energy capacity (2022)	105.8GW
Solar PV Share in Renewables (2022)	4%
Renewable Energy Target	90% of Canada's electricity to be generated from renewable and non-emitting resources by 2030, and 100% in the long-term

GDP Source: IMF WEO, S&P and IRENA



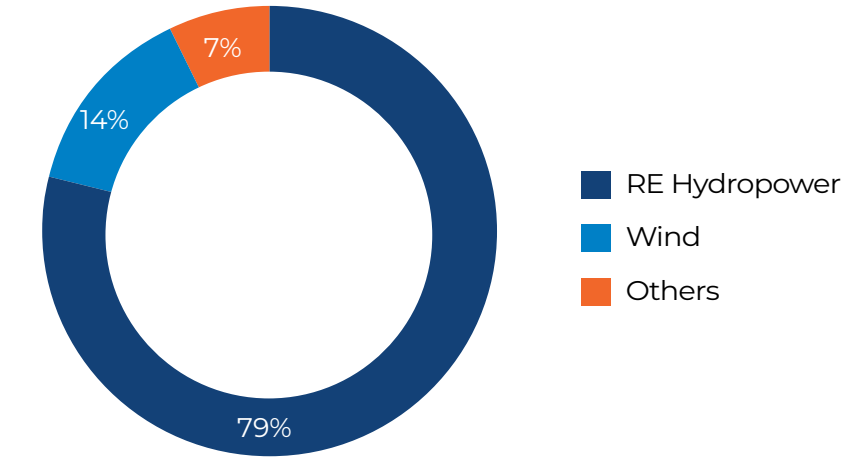
4.4GW Solar PV Capacity

- ✓ Investment tax credits (ITCs) of up to 30% for renewable energy technologies, including solar, wind, and storage
- ✓ Federal initiatives to support solar energy, including the $1.6 billion Smart Renewables and Electrification Pathways Program
- ✗ Variation in funding and support for solar initiatives across different provinces
- ✗ Lack of adequate transmission infrastructure to connect renewable power plants to major cities

Canada

Renewable Energy Mix

Current Renewable Energy Mix



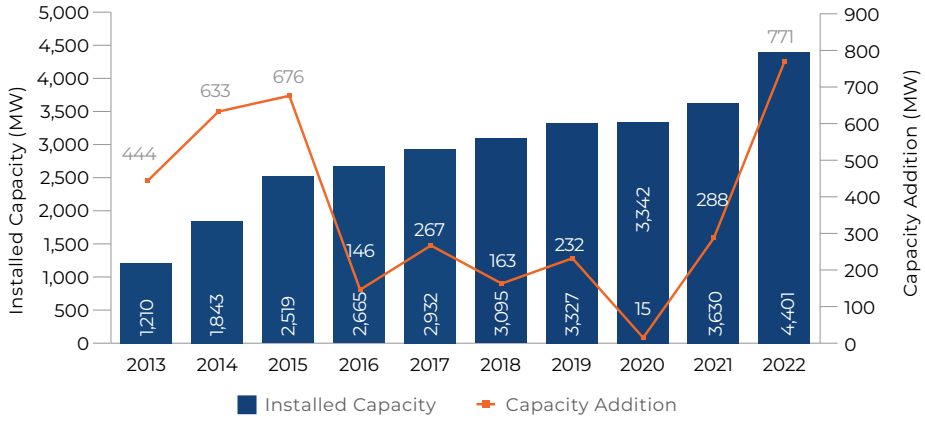
Source: IRENA Renewable Capacity Statistics 2023

Among IEA countries, Canada has one of the cleanest electricity profiles due to its high proportion of nuclear and renewable hydropower. As part of a future mix of low- carbon electricity and to phase out coal power completely by 2030, Canada has started a refurbishment programme to extend the life of the current fleet of nuclear reactors.

As per IRENA data, in 2022, renewable hydropower held the majority share of ~79% of the total renewable installed capacity. Wind and solar had shares of around 14% and 4%, respectively. Most of the new wind and solar projects are located in Alberta, where a deregulated market for surplus power sales coupled with an established market for emissions credit valuation and trade have encouraged investment in renewable energy sources.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics 2023

In 2022 Canada added a record 771MW of solar PV capacity, the highest within the last decade. However, according to the Canadian Renewable Energy Association (CanREA), the annual growth is insufficient to meet the country's target of net-zero GHG emissions by 2050 as it would need to add 1.6GW of utility-scale solar annually to achieve its 2050 vision.

Currently, Ontario is the leading province in terms of renewable capacity (solar 2.6+GW, wind 5.5+GW), followed by Alberta (solar 1.2+GW, wind 2.7+GW). However, due to the phase-out of coal-fired electricity generation and its replacement with clean technologies, Alberta province is expected to overtake Ontario by 2025 to become the country's leading province in terms of renewable activity. PV installation is projected to remain highly inconsistent among the provinces and territories in the upcoming years in the absence of a comprehensive pan-Canadian policy framework with annual capacity targets.

Canada

Demand Drivers

The growth of the solar PV industry in Canada fits into the broader context of initiatives to decarbonize the economy and arrive at a net-zero electricity supply by 2035. The federal, provincial, and territorial governments are working together to achieve the ambitious clean energy goal at the national level. To attract more businesses to invest in renewable energy and close the competitive gap with US companies, Canada introduced investment tax credits (ITCs) of up to 30% for renewable energy technologies, including solar, wind, and storage. This came into effect in March 2023 and will be available until 2034.

Lately, Corporate PPAs have gained significant traction in Canada, particularly as the C&I consumer segment continues to struggle with escalating energy expenses. They desperately seek opportunities to mitigate costs while meeting renewable energy targets. Among notable developments, in January 2023, Canadian power producer Capital Power Corp signed a 15-year deal to supply ~30MW of energy to Shaw Communications. Big organizations such as Microsoft signed 37MW solar PPA with ATCO Group to buy energy in the city of Calgary in the first half of 2022. During the same time frame, Scotiabank and Evolugen announced a ~40MW 15-year renewable energy PPA agreement in Alberta. PPAs have emerged as a primary driver for integrating new renewable energy sources in Alberta.

The March 2023 budget revealed that the Canadian government plans to seek input on creating a comprehensive strategy for carbon contracts for difference. The objective is to enhance the predictability of carbon pricing and facilitate investments required for fostering a thriving clean economy, thereby assisting Canada in achieving its climate objectives. These efforts will supplement the existing contracts for difference provided by the Canada Growth Fund.

Another factor contributing to the increased demand for solar in the region is the growing usage of energy storage. PV module manufacturers are investing heavily in energy storage technologies. Canadian Solar has doubled its energy storage shipments to 1.79GWh in 2022. CSI Energy Storage, a subsidiary of CSI Solar Co. Ltd., launched the SolBank, a proprietary designed and manufactured energy storage battery solution for utility-scale applications in September 2022.

Market Opportunity

Canada holds significant untapped potential for solar energy owing to its extensive land area. This provides considerable growth opportunities, as apart from Ontario no other provinces have made notable progress. Especially in the southern regions of Alberta and Saskatchewan, have yet to fully explore solar energy although they enjoy higher solar irradiation. The introduction of a new renewable energy strategy, the federal government's commitment to a cleaner climate, and the adoption of advanced technologies will further enhance the prospects for solar deployment in Canada.

The federal and provincial governments in Canada are collaborating to achieve their ambitious clean energy objective on a national scale. The Canadian government has implemented various federal initiatives to support solar energy, including the $1.6 billion Smart Renewables and Electrification Pathways Program, the $500 million Low Carbon Economy Fund, the $520 million Clean Energy for Rural and Remote Communities program, and the $100 million Smart Grid program. Additionally, at the individual household level, the Canada Greener Homes Grant offers rebates of $1,000/kW for solar systems with a maximum size of 5kW.

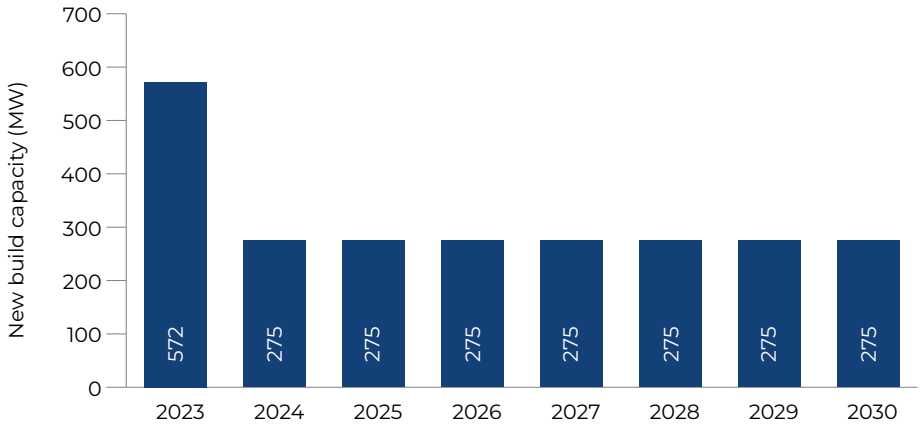
Alberta, with its deregulated electricity market and ambitious carbon tax policy, has set a target to deploy 5GW of renewable energy by 2030. This initiative aims to ensure that 30% of the province's electricity comes from renewable sources by the end of the decade while simultaneously phasing out coal power. As part of this renewable energy push, French renewables developer "Neoen" has commenced the construction of a 93MW solar project in Alberta. The solar plant is scheduled to get commissioned by the first quarter of 2024 and will contribute electricity to the local grid, which is managed by ATCO Electric.

In recent times, the integration of energy storage with solar power has become increasingly popular, serving as a valuable solution for enhancing grid flexibility, efficiency, and supporting Canada's energy transition and decarbonization efforts. Notably, there are significant projects under development that combine solar and energy storage, such as Westbridge Energy Corporation's Georgetown, Sunnynook, and Dolcy projects, which collectively incorporate 300MW of battery storage. Additionally, Jurassic Solar LP's Jurassic Solar+ project includes 80MW of battery storage to complement its solar installation. These projects exemplify the growing trend of deploying energy storage alongside solar power to maximize the benefits of renewable energy integration. Recently, Westbridge Renewable Energy Corp. has started development of its fifth solar-plus-storage project in Alberta. The company is targeting the development of a 295MW solar PV plant with a 100MW/200MWh battery energy storage system at its Red Willow Project.

Canada

Outlook

Canada Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

The expansion of the solar PV market in Canada is consistent with broader initiatives to decarbonise the economy and achieve a net-zero electricity supply by 2035. According to the forecast of CanREA, over 2GW of solar would come online by 2025 based on the strong pipeline. In the longer term, Canada Energy Regulator (CER) anticipates the PV capacity to reach 27GW by 2050 even when no specific capacity targets for PV have yet been set at federal, provincial, or territorial level.

The relatively slow uptake of solar energy in Canada can be attributed in part to the variation in funding and support for solar initiatives across different provinces. Additionally, the overall cost of solar installations remains prohibitive for many homeowners and businesses, limiting widespread adoption. To address these challenges, it is imperative that the governments take a more proactive role in encouraging the transition to solar energy through subsidies and financial incentives.

One of the primary obstacles to renewable energy generation in Canada is to have adequate transmission infrastructure in place to transport the power from renewable powerplants in the countryside to the high demand zones, i.e., the densely populated cities. This poses a particular challenge for utility-scale solar PV projects. Canada has plans in place to improve transmission and infrastructure across the country, with a specific focus on key transmission lines in British Columbia, Alberta, Saskatchewan, Manitoba, and Quebec. Budget 2023 outlines the next steps in the government's plan to build Canada's clean economy and have a cross-Canada electricity grid in place that is more sustainable, secure, and affordable. The measures proposed in this budget are important steps toward the goal of integrating increasing number of new renewable generation facilities into the grid.

5.2.2

Mexico

Thanks to its favourable geographical conditions, Mexico lends itself well to renewable energy development. Solar power is one of the most promising forms of energy generation among all renewable sources in Mexico because of the country's excellent radiation. It is expected to play a crucial role in the expansion of renewable energy and in meeting Mexico's net-zero carbon emissions target by 2050. An average of 300 days of sunshine every year provides significant potential for the growth of the technology. The Government of Mexico's energy transition law, which aims to achieve 35% of its electricity generation from clean energy sources by 2024, 39.9% by 2033, and 50% by 2050, sets the base for overall renewable deployment in the country.

GDP (Current Prices) USD (2022)	1,414.10bn
GDP Growth Forecast (constant prices) (2023-2027)	1.79%
Currency	Mexican peso
Country Credit Rating (S&P)	BBB
Renewable Energy capacity (2022)	31.7GW
Solar PV Share in Renewables (2022)	29%
Renewable Energy Target	35% of electricity generation from clean energy sources by 2024, 39.9% by 2033 and 50% by 2050

GDP Source: IMF WEO, S&P and IRENA

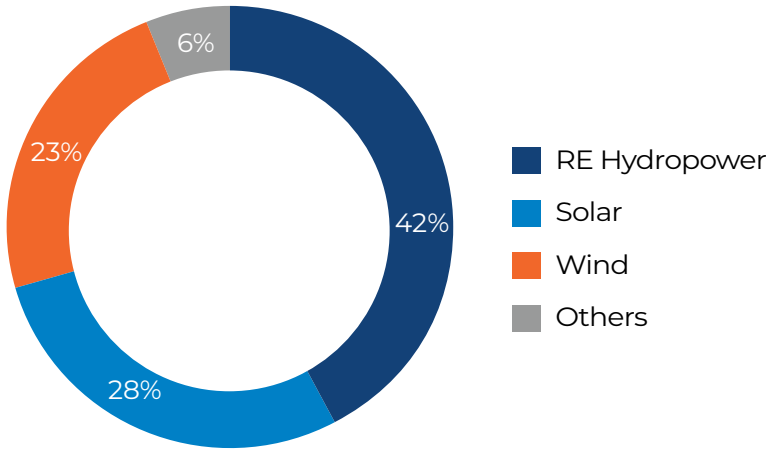
9.0GW Solar PV Capacity

- ✓ Distributed generation increasingly permeating the Mexican energy mix
- ✓ Investment plan largely targeted towards the development of untapped solar potential at locations suitable for large utility-scale solar PV plants
- ✗ Decrease in solar PV deployments due to unsupportive government policies
- ✗ Permit delays, transmission constraints, policy changes, and a lack of return on investment discourages private sector participants from developing and participating in renewable energy projects

Mexico

Renewable Energy Mix

Current Renewable Energy Mix



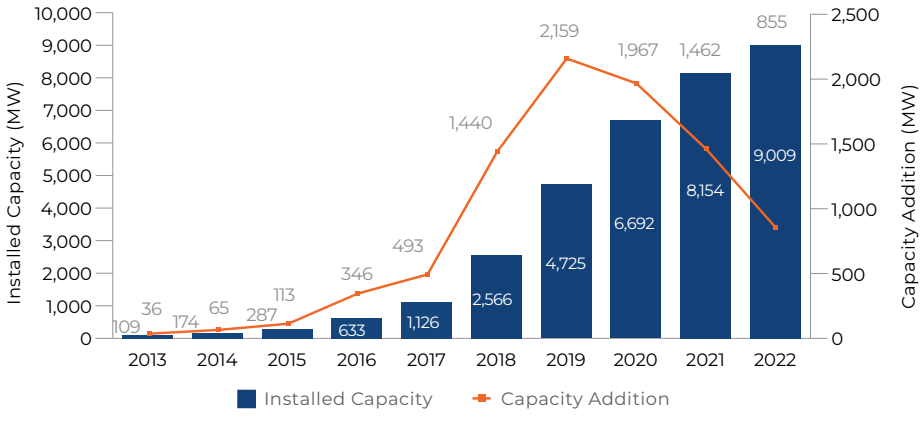
Source: IRENA Renewable Capacity Statistics April 2023

Mexico's renewable energy mix is dominated mainly by hydropower. However, solar and wind energy is gradually displacing hydropower from the leading position. In 2022, the share of solar power increased by 3% YoY, displacing the other technologies marginally. The marginal growth was facilitated by the distributed generation segment following the slowdown of utility-scale generation due to controversial energy reforms.

The share of solar power grew sharply in the last six years to 2022 – it was only 5.7% in 2017. According to NREL, solar has the greatest untapped potential, which could attribute 77% of new renewable energy additions in the next decade. The remaining goes to wind (8.2%), geothermal (7.7%) and additional capacity from existing hydropower facilities (3.7%).

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

The jump in solar PV capacity addition can be observed since the end of 2017 – a period after capacity auctions led to the market entry of leading developers in utility scale PV projects. However, after registering a record capacity addition of 1.8GW on an average between 2018 - 2021, Mexico has seen a decrease in solar PV deployments in 2022 when capacity addition dropped below GW level.

In the last decade until 2021 the constitutional reforms allowed the renewable sector to expand, resulting in significant growth in utility-scale solar and wind sectors. However, since 2021, the pro-fossil López Obrador administration's policies have slowed renewables growth, by granting state-owned entities more control and suspending construction permits. This has stalled a significant portion of the large PV pipeline of the country to be materialized during the last year.

Mexico

Demand Drivers

Although energy regulations have changed, Mexico has taken significant steps toward achieving its energy transition by allowing companies to invest in rooftop solar, also known as distributed generation, and generate their own electricity within their facilities. By policy norms, distribution generation refers to the plant capacities up to 500kW. Such smaller systems are increasingly permeating the Mexican energy mix, especially now that larger-scale projects are being put on hold due to sector uncertainty.

In Mexico, distributed generation is gaining traction because it is the only thing moving forward, unaffected by new policies. In contrast to utility-scale projects, DG projects do not need a generation permit and can be approved in a matter of weeks instead of months or years. Distributed generation has become very competitive in recent years, and local incentives around it are growing quickly, although space and capacity are limited. Consequently, companies are increasingly turning to smaller-scale renewable options to reduce their carbon emissions while avoiding regulatory complications in Mexico. The sector enjoyed an annual growth rate of 45% between 2020 and 2021 and installations have increased significantly over the last decade.

At COP27, Mexico committed to expand its combined solar and wind capacity from 16GW currently to over 40GW by 2030. To expand clean energy capacity as targeted, Mexico also presented a preliminary investment plan for up to $46 billion, which will be largely targeted towards the development of untapped solar potential, as the country has some of the best locations for large utility-scale solar PV plants that remain to be commercially exploited by prospective investors and developers seeking projects at locations with competitive costs. The country's southeast region is particularly rich in this regard.

Market Opportunity

Solar thermal energy is progressing at an accelerated pace in Mexico. With c.4GW of installed solar thermal capacity, Mexico has the largest number of solar heating systems for industry in the world. Despite its dynamism, it still has enormous potential that could trigger investments worth at least US$634 billion. Solar thermal energy along with distributed generation are boosting solar energy's installed capacity, since large-scale projects are being stopped because of uncertainty generated by the new energy policy.

As a result of the energy reform (2013-2014), the industrial sector has expressed a strong interest in renewable energy projects. Private sector participants recognize that there are still challenges to developing and participating in these projects, including permit delays, transmission constraints, policy changes, and a lack of return on investment. It is important to note that small-scale projects face lesser permitting hurdles than larger projects. While these challenges exist, the industrial and commercial sectors offer significant opportunities for energy exports.

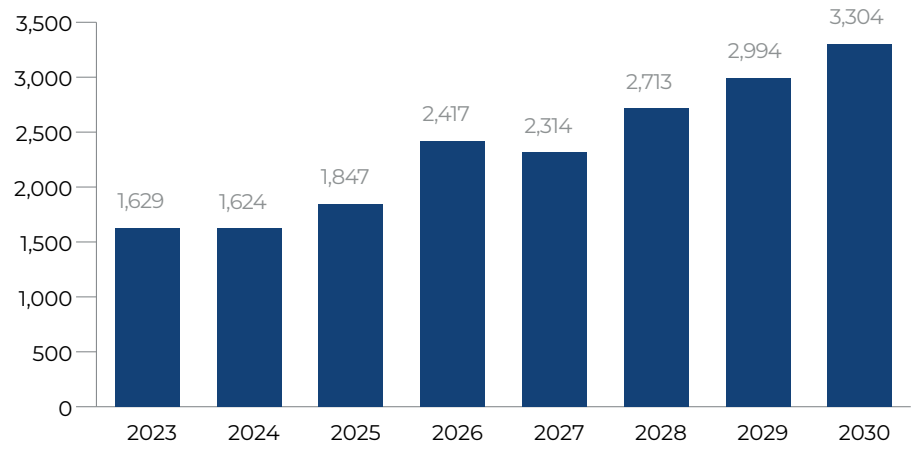
Commercial deployment of energy storage solutions could be a catalyst for the Mexican solar PV market, especially in the small-scale or rooftop solar segment. Although, compared with more widespread developments in the US and several European countries, Mexico's energy storage operations are in their infancy, the advancement of battery materials and related technologies is making this segment more attractive, while at the same time falling battery costs are encouraging smaller energy companies to invest. To combat more frequent blackouts, Mexico has recently developed hybrid power stations that generate solar power and store battery power. In January 2023, The Ministry of Environment and Natural Resources (Semarnat) authorised the construction of a transmission line for the Puerto Peñasco Photovoltaic Power Plant. Once completed, the full $1.6 billion project will have a generating capacity of 1GW of solar PV and 190MW of battery energy storage.

Meanwhile, the grid infrastructure has a significant scope of investment considering the rising demand on the network from varied renewable energy generation resources. In this regard, on June 1, 2022, the Secretariat of Energy ("Secretaría de Energía or SENER") published the 2022- 2036 National Electrical System Development Program ("PRODESEN"), which specifically includes provisions concerning the modernization of the electrical system, which includes combined cycle, transmission, and distribution projects. In addition, Mexico has all of the key characteristics to develop into a robust smart grid market. Earlier in 2020, Mexico's energy regulator Comision Reguladora de Energia (CRE) developed a smart grid Roadmap that highlighted the potential of the smart grid market to reach $12.1 billion by 2023, with annual spending ramping up from $205 million in 2014 to $2.1 billion per year in 2023.

Mexico

Outlook

Mexico Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

Mexico's renewable energy industry is poised to play a key role in decarbonizing the economy, electrifying rural areas, and strengthening the country's transport system through renewable energy. The US Department of Energy estimates that Mexico has the technical potential of 24,918GW of solar PV across its entirety.

Despite ample opportunities for solar investment in Mexico, recent legal and regulatory changes are hampering investors' appetite big time due to risks associated with new project development. A number of reforms have been implemented by the Mexican government that will impede the development of private renewable energy projects. A new set of rules will allow the country's state-run electric company, the CFE, to prioritize fossil fuel-produced electricity instead of less expensive electricity produced from solar and wind. In turn, this fuelled the trend of renewable projects being shelved, mothballed, or cancelled (a total of 11.6GW), which reveals the challenging development conditions in the country, including a lack of legal authority and long approval processes.

These policies are expected to impede the deployment of renewable energy further, at least in the near future, as there is no sign yet for these regulatory uncertainties to be alleviated. As a result, a spike in fossil fuel investments has been observed in recent times. The Global Gas Plant Tracker estimates Mexico has 13.3GW of prospective gas projects, more than twice its prospective solar and wind projects combined (6.7GW). The López Obrador administration has been upholding policies that favor fossil fuel power plants owned by the Federal Electricity Commission (CFE). Therefore, utility-scale solar and wind development interests are unlikely to increase due to the shift in policy focus. Moreover, legal barriers are curtailing foreign direct investment into the renewable sector.

5.2.3

United States

The United States ranks second in the world in terms of solar PV capacity and renewable energy market size. The nation passed its 300GW mark in 2021 and currently stands at 352GW of total renewable energy capacity. Attractive fiscal incentives for renewable deployment from the Biden administration is playing a pivotal role in shaping up the growth trajectory of the sector. The White House has set a target of 80% renewable energy production by 2030 and 100% carbon-free electricity by 2035. A direct impact of such ambitious targets will result in amplified deployment of solar PV, supported by declining system investment costs. Additionally, enhanced government support like the Inflation Reduction Act (IRA) implemented in 2022 will act as a key enabler for solar PV growth by catalysing state aid and private investment.

GDP (Current Prices) USD (2022)	25,464.48bn
GDP Growth Forecast (constant prices) (2023-2027)	1.71%
Currency	US Dollar
Country Credit Rating (S&P)	AA+
Renewable Energy capacity (2022)	351.7GW
Solar PV Share in Renewables (2022)	32%
Renewable Energy Target	80% renewable energy production by 2030 and 100% carbon-free electricity by 2035

GDP Source: IMF WEO, S&P and IRENA

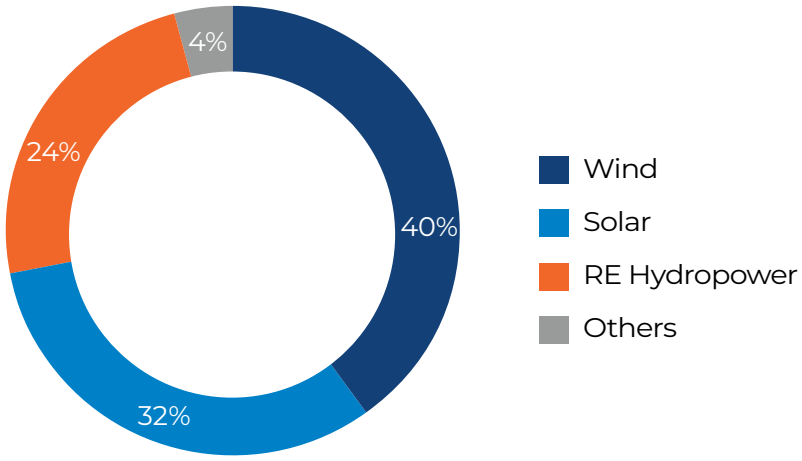
111.5GW Solar PV Capacity

- ✓ Combination of existing policies at the national and state levels have contributed to PV's rapid growth
- ✓ Attractive fiscal incentives for renewable deployment plays a pivotal role in shaping up the growth trajectory
- ✗ Trade law enforcement, supply chain issues, and price hikes for shipping and components caused delays and cancellations of project deployments
- ✗ Department of Commerce's investigation into anti-dumping violations is likely to continue to limit solar technology deployment and challenge supply

United States

Renewable Energy Mix

Current Renewable Energy Mix

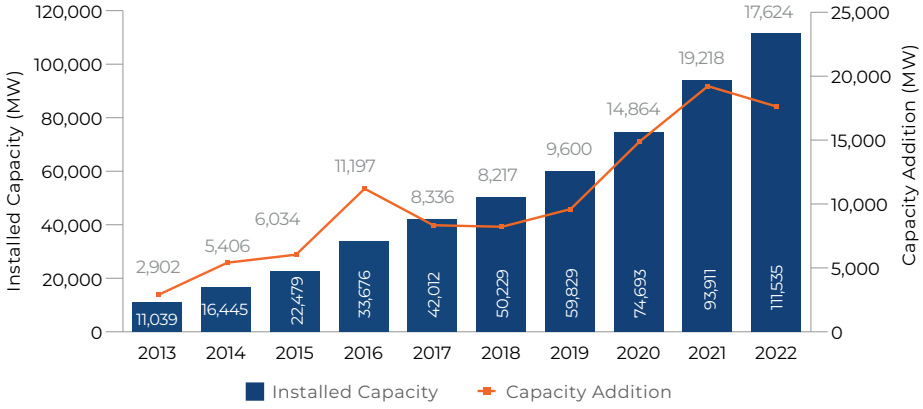


Source: IRENA Renewable Capacity Statistics April 2023t

Conventionally, wind and solar dominate the renewable energy mix. The share of solar power has increased by 3% year-on year, marginally eating into the respective shares of wind, hydropower and bioenergy. Domestically produced electricity from wind and solar in 2022 accounted for 14% of total electricity production. Hydropower contributed 6%, and biomass and geothermal sources generated less than 1%. The Energy Information Administration projected that the wind share of the US electricity generation mix will increase from 11% to 12% from 2022 to 2023 and that solar will grow from 4% to 5% during the same period.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

Annual solar PV capacity addition has generally been on the upswing during the last 5 years, with the country adding c.14GW on an average in the period of 2018- 2022. The US residential solar market continues to be a major growth driver, having added a record breaking ~4.2GW installed capacity across more than 500,000 projects for the first time in a calendar year during 2021. The trend continued in 2022, when capacity addition rose a further 40%, with a record 700,000 homeowners installing 5.9GWdc of rooftop solar. The commercial and community segment installations amounted to 1.4GW and 1GW respectively. Utilities segment installed 4.3GWdc in Q4 of 2022, bringing their annual installed capacity up to 11.8GW. In terms of electricity generation, California led in production with 26% of the national utility-scale solar electricity, followed by Texas with 16% and North Carolina with 8%.

However, PV installation growth in the U.S. dropped during the first three quarters of 2022, from 15.9GWdc in 2021 to an estimated 13.3GWdc by the end of 2022. The decline in 2022 was driven by a ban on some Chinese goods, supply chain constraints and tariff uncertainty in the utility sector, leading to a decline in installer confidence. Despite a slow start, solar PV now accounts for 50% of all new electric-generating capacity additions in 2022, marking the fourth straight year that solar has topped the list of new additions.

United States

Demand Drivers

In the US, both national and state-level financial incentives support the development of the photovoltaic market, although the forms and magnitude of these incentives vary. An executive order signed by President Biden in late 2021, Executive Order 14057, establishes a national level Executive Branch goal of achieving carbon pollution-free electricity by 2035 and net zero emissions economy-wide by 2050. A renewable portfolio standard (RPS) has also been established in 29 states by November 2022, which requires or encourages electricity suppliers to provide their customers with a minimum share of electricity produced by eligible renewable resources (11 of which mandate 50% or more renewable energy).

Historically, national incentives for renewables deployment had been provided primarily through the US tax code, in the form of an Investment Tax Credit (ITC) and accelerated 5-year tax depreciation. In this regard, the Inflation Reduction Act (IRA), implemented in August 2022, has allocated a record amount of capital to the climate and energy sector, resulting in significant changes to renewable energy credits. Most of IRA's record $369 billion investment into renewables will be in the form of tax credits for deployment and manufacturing. The IRA extends the ITC at 30% through at least 2032, then drops to 26% in 2033, and 22% in 2034, before expiring in 2035.

A major boost for solar power producers was provided by the reinstatement of the Production Tax Credit (PTC) under the IRA. It is now possible for solar projects to choose between the PTC and the Investment Tax Credit (ITC) to maximize efficiency, while large land-based wind projects are only eligible for the PTC. Companies like AES Corporation, NextEra Energy, and Xcel Energy plan to increase solar development and are poised to take advantage of the benefits.

Commercial solar adoption has been boosted by corporate clean energy goals. Through June 2022, US businesses have installed nearly 19GW of on-site and off-site solar capacity, which is double the 9.4GW installed through 2019. This recent growth is due to the rapid expansion of off-site corporate solar procurement which now represents 55% of all commercial solar use.

Market Opportunity

After experiencing a relatively lower capacity addition in 2022 with respect to the previous year, the solar industry is expected to return to growth at an accelerated pace from 2023 onwards. Several projects, delayed by procedural roadblocks in 2022, are expected to obtain module supply and come online. And by 2024, the real impacts of the IRA will begin to come to fruition as various ambiguities related to IRA tax credit would have been addressed by then.

Power purchase agreements will be a key instrument for enhanced deployment of renewables in the country. Although historically the PPA prices for wind and solar power remained competitive compared to other sources of energy, the prices have risen considerably recently due to increased capital costs, and supply chain challenges. In 2022 Solar PPA prices were up 8.5% YoY to $49.52/MWh. However, there has been some stabilizing influence in all renewable energy sectors due to the IRA, and supply chain constraints are likely to become less onerous as a result. A higher level of future energy price uncertainty will also inevitably drive corporations and off-takers to seek long-term contracts to ensure stability.

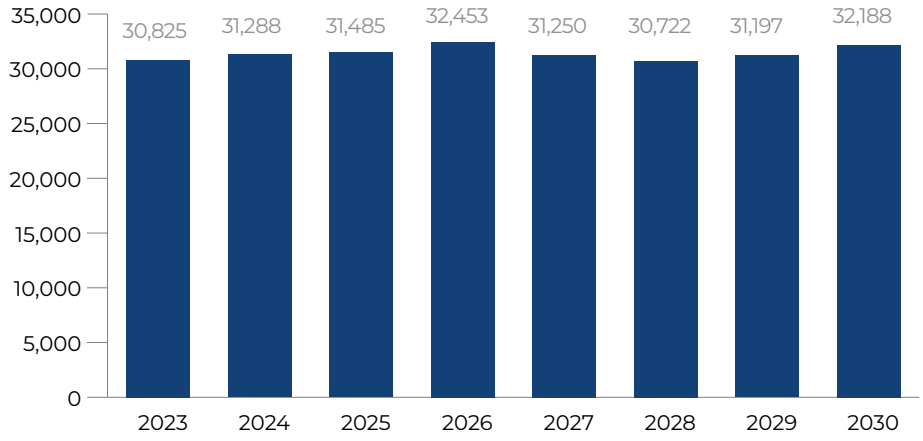
A significant role is played by energy storage in the US renewable industry. In order for the US to achieve its economic and climate goals over the next decade, standalone storage and solar + storage installations must be ramped up dramatically. EIA estimates that battery capacity in the US will more than double by 2023. Developers have reported plans to add a further 9.4GW of battery storage to the existing 8.8GW of battery storage capacity accounted for in recent years.

The US government is actively encouraging indigenous solar manufacturing and recycling to strengthen America's domestic solar supply chain and increase energy security. In April 2023, the Department of Energy (DOE) announced $52 million for 19 such projects, including $10 million from the Bipartisan Infrastructure Law and $30 million in funding for technologies that will help integrate solar energy into the grid. The US is now on track to increase domestic solar panel manufacturing capacity 8-fold by the end of 2024. Further, the DOE envisages the domestic supply chain for solar energy to generate $20 to $40 billion in new investments.

United States

Outlook

United States Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

Delays caused by the pandemic, trade law enforcement, supply chain issues, and price hikes for shipping and components caused delays and cancellations of project deployments at the beginning of the year. Despite this, the second half of the year was marked by renewed optimism, as the landmark US IRA of 2022 approved a record $369 billion in climate and energy spending. After an exceptionally low quarter for project availability in the July-September period, US developers are more confident in marketing projects, with clearer guidance on import tariffs and long- term certainty thanks to the IRA.

Even with diverse market conditions, the US solar industry is poised to grow over the next several years. As per Solar Energy Industries Association and Wood Mackenzie, capacity is expected to grow threefold and reach over 320GW in 2027.

The US PV market, like others, is also plagued with challenges that can hamper its growth despite a rising growth trajectory. The implementation of the new Net Energy Metering 3.0 scheme may threaten the growth of the most crucial residential rooftop solar segment. The California Public Utilities Commission (CPUC) unanimously approved NEM 3.0, altering the mechanism. This means that Californians will be paid 75% less on average for their exported solar production, compared to the previous regime. California will prove to be an experimental subject for the solar industry, which will closely monitor the state's adaptability to the loss in system value.

Moreover, the Department of Commerce's investigation into anti-dumping violations by major international solar panel providers, as well as ongoing international trade and labour concerns, including the Uyghur Forced Labor Prevention Act (UFLPA), are likely to continue to limit solar technology deployment and challenge supply.

5.3

Key Regional Markets - South America

5.3.1

Brazil

Brazil continues to be the largest energy market in Latin America with opportunities across many subsectors. Most importantly, the Brazilian Energy Planning Agency (EPE) Energy Expansion Plan (PDE) for 2021-2031 indicates that renewable energy will remain a high priority in Brazil's energy market, accounting for about 50% of the energy matrix between 2021 and 2031. Further the country also aims to generate 48% of the national energy demand from wind and solar sources by 2027. In addition to historically supportive government policies, well-established infrastructure, and abundant natural resources, Brazil has all the necessary ingredients to support clean energy generation. A surge in wind and solar energy is taking place in the region, with Brazil entering the top ten countries for the first time with the most accumulated installed capacity from photovoltaic sources.

GDP (Current Prices) USD (2022)	1,924.13bn
GDP Growth Forecast (constant prices) (2023-2027)	1.67%
Currency	Brazilian Real
Country Credit Rating (S&P)	BB-
Renewable Energy capacity (2022)	175.3GW
Solar PV Share in Renewables (2022)	14%
Renewable Energy Target	"Generate 48% of the national energy demand from wind and solar sources by 2027. Achieve 45% renewable power in the energy mix and 23% renewable power in electricity generation by 2030"

GDP Source: IMF WEO, S&P and IRENA

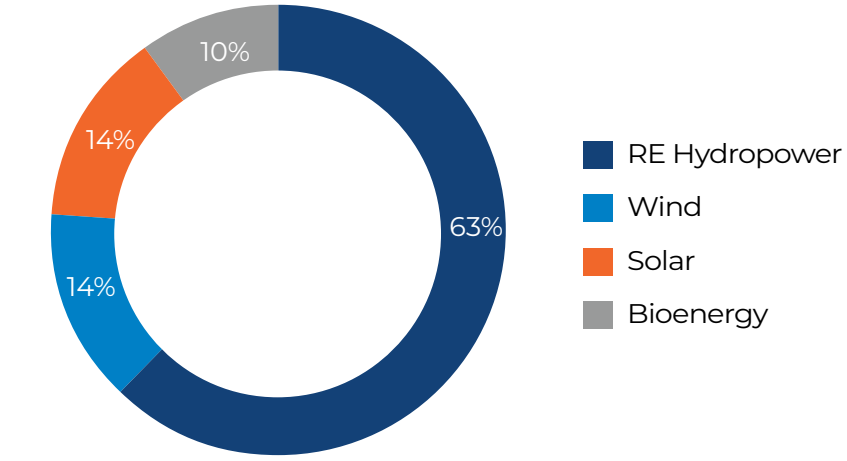
24.07GW Solar PV Capacity

- ✓ Implementation of new policy frameworks, liberal net metering policy, and PPA promotions
- ✓ New transmission investment set to unlock new wind and solar capacity and allow for greater renewables penetration
- × Operational underperformance threatens to exacerbate existing problems with pricing, connection availability, and contract closures
- × Rework in civil construction and lack of training among professionals are causing a poor legacy during the commissioning phase

Brazil

Renewable Energy Mix

Current Renewable Energy Mix



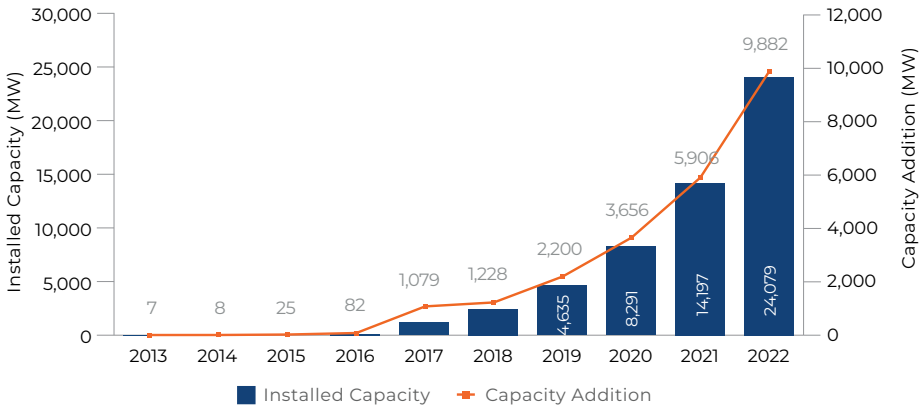
Source: IRENA Renewable Capacity Statistics 2023

According to the Brazilian Power Trading Chamber (CCEE), Brazil generated approximately 92% of its electricity in 2022 from renewable sources. Although a vast majority (63%) of the capacity is attributed to hydropower, its share has declined due to recurrent droughts and aging assets. In addition to drought risks, large hydroelectric projects also face regulatory hurdles because of flood threat. Consequently, wind and solar energy sectors are growing rapidly in the region, and each contribute 14% to the overall renewable energy mix.

Solar power in the country grew 4% YoY from 2021, whereas the share of hydropower decreased by 6%, thereby indicating a gradual shift of focus from historically predominant hydroelectric generation.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics 2023

According to the International Renewable Energy Agency (IRENA), Brazil entered, for the first time, on the list of the top ten countries with the highest accumulated installed capacity from solar source, rising from 13th place in 2021 to eighth in 2022. The country added c.10GW of solar power in 2022, ending the year with a cumulative installed capacity of 24GW. Solar capacity addition in the country expanded radically since 2017 accelerating at a CAGR of c.56% throughout the period till 2022.

The 2050 National Energy Plan (NEP 2050) highlights the importance of solar energy for Brazil's energy mix. As a renewable energy source, solar power has become a competitive and affordable solution. It is quick to install and helps reduce electricity costs by up to 90%. As a result, Brazil's solar sector attracted more than R$45.7 billion in new investments in 2022, a growth of 64% in relation to the financial values accumulated until the end of 2021.

Brazil

Demand Drivers

Brazil accounts for almost 7% of the planet's renewable energy production – outpacing its 3% share of the global population and 2% share of global GDP – and has long been a leader in biofuels and hydropower technologies. The country is now seeking to expand its energy innovation into new technological areas. To accelerate solar deployment, the government is working towards ramping up the participation of solar operators through implementation of new policy frameworks, liberal net metering policy, and PPA promotions.

The Brazilian energy sector is undergoing a transformation. This is a reaction to the recent energy crisis, in which dry summers caused a reduction in hydro reservoir capacity at a time of rising electricity demand. In recent years, the government has gradually realized that the power sector needs diversification to reduce its over-dependence on hydropower and increase the share of other renewable sources like solar and wind in its energy mix. As part of this strategy, attractive legislation is being introduced to unlock investment and enable increased adoption of solar. Solar PV's value proposition has strengthened in recent years due to the country's attractive climate and solar irradiance characteristics, high electricity costs, and a fall in solar input prices.

The country updated the solar regulatory framework publishing the long-anticipated Law 14.300 that came into force on January 1st, 2023. In broad terms, the law introduces a new framework for distributed generation in the country (>60% of installed grid connected solar capacity), with a key feature lowering the eligibility criterion for net metering (to any solar PV systems below 5MW). The anticipation of this law has seen a recent surge in new small- scale solar project developments. The framework will remain in place until 2045, ensuring regulatory and legal certainty for owners of small-scale solar PV systems. For this small-scale distributed generation segment multiple financing options are also available from Brazilian public banks such as Banco Nacional de Desenvolvimento Econômico e Social (BNDES) and Banco do Nordeste.

Solar PPA agreements have gained traction in the Brazilian market and there are growing instances of corporates being involved in long-term PPAs to secure energy prices and meet sustainability goals. Scatec ASA signed a 20-year PPA with Equinor ASA and Hydro Rein for the Mendubim 531MW solar project. Additionally, in 2023, Brazil saw the longest corporate renewable PPA ever signed in Latin America. Atlas Renewable Energy has signed a 21-year PPA with Albras, the largest aluminum producer in Brazil for its 902MWp PV project. The solar farm is expected to begin commercial operations in 2025 and generate approximately 2TWh annually.

Market Opportunity

Solar distributed generation capacity in Brazil is growing rapidly. As of March 31, 2023, home and building owners have installed more than 1.8 million renewable distributed generation systems in Brazil, totalling about 19GW of capacity, the vast majority of which (99%) is solar. This sector is expected to maintain its dominance aided by the enactment of Law 5829, which sets out a seven-year transition period to introduce grid access charges in a phased manner. As the grace period ends in 2023, this year is expected to be flooded with installations. In this regard, energy storage is likely to play a crucial role in shaping the growth trajectory of the next phase of the distributed generation market in Brazil. Behind-the-meter energy storage market is starting to take off as this segment is already competitive in several Brazilian states.

On the other hand, grid connected utility scale energy storage development is still in its infancy. In 2022, Brazil launched its first large-scale energy storage system with a total capacity of 30MW/60MWh. The project is sited at an ISO CTEEP substation in São Paulo and required a total investment of US$27 million. With more than 8GW small and medium scale diesel generator sets connected to the grid, the replacement opportunity for battery storage is massive.

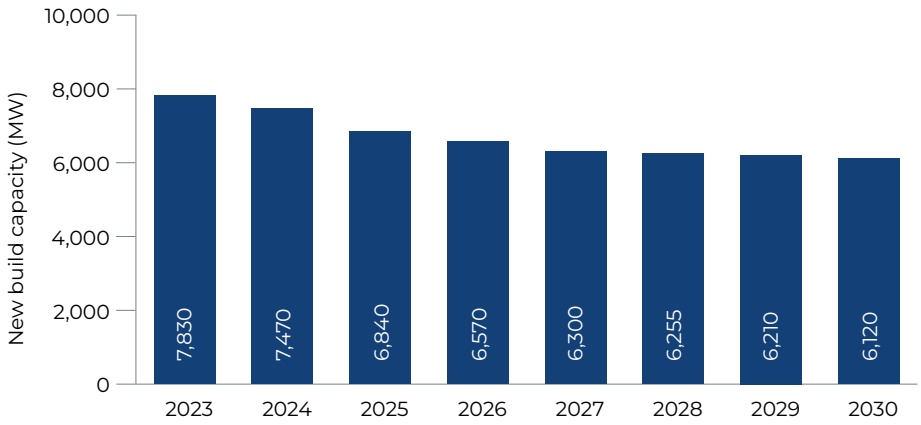
The government has announced its investment plan of US$9.5 billion in new transmission lines and infrastructure to boost solar and wind deployments. The plan is to hold at least three major transmission auctions in 2023 alone. The new transmission investment is set to unlock new wind and solar capacity and allow for greater renewables penetration across the country. Particular focus has been given on hybrid solar and wind projects, whose dual generation is believed to add greater stability to the country's grid. This will be supported by simpler approval and interconnection processes so that the two distinct facilities operate under the same network and grant.

Brazil has seen multiple sizeable PV development announcements of late, validating its position as a fertile emerging market for solar PV. Cubico Sustainable Investments announced its acquisition of a 1GW PV plant in January 2023 whilst Atlas Renewables secured a loan in excess of US$200 million to fund a 438MW Brazilian solar PV project.

Brazil

Outlook

Brazil's Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

New policy frameworks and laws will cause a rush in solar PV system applications and installations within a grace period to avoid grid charges. Consequently, solar power in Brazil is poised to retain its upward trajectory and overtake wind energy to become the country's second largest electric power source. In 2023, the Brazilian Association of Photovoltaic Solar Energy (ABSOLAR) expects a 10GW expansion of solar energy in operational installed capacity, representing US$9.4 billion in new investments. Green hydrogen projects, which require solar or wind power, will also contribute significantly to future solar growth.

Hydropower generation is expected to decline from 2030 onwards due to an increase in non-hydro renewable energy use and frequent droughts, making solar more attractive. An increased focus on NEP 2050 and reducing fossil fuel fired energy means renewable energy from solar, wind, and bioenergy will gain much-needed support to achieve national net-zero goals.

Solar plants in Brazil, however, were hit by low performance in 2022 despite tremendous growth in the sector. The solar energy industry in Brazil faces new challenges, as operational underperformance threatens to exacerbate existing problems with pricing, connection availability, and contract closures. In a scenario where deadlines are tight, rework in civil construction and lack of training among professionals are causing a poor legacy during the commissioning phase. The PV segment could be impacted by several other factors in the near future, including currency fluctuations, increased shipping costs, and a lack of skilled workers. However, the timely commissioning of ongoing projects and installation rush, supported by an updated regulatory framework and supportive grid is anticipated to boost solar PV installation capacity over the next few years. In this regard, developing a clear vision for deployment and communicating amongst concerned agencies and operators is crucial to avoiding deployment bottlenecks.

5.3.2

Chile

Despite its historic ties to fossil fuels, Chile has accelerated its energy transition in recent years through broad-based political support, private-public partnerships and innovative green technologies. The country aims at converting 70% of its total consumption of energy to renewables by 2030 and becoming carbon neutral by 2050. The government is currently developing a Just Transition Strategy to support this goal. The Chilean energy policy has evolved dynamically in recent years in response to changing domestic and international conditions through institutional and policy reforms and the implementation of major infrastructure projects.

GDP (Current Prices) USD (2022)	300.72bn
GDP Growth Forecast (constant prices) (2023-2027)	1.53%
Currency	Chilean Peso
Country Credit Rating (S&P)	A
Renewable Energy capacity (2022)	17.9GW
Solar PV Share in Renewables (2022)	35%
Renewable Energy Target	Plans to convert 70% of its total consumption of energy to renewables by 2030 and becoming carbon neutral by 2050

GDP Source: IMF WEO, S&P and IRENA

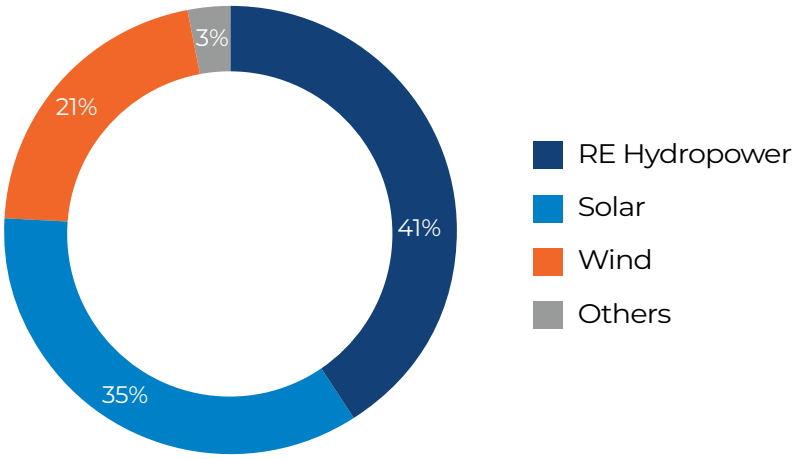
6.1GW Solar PV Capacity

- ✓ Rapid growth in the distributed generation segment owing to incentives, including liberal norms in grid connectivity and a separate price determination mechanism that guarantees stable prices
- ✓ A surge in renewable energy investment from the private sector driven by the coal phase out policy
- ✗ The issue of transmission bottleneck
- ✗ Infrastructure expansion has caused delays in projects in the past and could slow expansion further in the future

Chile

Renewable Energy Mix

Current Renewable Energy Mix

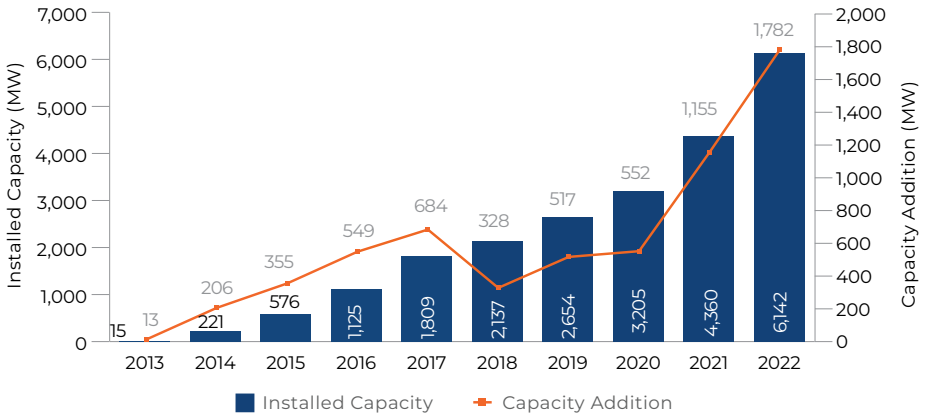


Source: IRENA Renewable Capacity Statistics April 2023

The country's energy mix has been predominated by hydropower, solar and wind energy. As a result of enhanced solar deployment, the share of solar energy in the renewable mix is continuously on the rise, eating into the share of hydropower, the country's most prominent renewable energy source. Hydropower generation in Chile has decreased due to lower water availability because of climate extremities, and community opposition. In response, the country switched its focus to solar development, which resulted in an increased share of 5% YoY over 2021.

Installed Capacity: Status and Trend

Trend in Installed Solar PV Capacity (MW)



Source: IRENA Renewable Capacity Statistics April 2023

As of 2022, renewable sources accounted for 56% of total electricity generation, with half of this generation coming from solar power and wind energy. Chile has seen an accelerated growth of solar energy, with a current installed base of 6.1GW, nearly three times the capacity in 2017. During 2017-2022, Chile's solar PV installed capacity grew 28%, driven primarily by utility-scale projects. The sector's growth is primarily attributed to increased private sector investment over the last few years.

The nation has also expanded its distributed generation segment through its Pequeños Medios de Generacion Distribuida (PMGD) programme. According to the National Electricity Coordinator, PMGD's installed capacity reached 2.2GW by February 2023. Solar capacity accounted for 77% of the total installed capacity with 1.7GW.

Chile

Demand Drivers

The energy sector in Chile is going through a transformation phase as it is in the process of phasing out 28 coal- fired plants by 2040. Chile generates nearly 40% of its electricity from coal and the phase-out of this capacity trigger transformational changes in other energy-related sectors. The Chilean government and private sector have been working together since mid-2019 to decommission or repurpose coal power plants by 2040. Moreover, they have pledged not to invest in new coal-fired plants without carbon capture and storage. As of 2022, eight power plant units have been retired, with more set to be retired in the future. Such voluntary decarbonization measures set the stage for renewable energy, especially solar power generation.

The excellent solar resources in Chile have helped it to become a destination of choice for solar developers. The country receives some of the strongest and most consistent sunshine on the planet, especially in the Atacama Desert, in the north (2,400kWh/m2). Due to its aridity, irradiation, and market conditions, the Atacama Desert is among the best places on Earth for developing solar power. The country's Northern region alone has an estimated 1,260GW of untapped solar PV potential. The available solar resource thus outstrips the different renewable energy resources, including wind energy, by a wide margin.

High-capacity factors allow energy production at a very low price, which is essential for the economic and competitive production of green hydrogen, in line with the country's hydrogen ramp-up strategy. Chile has realized that green hydrogen could be one of its top exports alongside copper and plans to use its solar potential to expedite solar powered electrolysis. During the next 5 to 10 years, Chile will be able to produce green hydrogen for less than 2 USD/kg.

With more than 2.2GW of installed capacity, the PGMD segment has experienced rapid growth, thanks to incentives such as liberal grid connectivity regulations and a separate price determination mechanism that guarantees stable prices. The trend is expected to continue, as nearly 40% (2.3GW) of total PV projects under construction belong to this segment. To facilitate more such systems, in April 2023, the Chilean National Energy Commission (CNE) announced the start of the public consultation process for the draft modification of the technical standards for connection and operation of PMGD in medium voltage facilities.

Market Opportunity

Bloomberg New Energy Finance Climatescope 2022 report highlights Chile as one the most attractive emerging market for renewable energy investment. After achieving its goal of generating 20% of its energy from renewables by 2025 five years early, the country aims to generate 40% by 2030. Chile's coal phase out policy is driving a surge in renewable energy investment from the private sector, and opportunities are multiplying. Chile's clean energy sector has attracted US$20.8 billion of investment in the past seven years, mainly due to its well-structured electricity sector. This sector offers, for example, renewable energy auctions for standardized PPAs denominated in US dollars, as well as the option of developing bilateral contracts with large consumers outside the regulated market.

Chile's success to date can be attributed to its innovative auction process, supported by regular tenders and a thriving PPA market. In August 2022, Chile's national energy commission CNE awarded 777GWh/y of new supply for regulated electricity clients at an average price of US$37.4MWh/y. The plan is to allocate 5,250GWh/y, for 15 years starting in 2027. This means clean energy developers will have attractive opportunities to participate in the future tendering rounds when the remainder will be sought. Notably, in the latest auction, efficient prices for renewable technology with energy storage had been obtained.

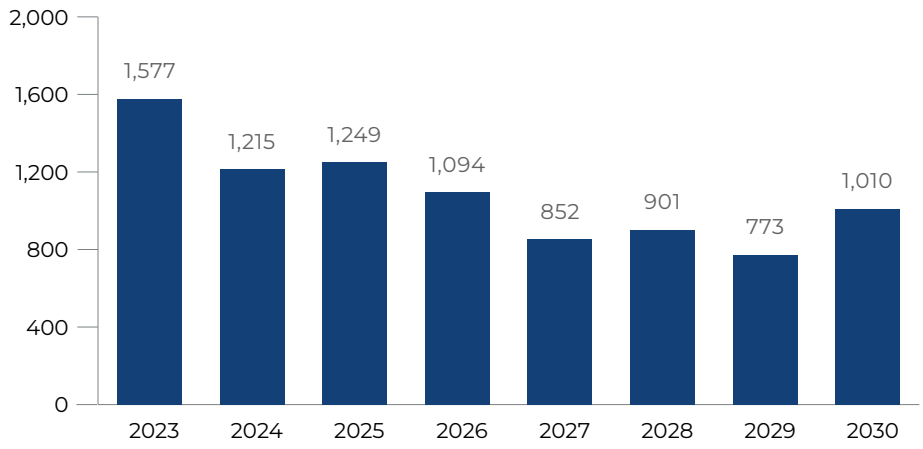
The decarbonization of Chile's mining industry would be an important step in transitioning to a low-carbon economy. Signing power purchase agreements with major power providers is a more straightforward route for mine projects with grid connections. Currently, 16 mining companies have signed clean energy supply contracts, while four have their own non-conventional renewable energy projects. Usage of renewable energy in mining has increased from 3.6% in 2019 to an astounding 47.5% in 2022 and is further estimated to reach 49.2% by 2030. The goal is likely to be surpassed by long shot at current growth rate.

In order to address the issue of transmission bottleneck Government has taken several steps recently. In November 2022, the congress approved a bill encouraging investments in energy storage and electromobility to alleviate congestion in power transmission. Standalone storage projects will be able to receive payment for power they inject into the grid under the bill. Also, electric vehicles will have access to the power market and vehicle owners would be remunerated for injecting electricity into the grid. The National Electricity Coordinator ("NEC") also announced its electrical expansion proposal for 2023 in January. The proposal consists of 23 projects totaling $279 million in investment value.

Chile

Outlook

Chile Projected Solar PV Builds



Source: BNEF Global PV Market Outlook

Note: The above data, as sourced from BNEF, are based on a 'low' investment scenario

The government's efforts to expand transmission and storage infrastructure have boosted investor interest in the renewable sector. BNamericas data predicts Chile to be the fastest growing Latin American country for renewable energy projects in 2023. A total of 9.2GW of renewable power projects (excluding hydropower) are expected to be built, up from 6.1GW in 2022. According to projections, solar energy will contribute 5.9GW, compared to 4.5GW in 2022, representing 64% of the total capacity for 2023. Capital expenditures on Chile's renewable energy projects are expected to reach US$7.95 billion.

The two biggest projects in the region are 1.2GW ERNC Antofagasta complex and the 862MW Terra Energía renewable energy park, attracting an investment of $874 and $750 million respectively.

Rapid growth in renewable deployment poses a significant challenge in the form of grid curtailment. Considering most high solar irradiance locations are remote and desert regions, it is imperative that the energy generated from the powerplants located in those regions are transferred to the places where energy demand is greatest. Infrastructure expansion has caused delays in projects in the past and could slow expansion further in the future. Therefore, for Chile to do justice to its true renewable potential, policy level support for critical infrastructural requirements such as power transmission is absolutely necessary. There is, however, a new 1,500km HVDC power line due to enter service by 2028. The USD$1.4b transmission line would relieve pressure between the north where the electricity is being generated and the central region where it can be used.

A viable solution to the shortfall involves investing in batteries that store production at night so spills and waste can be avoided. There are considerable amounts of projects in the pipeline (2GW+) that have battery storage attached to them. In addition, a substantial number of projects are pure play batteries that require legislation adaptations so that their electricity can be sold in Chile. There is hope that the new laws will give investors enough confidence to potentially attract more investment into battery solutions.

While enabling policy and regulatory measures such as the bulk capacity auctions help sustain the momentum, the growth rate remains muted for a lack of comparable support to other leading PV markets worldwide. At the same time investors will be watchful for the response to the upcoming auctions. The role of battery storage will be increasingly crucial for the upcoming renewable powerplants to operate at their full potential.

06

About CleanBridge

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Sustainable Energy

Climate Finance

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