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EU Market Outlook for Solar Power 2024-2028

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A message from Krzysztof Bolesta, Secretary of State of Poland for Climate Policy and Green EU Funds

Europe has learned hard lessons on energy in recent years. The continent's energy security and economic prosperity cannot rely on imported Russian gas. On the other hand, one dependency should not be replaced by another. Europe must remain an industrial powerhouse and a place where clean technologies are made to fuel energy transition but also growth and the European way of life. There is no time to lose in the transition, and citizens must be brought along the process. As Poland takes the rotating Presidency of the EU Council on 1 January 2025, energy security, competitiveness and Ukraine will be our three priorities. We won't leave anyone behind with special focus and care on energy-intensive consumers as well as households experiencing or at risk of energy poverty.

Solar PV will play a key role in decarbonising and securing Europe's energy. Poland for example, installed its first solar megawatt in 2011. Today, Poland installs more than 4 GW of solar per year, and solar supplies around 8% of our electricity. By 2030 we plan to have at nearly 30 GW of solar operating in Poland and, under our National Energy and Climate Plan, around 30% of our final energy demand will come from renewable sources.

It is key to prioritise the uptake of the most popular technologies (including solar), the deployment of heat pumps and the development of electro-mobility. Of course, the sun does not always shine, nor the wind always blow. Therefore, it is critical that we provide technical opportunities for a stable grid. That means, amongst other elements, adapting energy transmission and distribution infrastructure, developing generation and demand flexibility, and growing energy storage. In the picture of challenges the sector coupling will play a crucial role in terms of providing safe, reliable and cost effective energy system.

For the success of such an energy transition, citizens should be aware of its benefits. One of the most successful examples are home solar installations. Prosumers already play a leading role in Poland's energy transition. The upward revision of the national renewables target is, in part, due to the popularisation of distributed energy production in prosumer installations. At the end of 2023, almost 1.4 million renewable self-consumers produced energy in Poland, relying on rooftop solar installations.

Alongside citizens, our industries should feel the competitive gains of the energy transition. As signatories of the European Solar Charter, Poland supports the efforts to reshore solar manufacturing to Europe, and build an industrial strategy as an inseparable accompaniment of climate policy. Under the Polish Presidency of the Council of the EU, we will also discuss the Clean Industrial Deal, which should support industry in its effort to electrify, decarbonise and drive competitiveness.

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

Segmentation is based on the following system size: Residential (<10 kW); Commercial (<250 kW); Industrial (<1000 kW); Utility-scale (>1000 kW, ground-mounted). SolarPower Europe's methodology includes only grid-connected systems. Installed capacity is always expressed in DC, unless otherwise stated.

All figures are based on SolarPower Europe's best knowledge at the time of publication.

Foreword

Welcome to the EU Market Outlook for Solar Power 2024-2028

After years of stellar growth, the EU solar sector has been hit by a significant deployment slowdown – tumbling from 53% growth in 2023 to 4% in 2024, amounting to a 92% slowdown in solar growth over the last year. With 65.5 GW of new solar in 2024, the sector just inched past its 2023 record of 62.8 GW. Despite the slide, solar PV still installed more than all other power technologies combined in 2024, bringing the EU's operating solar power fleet to 338 GW.

The slowdown is not too surprising. Following the solar boom during the gas crisis, the urgency of going solar has waned for citizens as their bills normalise. Developers face challenges for different reasons. The energy system has not kept up with the solar growth curve, and building bankable utility-scale solar becomes more difficult as grid and flexibility bottlenecks tighten.

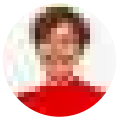
Looking forward, we anticipate low single-digit annual growth rates of 3-7% between 2025 and 2028. This would be good enough for the EU to meet its 2030 solar target of 750 GW. However, for the first time this report warns, in its low scenario, that Europe could actually miss this target altogether – by 100 GW.

As the continent sets competitiveness, climate, and energy security goals, a further slowdown of solar growth would undermine the key engine to deliver – renewable-based electrification. This is no option for Europe.

Policymakers, regulators and system operators must consider the 2024 EU solar market outlook a yellow card.

To keep solar in the game, and maintain an investment friendly environment, regulatory stability is fundamental. Furthermore, where EU structural support winds down (the NextGenEU and Recovery and Resilience Facility close in 2026), new support efforts should be waiting in the wings to take over – not least to support flexibility and grid development. EU electrification is stagnating at around 23%. We must achieve 35% within 5 years.

We look forward to working with the new European Commission and Parliament as they introduce game-changing plans to boost flexible electrification, energy storage, and distribution grids. With the success of the Clean Industrial Deal deeply dependent on flexible renewable electrification displacing Russian gas, the solar sector is ready to work with all stakeholders to overcome system barriers.



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The EU solar market reaches a new all-time high of 65.5 GW, but yearly growth has drastically decelerated

65.5 GW

65.5 GW installed in 2024: New market record for the fourth consecutive year

4.4%

4.4% annual market growth: The lowest market growth since 2017

816 GW

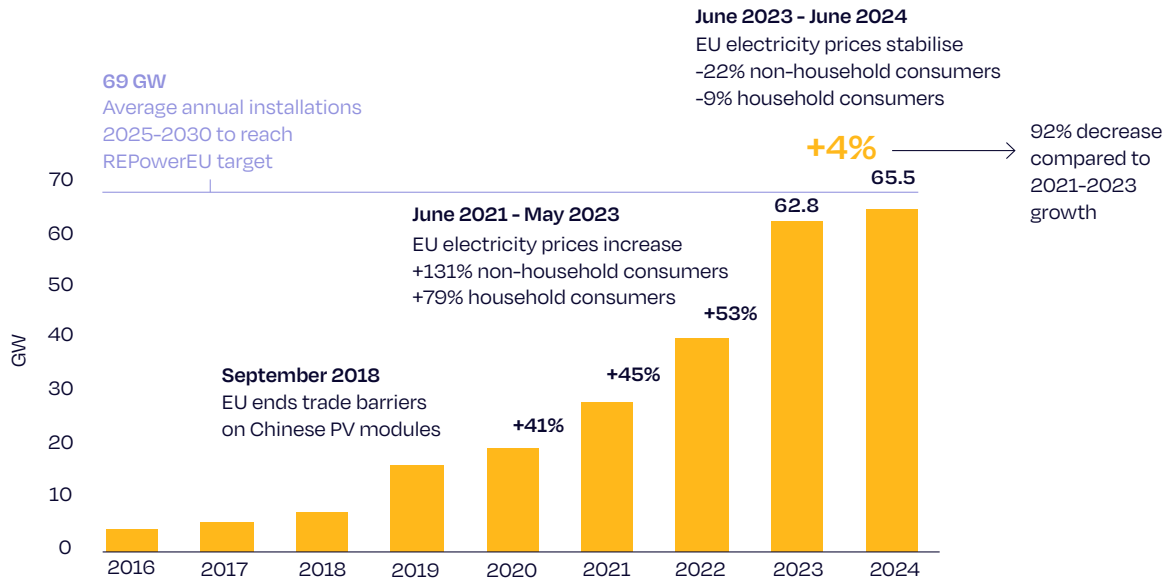
816 GW projected by 2030: Still above REPowerEU's target, but a 8% decrease compared to previous 6 months ago (GMO 2024)

In 2024, the European Union installed 65.5 GW of solar PV, marking the fourth consecutive year of record-breaking annual additions. However, the annual growth rate decelerated significantly to 4.4% compared to the robust 41-53% observed during 2021-2023. This slowdown was expected, as the exceptional surge in 2022 and 2023 was largely driven by soaring energy prices during the energy crisis (see Fig. 1).

Figure 1

Newly added solar PV capacity growth has fallen dramatically, with a 92% decrease compared to previous years

EU-27 annual solar PV installed capacity 2016-2024



Source: SolarPower Europe

While EU solar market capacity additions improved a little in 2024, solar investments declined by 13%

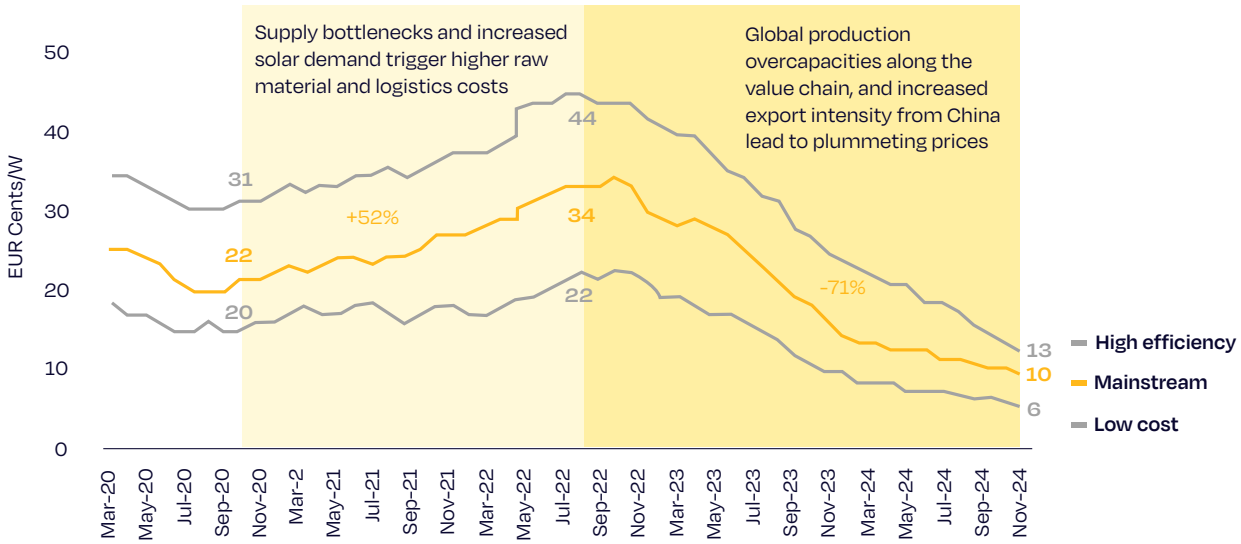
While growth remains positive, this deceleration raises concerns, particularly as annual additions need to increase continuously to meet the EU's REPowerEU solar PV targets. The situation is further complicated by different challenges, including worsening incentive framework conditions to rooftop solar today and the lack of flexibility in the EU electricity system that increasingly hinders the growth of utility-scale projects, especially in the medium and long term. This drastic slowdown is a stark reminder that renewable energy development cannot be taken for granted, even for the price-competitive solar PV sector.

Until recently, capital investments in solar PV in the EU were on a steady upward trajectory, rising from around 19 billion EUR in 2020 to around 60 billion EUR in 2023 (see Fig. 2). However, the trend shifted significantly in 2024. Module prices in European wholesale markets fell to record lows, dropping by an average of 35% between January and November 2024, after they had already fallen by around 50% the year before, all this driven by declining supply chain costs and overcapacities. As a result, average CAPEX for rooftop PV systems decreased by 2%, while ground-mounted PV systems saw a sharper 28% decline in 2024. These record-low PV prices, coupled with the slowdown in market growth during 2024, led to a 13% reduction in capital investments, which fell to 55 billion EUR compared to 2023.

Figure 2

After peaking in August 2022, EU wholesale prices for solar modules have dropped by more than 70%

EU wholesale PV module prices 2020-2024



Note: Data considers only capital investments in PV capacity that was grid-connected in 2024
Source: SolarPower Europe

Utility-scale solar becomes largest market segment in 2024 on expense of significant residential rooftop solar losses

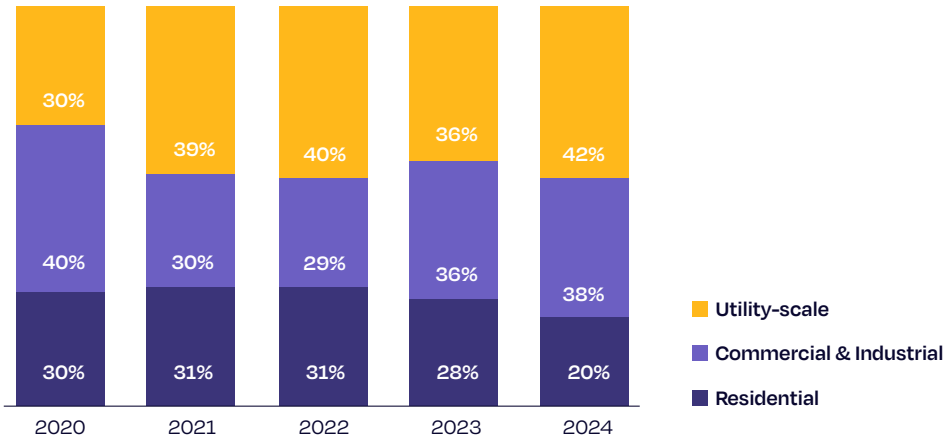
After the residential rooftop segment experienced strong absolute growth in 2022 and 2023, driven by the energy crisis, the growth dynamic began to slow in 2023 and came to a halt in 2024. Demand for residential systems fell sharply by nearly 5 GW to 12.8 GW in 2024, returning to levels similar to those of 2022. Key markets across the EU, including Germany, Austria, Italy, Poland, the Netherlands, Belgium, Sweden, Spain, and Hungary, saw substantial declines in the solar homes segment. As a result, the market share of residential rooftop solar in the EU dropped to 20% in 2024, down from 28% in 2023 (see Fig. 3).

In contrast, the commercial and industrial rooftop segment experienced modest growth, with its market share rising slightly to 39% in 2024 from 36% the previous year. EU solar in 2024 was dominated by the utility-scale segment, which captured 42% of the market – an increase from 36% in 2023 and its strongest performance in the past five years.

Figure 3

Utility-scale drives new EU solar installations in 2024 as residential rooftop segment slumps

EU-27 annual solar PV segmentation 2020-2024



Source: SolarPower Europe

Several trends are shaping the future of solar PV

The European solar PV market is poised for continued growth, but the explosive expansion driven by the energy crisis is now subsided. In the coming four years, growth is expected to stabilise at a more moderate annual rate of 3% to 7%. These lower rates reflect the emergence of structural challenges and lingering obstacles that the European solar sector is expected to face (see Box 1).

Box 1

Trends affecting the EU solar PV market

Rooftop market is slowing down. As the sense of urgency to shield against high electricity prices during the energy crisis has faded away, several incentive schemes are being phased out, leading to a significant slowdown in the residential rooftop market.

Low flexibility hinders large-scale PV. Grid congestion and lack of storage lead to a rise in negative electricity prices and higher curtailment rates, diminishing the financial appeal for solar investments.

EU electrification rate is too slow. The electrification rate in the EU is stagnating for the past five years. Heavy industry and transport need to electrify faster to allow integration of more renewable electricity.

Permitting challenges continue. Permitting and land access remain cumbersome across several Member States, delaying project timelines and hindering growth.

Risk of a slower Green Deal. Several political parties, that are traditionally less supportive for renewables, have come to power in various European countries, potentially slowing down the implementation of the Green Deal.

Source: SolarPower Europe

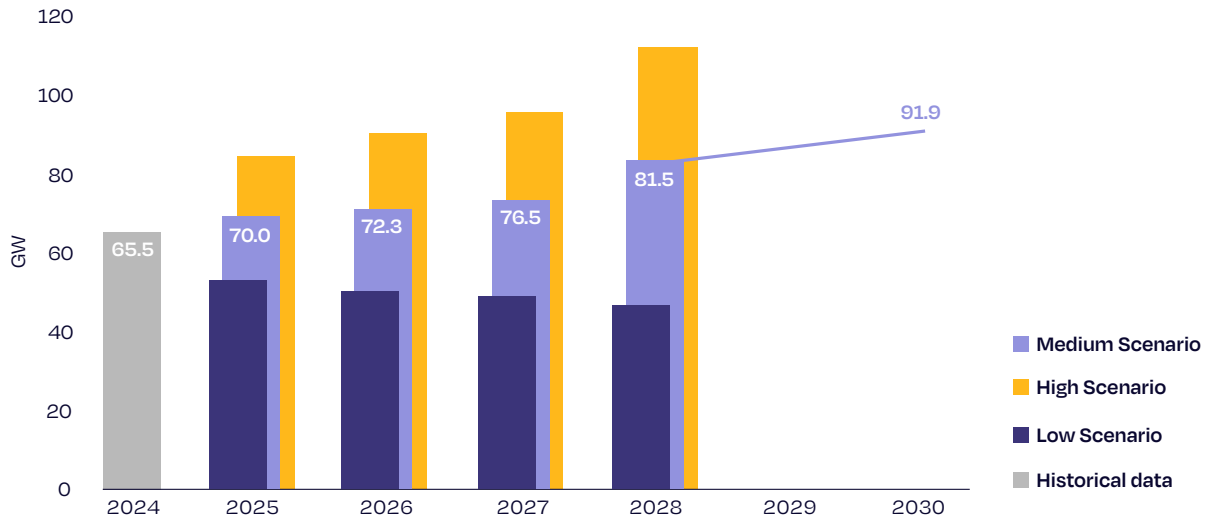
Growth ahead, but looming challenges are putting solar bankability at risk

The challenges outlined in Box 1 have led to a downward revision of our growth projections. Following the downgrade of our Medium Scenario in the Global Market Outlook 2024 (GMO 2024) six months ago, we are once again lowering expectations as issues related to flexibility, electrification, and policy weigh heavily on the sector's outlook. For 2025, the market is expected to add 70 GW of capacity, reflecting a 7% growth rate. This growth will primarily be driven by utility-scale projects initiated in 2023-2024, which capitalised on record-low module prices. However, growth is projected to slow further in 2026, with only a 3% increase to 72.3 GW, as developers face mounting grid constraints and market uncertainties. By 2027, the EU market is forecast to reach 76.5 GW, and 81.5 GW by 2028, under our Medium Scenario. After the steep PV product price drops over the last two years, there's no further room for notable reduction in the near future; major manufacturers are desperately working to increase prices to a more sustainable level. Without strong policy support, the EU solar market environment will face increasing challenges.

Figure 4

EU solar capacity deployment most likely will grow in coming years but at much lower levels than anticipated before

EU-27 annual solar PV market scenarios 2024-2030



Source: SolarPower Europe

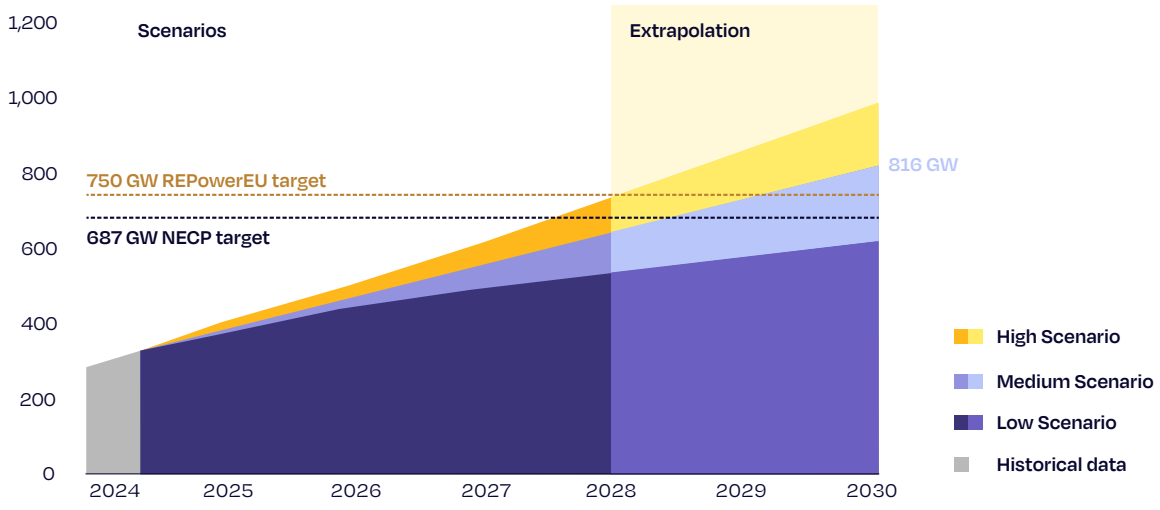
The EU remains on track to meet its REPowerEU solar targets for 2030, but a continued decline in our Medium Scenario projections - this time by 8% - could jeopardise these goals

According to our Medium Scenario projections, the EU solar market remains on track to achieve the 750 GW_{DC} (600 GW_{AC}) REPowerEU target by 2030. Under this scenario, total installed solar capacity in the EU is expected to reach 816 GW by 2030, exceeding the EU Commission's target by 9%. However, this forecast represents a 8% or 74 GW reduction compared to our previous analysis in mid-2024, amplifying a downward trend that began with a 12 GW decrease in the 2030 outlook from 902 GW in the EMO 2023 to 890 GW in the GMO 2024. A further slowdown in the solar market in the coming years could put the European Commission's solar commitment at risk. Under our current Low Scenario, total capacity by 2030 is projected to reach just 644 GW, falling significantly short of the REPowerEU target by 14%. When considering the aggregate NECP solar target – derived from an analysis of direct and indirect national targets outlined in NECPs – EU Member States are projected to collectively deploy 687 GW of solar capacity by the end of the decade, a 8.4% miss of the REPowerEU target.

Figure 5

NECP and REPowerEU targets will narrowly be reached under the Medium Scenario, despite the outlook being lowered by 8%

EU-27 total solar PV market scenarios 2024-2030



Source: SolarPower Europe

Support to solar is needed, after it delivered to Europe when Europe needed it most

Following a period of exceptional growth, the EU solar market is facing stagnation and a declining investment, putting 2030 renewable energy goals at risk. The sector's ability to take a leading role in EU decarbonisation will depend on policymakers' efforts to lift regulatory and market challenges that continue to hamper solar power (see our Policy Recommendations at p. 14).

This year's report features an overview of EU solar hot topics in 2024, which includes relevant updates for the solar PV sector at the upstream, downstream and legislative level. Additionally, the report includes a deep-dive analysis for each EU Member State that achieved at least 1 GW of annual installations in 2024. These analyses were authored by our national solar or renewable energy association members and can be found on page 92.

EWS Sonnenfeld agri-PV plant in Bruck/Leitha, Austria

How can EU policymakers help the solar sector achieve its targets

Solar growth is slowing down, putting EU 2030 renewable energy goals at risk. After years of stellar growth, solar deployment in Europe by and large stagnated at similar levels as last year. Looking at the glass half full, the solar sector is clocking yet another record year, which is a remarkable achievement of the sector. However, the slow-down is a sign of challenges ahead, mostly related to the lack of flexibility in the European energy system. Despite the fact that these challenges have been extensively described, anticipated and warned about for years, it has not led to adequate political attention and policy action.

The coming year, therefore, must be the year of policy action on energy system flexibility and electrification, if the EU is to avoid missing out on its REPowerEU targets for 2030, and miss out on the security, affordability and competitiveness benefits of solar and other renewables. SolarPower Europe estimates the EU needs to build an average of 69 GW per year until 2030 to reach the REPowerEU goals. The market is not at that level, and projections for next years depend a lot on progress on system flexibility and diligent implementation of EU law. The 2024 update of National Energy and Climate Plans (NECPs) has further improved national solar targets for 2030, but a significant 59 GW gap to the REPowerEU target remains, while several Member States have not yet submitted their updated NECP. The solar sector, including its entire value chain, stands ready to meet the annual deployment rates required for 2030 and climate neutrality goals. The new EU leadership and policy cycle is an excellent opportunity to put solar and renewables growth back on track and make this flexibility revolution happen.

At the same time, solar and inverter manufacturing in Europe continues to be under pressure, leading to further reductions in production capacity across the continent. The indispensable renaissance of solar manufacturing in Europe, guaranteeing a sustainable, secure and resilient supply chain, is not coming off the ground. So far the ambitions by the EU missed their own targets. EU leaders should, in addition, pay urgent attention to solar inverters, which function as the brain of the solar system, given its critical role in cybersecurity and data management.

Solar has delivered for Europe when Europe needed it most. The solar industry's ability to deploy swiftly and affordably was a decisive factor in overcoming the energy crisis for Europe's businesses and citizens, and continues to be essential for the EU's energy security and competitiveness. Today, solar is one of the most affordable energy sources in the EU for businesses and households alike. As EU leaders expect the solar sector to break records every year at breakneck speed, they shall also pay attention to the sectors' needs:

1 Implement the rulebook: regulatory stability is key to maintain an investment-friendly environment for solar PV

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

2 Embark on a flexibility and electrification revolution

Across Europe, solar developers are confronted with the limits of the current energy system. Investment in system flexibility – like smart and interconnected grids, storage and demand response - have not kept pace with the required growth of solar and other renewables in the last years, resulting in an increase in curtailment and negative electricity pricing in several leading markets. In addition, electrification of European energy demand has by and large stalled at around 23% in the last two decades, further exacerbating the situation.

All of this needs to change in order to keep the energy transition on track and secure attractive investment signals for solar projects going forward. The coming year must, therefore, be the year of policy action on flexibility and electrification, in particular by:

1. **Advancing the provisions in the EU Grids Action Plan**, and in particular on developing regulatory frameworks to allow for anticipatory investment, both on transmission and distribution grid level. On distribution level, the EU needs to establish a Distribution Grids Facility, that could make use of the existing regional funds, to finance grid expansions but also grid operation modernization.

2. **Adopting a new EU Storage Action Plan**, with a particular focus on Battery Energy Storage Systems (BESS). This is currently lacking from the new Commission work programme and is essential to accompany the EU Grids Action Plan. To adequately enable further solar deployment, battery storage needs to grow by a factor of 16, from 48 GWh of BESS capacity estimated in 2024 to 780 GWh in 2030, according to calculations in our Mission Solar 2040 report.[1] Although some positive provisions are already in national and EU legislation, an Action Plan is needed to grow the battery market at EU level, and looking at removing barriers to BESS uptake (like double charging), developing better price signals and financial incentives (like Time-of-Use grid tariffs, local flexibility markets, and competitive auction processes for storage) and most importantly providing guidance on how developers can accumulate, or 'stack', different services on the battery to optimise its use.

1 Modelling assumes that by 2030, front-of-the-meter battery systems will offer a discharge duration of 3 hours, in accordance with TYNDP 2022 Scenario Report: Building Guidelines.

3. **Adopting a new EU Electrification Action Plan**, to progress electrification across the energy economy. The upcoming Clean Industrial Deal must particularly focus on industrial process electrification and must leverage the potential of renewables-based electrification for industrial competitiveness. Parts of Europe's industrial ecosystem have been hit hard by the energy crisis. Europe no longer wants to rely on cheap gas imports from Russia. This is a unique opportunity for accelerating the shift to an industrial competitiveness based on renewable and flexible electrification. According to our report Mission Solar 2040, more renewables, electrification and flexibility can boost European competitiveness, slashing average day-ahead electricity prices by 25% by 2030, and by 33% by 2040. Of course, more is needed to secure internationally competitive electricity prices for energy-intensive industries, primarily by temporarily allowing direct state support for capital and operational expenditure (CAPEX and OPEX) conditional to progress on flexible electrification. Finally, investment into the needed infrastructure will be key. Europe's energy-intensives industries need clean and affordable electricity to stay competitive, and Europe's renewable industries need more flexible electricity demand to keep business cases healthy and avoid price cannibalisation. The EU Clean Industrial Deal, the Industrial Decarbonisation Accelerator Act and the European Competitiveness Fund, therefore, must have industrial electrification at its core.

4. **Shifting energy taxation to foster competitiveness and accelerate electrification in the EU.** A clear and strategic approach to energy taxation is essential to promote fair tax policies and reduce barriers to electrification within the EU. To support various sectors in their transition to electrification, both electricity and non-electricity related taxes must be reformed to lower the overall electricity costs, enhancing competitiveness on the global stage. Currently, electricity is one of the most heavily taxed energy source, with taxes 3.5 times higher for industries than gas. This issue, particularly pronounced in the EU, where electricity taxes are significantly higher compared to other global regions creates a competitive disadvantage. Therefore, addressing this imbalance, notably through the adoption of the Energy Taxation Directive (ETD) will help boosting the EU's global competitiveness while supporting our climate goals.

5. **Developing a "Single Market for Flexibility"**: we encourage the EU-law maker to complement the current infrastructure-centric approach with more attention to flexibility, in order to use the grid infrastructure in the smartest way possible. Distributed energy resources avoid single points of failure, making it more difficult to weaponise power systems. This can be achieved by the creation of a single market for flexibility devices and services (or "Single Market for Flexibility"), including harmonizing electricity system requirements, creating free movement of goods for flexibility devices and free movement of services for flexibility service providers, among others through more harmonizing EU Network Codes.

6. **Setting political goals for renewables and clean flexibility for 2040**: The current EU regulatory framework includes 2030 targets for renewables. This must continue after 2030 and be complemented with parallel goals for grids, storage and electrification. Establishing such targets is essential to provide a political steer and ensure political oversight on flexibility and electrification. This is currently lacking, which partially explains the slow progress in this area. An analysis of the latest National Energy and Climate Plans (NECPs) backs up the argument: while ambition levels for renewables have substantially improved, it is not matched with objectives and investment plans in grids, storage and electrification. This disconnect cannot continue if we are to avoid the limits to renewables growth.

3 Reshoring and diversifying solar manufacturing supply chains; strengthening the EU inverter industry

Solar PV supply chains are currently highly concentrated in China. The EU needs to take a pro-active approach to building resilient and sustainable solar module, equipment and inverter supply chains, including saving the companies still present in Europe. We much welcome the ambition to take the Global Gateway Initiative to the next level, including with a focus on diversifying global solar supply chains. This is essential for Europe's position in the changing map of energy geo-politics.

Investment conditions for European solar manufacturing must be improved, in particular by allowing for state support for operational expenditure under an extended TCTF and by swiftly implementing the Net Zero Industry Act provisions. This, however, will only be effective in combination with a dedicated financing instrument for scaling up solar PV manufacturing capacity in Europe, similar to the Hydrogen Bank or the Battery Fund. This is still lacking despite a clear commitment from EU Commission and Member States in the April 2024 EU Solar Charter to take concrete steps for reshoring solar manufacturing.

Solar inverters, too, require urgent attention. Inverter manufacturing has historically been Europe's strongest link in the solar supply chain. As recently as 2023, the continent hosted more than 80 GW of inverter manufacturing. This position is however coming under increased pressure due to international competition and record-low prices. As a structural solution, we call on European policy-makers in Brussels and Member States to consider a dedicated IPCEI on smart and secure electrification, to better leverage public funding and guarantee EU's leadership in the critical communication components of the future energy systems, like solar inverters. But more immediate measures are needed as well. We ask European policy-makers to develop an action plan for the EU inverter industry to restore the level playing field and enforce the highest standards on cyber- and energy security. Inverters are the brains of the energy system, connecting solar output to grids, batteries and other clean energy technologies, which will become even more important as Europe electrifies and digitalises its energy systems. Europe can simply not afford to lose this critical industry.

4 Leveraging the potential of solar PV for Europe's social, environmental and agricultural agendas.

Solar is a very versatile and adaptable technology. Most European citizens' first contact with the larger energy transition starts with solar on their rooftops or in their neighbourhoods. Solar has proven its constructive and positive bridging role to communities that would otherwise feel left behind, empowering people to become prosumers. The upcoming European Affordable Housing Plan should embrace the potential of rooftop solar to directly reduce energy bills, not in the least on social housing. This aligns well with the solar rooftop mandate agreed on in the European Performance of Buildings Directive (EPBD).

Similarly, as Europe and the world grapple with the challenges of climate change and the need for sustainable farming practices, the marriage of solar power and agriculture offers a promising solution. Agrisolar has proven to foster sustainable agriculture practices, bringing crops and animals protection, improving local adaptation to climate change – not in the least with respect to water and soil quality retention - and supporting income security for farmers. The upcoming European Vision for Agriculture, the revision of the Common Agricultural Policy and the European Climate Adaptation Plan should have the positive contribution from solar on the agenda. In particular, the new policy framework should recognise agrisolar technology where solar power generation is integrated into agricultural activity, remaining eligible to Common Agricultural Policy funding. Moreover, additional support could be granted to agrisolar installations, recognising their added value in terms of dual use of land, ecosystem services or sustainable support should be coupled with agrisolar installations.

Furthermore, in response to the rate of biodiversity loss in the EU, conservation and restoration of habitats and ecosystems has become key priority for the EU policymakers. Nature-inclusive solar parks can play a crucial role not only in mitigating the impacts of climate change, but also helping in protecting and restoring Europe's precious ecosystems. Nature-inclusive solar parks are solar installations designed to produce renewable energy while also enhancing local biodiversity, combining nature restoration and conservation and energy production on the same plot of land.

To ensure that solar development creates a positive impact on biodiversity, creating an enabling policy framework is key. Key policy actions that are necessary to realise a win-win for renewable energy and biodiversity include the creation of a common, clear and ambitious definition of nature-inclusive solar parks at EU level; the provision of solar park development guidance to avoid and minimise biodiversity loss in planning during and after construction phase, alongside practices to restore, offset and/or add net gain biodiversity; and the development of a robust monitoring and evaluation system.

5 Support Member States in improving permitting practices

Member States are obliged to transpose the rules of the new 2024 Renewable Energy Directive on national level, in particular around accelerating the administrative procedures for spatial mapping and permit granting procedures for renewables. Several Member States are doing that well and have approved rules for streamlining permitting, showcasing positive impact in areas of capacity building for permitting authorities, digitalisation and knowledge-sharing, and one-stop shops. Countries such as Italy, Spain, Greece and Portugal have approved regulations aimed to accelerate permit-granting procedures. Many other countries, however, still lag far behind and are in some cases misinterpreting the rules.

Specific attention needs to be drawn to renewable acceleration areas (RAAs), which in countries like France and Italy is leading to overly restrictive measures for ground-mounted solar. In the Italian region of Sardinia the designated areas for renewables even led to making 98% of their territory unavailable for any RES project deployment, and has resulted in no-go zones, stalling project approval processes.

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EU solar market 2024

In 2024, the EU solar market deployed a record 65.5 GW, but growth has significantly slowed compared to the record expansion of the previous three years. Despite substantial price reductions, the sector saw minimal market growth, with only five of the top 10 markets installing more PV capacity than in 2023, and a decline in annual investments in solar. While utility-scale solar increased its market share significantly in annual capacity additions, two-thirds of the EU's 338 GW total operating solar fleet remains on rooftops.

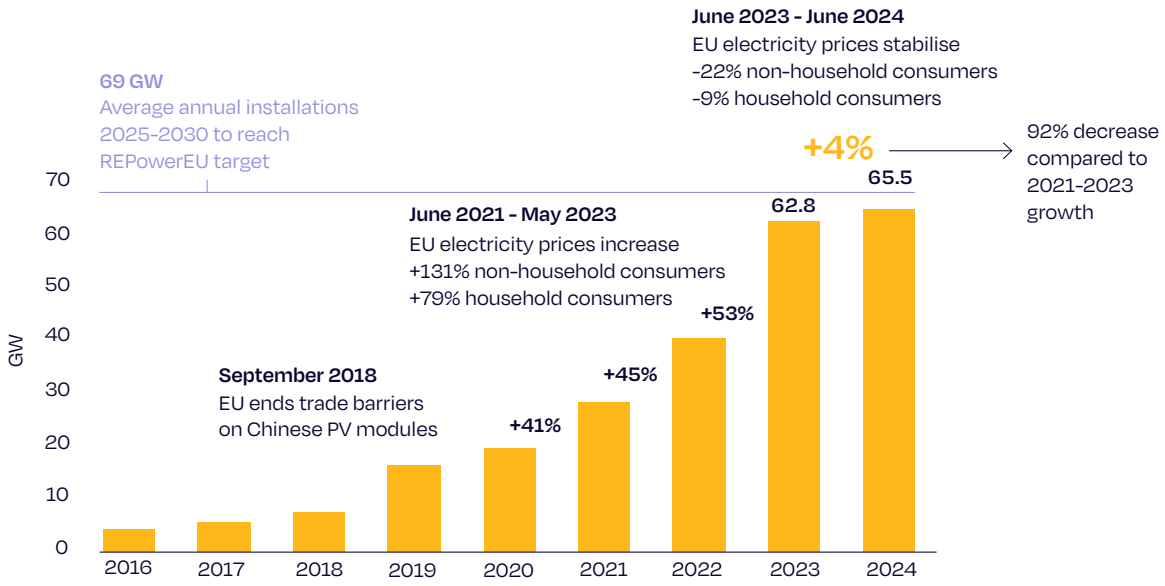
EU solar market reaches a new all-time high of 65.5 GW, but yearly growth is drastically slowing down

In 2024, the European Union installed 65.5 GW[1] of solar PV, marking the eighth consecutive year of record-breaking annual additions. However, the annual growth rate declined sharply over the previous years, reaching only 4.4%, compared to 41-53% in the 2021-2023 period. This deceleration was anticipated, as the exceptional surge in 2022 and 2023 was largely driven by the unprecedented rise in energy prices triggered by the energy crisis (see Fig. 6).

Figure 6

Newly added solar PV capacity growth has fallen dramatically, with a 92% decrease compared to previous years

EU-27 annual solar PV installed capacity 2016-2024



Source: SolarPower Europe

1 All numbers in the report are based on market research conducted until 30 November 2024

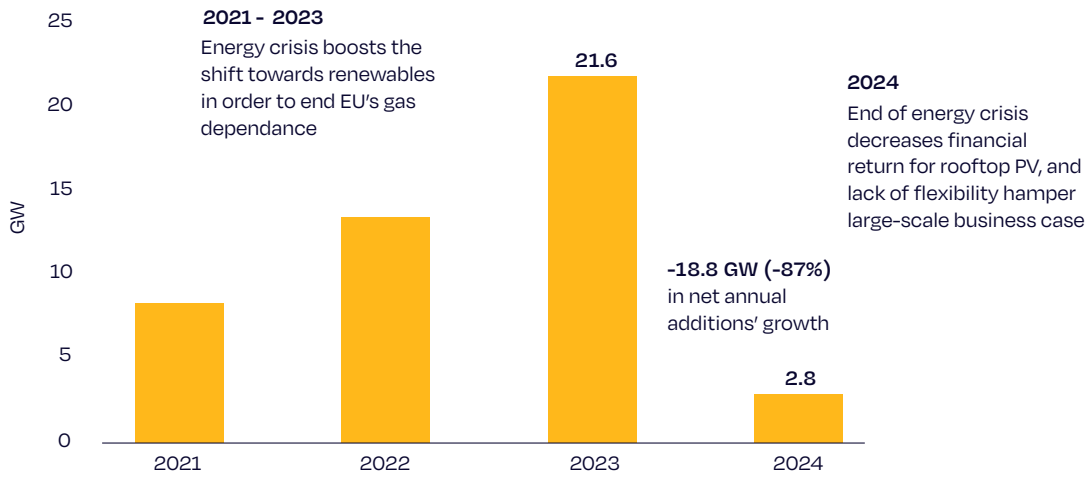
From 2019 until mid-2021, EU electricity prices for non-household and for household consumers remained relatively stable, increasing slightly from 78 EUR/MWh to 86 EUR/MWh for the first category, and from 128 EUR/MWh to 134 EUR/MWh for the second category.[2] However, from mid-2021 to May 2023 prices soared, peaking in the second half of 2022 at an average of 199 EUR/MWh for non-residentials consumers (+131% increase from mid-2021) and 240 EUR/MWh for residential consumers (+79% increase from mid-2021). This surge in power prices, in an insecure policy and business environment facing overall skyrocketing energy prices, fuelled strong demand for solar PV, with annual growth rates reaching 41% in 2021, 45% in 2022 and 53% in 2023. With electricity prices stabilising in 2023, albeit at levels significantly higher than pre-crisis averages and a general mood that felt the energy crisis was overcome, the growth rate of solar PV installations started to slow down in the second half of that year. This continued in 2024, despite solar product and system prices reaching record lows.

As part of the Green Deal, the EU has introduced several key legislative initiatives, many of which have provisions supportive of solar PV deployment, including the revised Renewable Energy Directive (RED III) and the REPowerEU plan with a 600 GW_{AC}/750 GW_{DC} installation target by 2030. But these policies' full potential impact on accelerating solar installation rates has yet to be realised. While few files are still under discussion at the EU level, like PV Ecodesign or NZIA Implementing Acts, it's mostly about implementation in the Members States: the RED III, for example, has been fully and accordingly implemented only in one country so far. To achieve the solar targets set by EU policies, swift and effective implementation is crucial.

Figure 7

EU annual solar PV additions decreased by about 90% in 2024 as energy crisis impact faded

Net changes in EU annual solar PV additions



Source: SolarPower Europe

2 Eurostat (2024): Energy statistics – prices of natural gas and electricity

In our previous EU Market Outlook 2023-2027, published in December 2023, the Medium Scenario projected newly installed capacity to reach 62.0 GW in 2024. This estimate was slightly increased to 63.9 GW in the Global Market Outlook 2024-2028, released in June 2024. Nearly half year later, we have further adjusted upward our forecast, raising the expected installation volume for 2024 by approximately 1.6 GW.

While the EU solar PV market has continued to grow, the slowdown in growth rates is becoming increasingly apparent when examining how much new solar capacity was added in a year compared to the previous year. During the energy crisis, these annual net additions surged considerably, rising from 3.1 GW in 2020 to a peak of 21.6 GW in 2023, after we've seen a sharp 18.8 GW (-87%) drop in annual net additions in 2024 (see Fig. 7).

While growth remains marginally positive, this deceleration is deeply concerning, particularly as annual additions need to increase continuously to meet the EU's REPowerEU 2030 solar PV target. The situation is compounded by several challenges, including decreasing incentives in rooftop markets, and the lack of flexibility in the EU electricity system risks hindering the long-term growth of utility-scale and distributed projects. With rooftop and ground-mount systems facing an increasingly difficult business environment, the further strong growth of renewable energy development cannot be taken for granted anymore. After the steep PV product price drops over the last two years, there's no further room for notable reduction in the near future. While the sector is working on further cost reduction measures, the manufacturing segment is desperately hoping for increase in prices to more sustainable levels. However, strong and targeted policy measures are urgently needed to reinforce the business case for renewables and ensure the EU remains on track to achieve its climate and decarbonisation goals.

91 MW, Părău PV park, Solar Open Day 2024, Romania

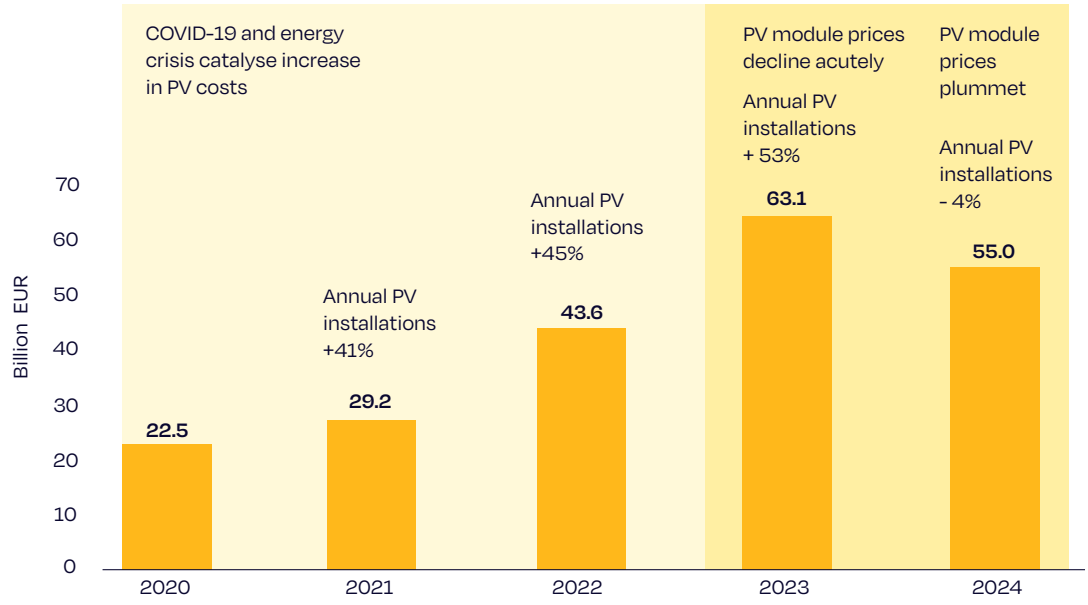
Despite dramatic PV product price decreases, the EU solar sector hardly grew in 2024

Until recently, capital investments into solar PV were steadily increasing in the EU, growing nearly three-fold within three years, from 22 billion EUR in 2020 to 63 billion EUR in 2023 (see Fig. 8). This growth was driven by both demand and supply factors. With annual market growth rates in the 40-50% range, investments in PV capacity deployment largely increased. In parallel, PV system prices saw a significant increase during this period. Supply chain bottlenecks and heightened demand following the COVID-19 pandemic led to an increase in raw material and logistics costs, which peaked in mid-2022. Financing costs also surged due to the rise in European interest rates during the peak of the energy crisis in 2022 and 2023.

Figure 8

In 2024, EU annual investments in solar declined for the first time in years

EU-27 capital investments in solar PV, 2020-2024



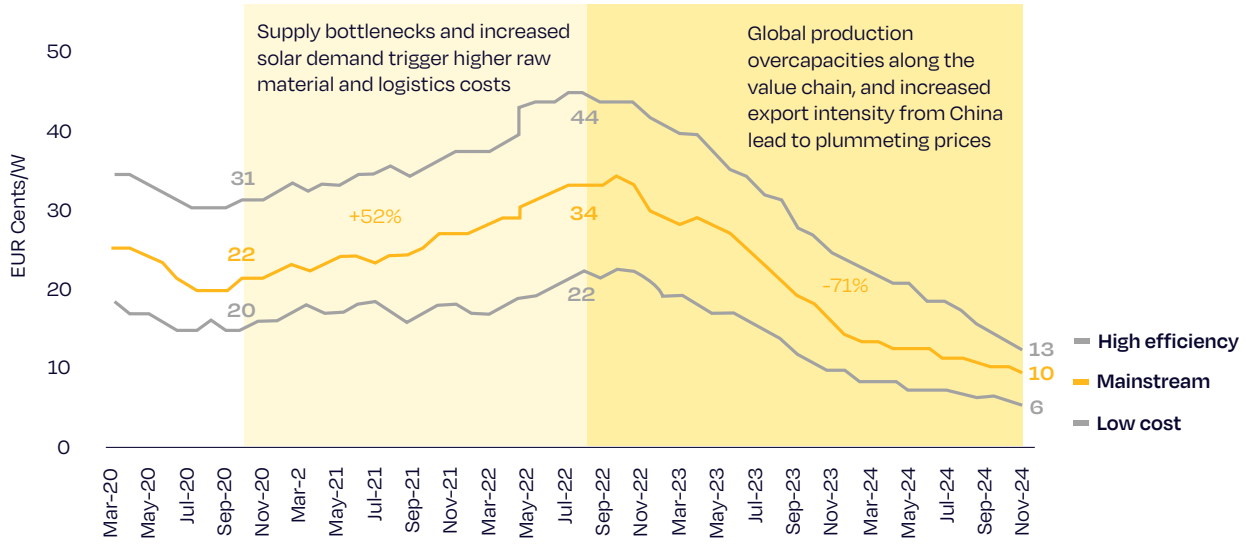
Note: Data considers only capital investments in PV capacity that was grid-connected in 2024
Source: SolarPower Europe

However, in 2023, the first signs of a price decline began to emerge. Driven by falling polysilicon prices and a continuous global demand boom, the world began to experience overcapacity in global PV manufacturing along the value chain, leading to increased Chinese export activity. As a result, European wholesale prices for solar PV modules more than halved from the latest peak in August 2022 until the end of 2023 (see Fig. 9), while CAPEX for utility-scale PV projects went down by 9% in 2023.

Figure 9

After peaking in August 2022, EU wholesale prices for solar modules have dropped by more than 70%

EU wholesale PV module prices 2020-2024



Source: pvXchange

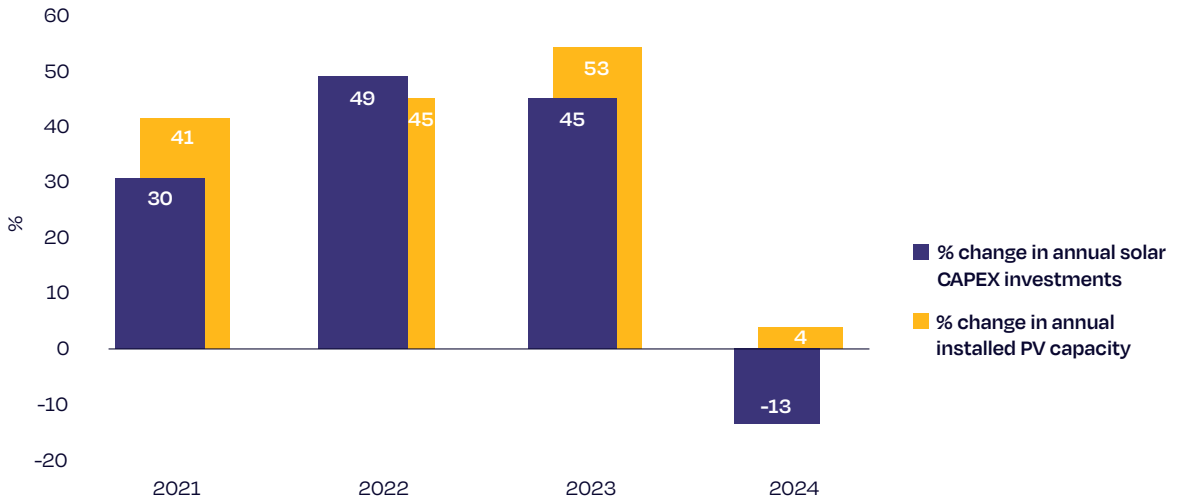
In 2024, the landscape has changed dramatically, as module prices plummeted to new lows in European wholesale markets, decreasing on average by 35% from January to November 2024, together with lower prices for balance-of-system (BOS) products and installation cost.. This led to a 2% and 28% decrease on average rooftop and ground-mounted PV system CAPEX respectively. Record-low PV equipment prices, combined with a sharp slowdown in annual market growth in 2024, caused capital investments to decrease by 13% to less than EUR 55 billion relative to 2023.

The reduction in PV module and component prices, coupled with a slowing of the EU market in 2024, have resulted in a decline of the solar sector's revenue pool. Although more business was made, it is not enough to outweigh the continued and sharp price drop. As shown in Fig. 10, there is a decoupling effect between deployment and CAPEX investments. In 2022, capital investment levels had to increase by 49% to sustain a 45% annual growth in solar PV deployment. However, in 2023 and 2024, these dynamics have reversed. More solar PV deployment does not lead to higher capital investment needs. In 2023, a 53% expansion of the annual market led to 45% increase in capital investments, while in 2024, a 4% year-on-year growth in solar PV annual installations meant 13% less capital expenditure.

Figure 10

Widening gulf: Solar investment growth turns negative as installation growth falls

Relationship between % change in solar capital investments and solar PV deployment in the EU, 2021-2024



Source: SolarPower Europe

183 MW solar plant, Santas project, Portugal

Total EU solar PV installed capacity reaches 338 GW by end of 2024, while top 5 markets hold over 2/3rd market share

Over the past decade, the total installed solar PV capacity in the EU has quadrupled, rising from 82 GW in 2014 to 338 GW in 2024. Notably, the bulk of this growth occurred in the past five years, with capacity nearly tripling from 120 GW installed in 2019.

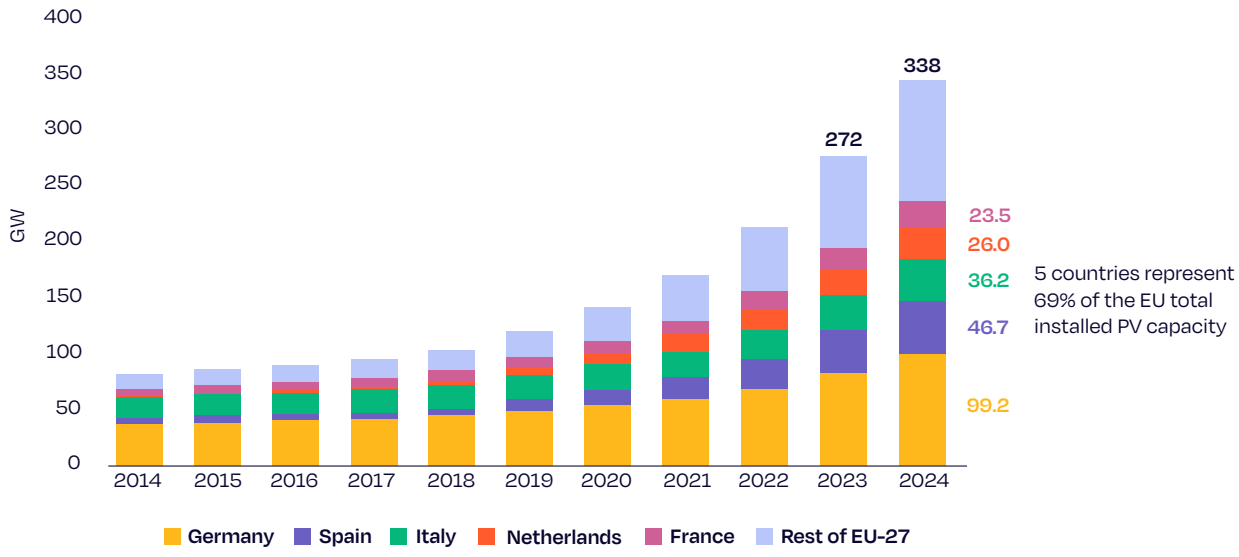
EU solar market distribution has also evolved, with the dominance of the top markets gradually lessening. In 2014, the top five markets accounted for 87% of total installations; ten years later, the top five's share has declined to 69% by the end of 2024. It includes Germany (99.2 GW), Spain (46.7 GW), Italy (36.2 GW), the Netherlands (26 GW), and France (23.5 GW).

The picture looks somewhat different for the top ten markets, as their combined very high share has decreased much less – from 87% of total installed capacity in 2024, down by 11 percentage points from 96% a decade ago. The top 10 markets now account for 292 GW of the EU's total 338 GW of installed solar capacity. In contrast, the remaining 17 markets collectively contribute just 45.1 GW – less than half of Germany's installed capacity alone. However, these 17 markets represent only 21% of EU population and 19% of GDP.

Figure 11

The EU crosses 330 GW of solar PV installed capacity in 2024

EU-27 cumulative solar PV capacity 2014-2024



Source: SolarPower Europe

Only 5 of the top 10 markets installed more PV capacity than in 2023

A notable shift in terms of growth dynamics among the top 10 EU solar markets has emerged in 2024, as only five of them installed more capacity than in the previous year. This contrasts sharply with 2023, when all major markets experienced growth, and 2022, when only France had to endure a decline of 400 MW.

The 2024 deployment contractions in the major markets – Spain, Poland, the Netherlands, Austria, and Hungary – partly had, next to the post-energy price crisis market slowness and other factors, another major reason for their decline: policymakers didn't follow the rulebook that regulatory stability is key to maintain an investment friendly environment for solar PV.

Those top solar countries that added more capacity than the year before, grew only very modestly. Among the top ten, only France, Greece, Italy and Germany achieved net annual increases exceeding 1 GW, with France at the front at 1.5 GW, Greece at 1.3 GW, while Italy and Germany respectively added 1.1 GW and 1 GW more than the year before.

This reflects national markets where the low hanging fruits have largely been captured, and significant year-on-year surges become less common as electrification and system flexibility have not kept pace with the fast growth of the solar market.

Among the top 10 experiencing a decline, the Netherlands saw the steepest drop, with annual installations falling by 1.8 GW – from 4.9 GW in 2023 to 3 GW in 2024. This decline was mostly driven by significant uncertainty surrounding the future of net metering for the residential market. In November 2024, the Dutch parliament provided some clarity by agreeing to phase out the net-metering scheme by 2027, but there remains policy uncertainty as no plans have been unveiled for what comes next.

In Spain, a decline in the rooftop market led to a reduction of approximately 400 MW in total annual additions. The rooftop segment had boomed during the energy crisis, boosted by local incentives from the EU Recovery and Resilience Fund (RRF), and to a lower extent by increased electricity prices. However, without structural changes to the support framework, the depletion of RRF funding, and the normalisation of electricity prices, the rooftop market has been losing momentum and contracted by 17% in 2024.

Figure 12

Five of the top 10 EU solar markets installed less in 2024 than 2023

Net change in newly installed solar PV capacity, EU-27 top markets 2022-2024

Source: SolarPower Europe

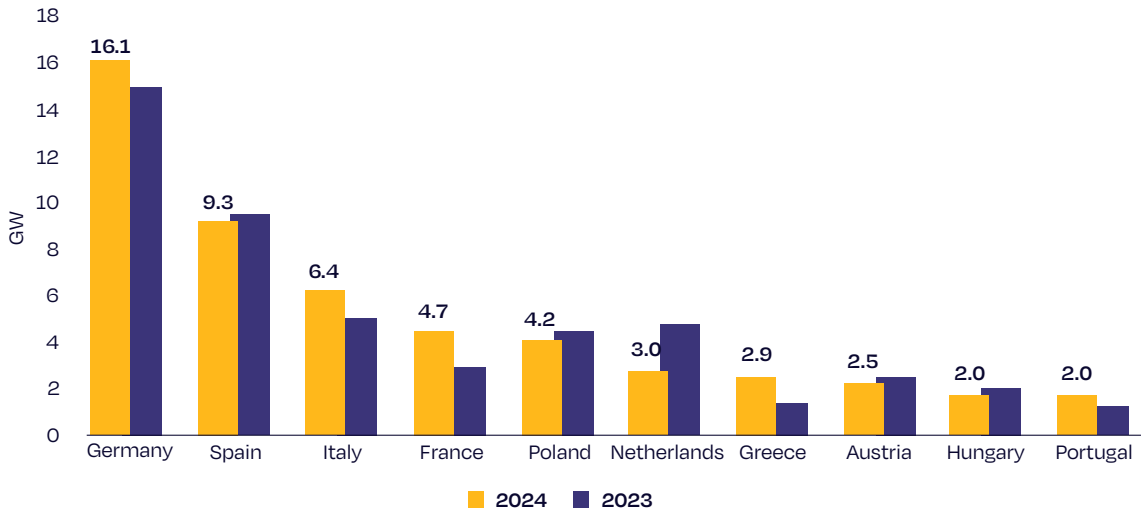
The Polish and Austrian markets also saw modest contractions in 2024, with Poland's annual installed capacity decreasing by 500 MW and Austria's by 400 MW. In Poland, the residential market has continued to decline gradually following the transition from net metering to net billing in 2023. Meanwhile, the Polish utility-scale segment faces ongoing challenges in securing grid connections, which has slowed the pace of new installations. In Austria, the market reduction was most pronounced in the commercial and industrial (C&I) segment. Many companies scaled back their solar project pipeline due to rising inflation, lower electricity prices, and broader economic pressures, creating a challenging business environment in that largely unexplored segment.
In Hungary, the smallest of the shrinking top 10 solar markets, the rooftop segment took a hit following the switch from net metering to net billing, while the electricity price for households is still regulated and kept at low levels.

Despite the challenges faced in the 10 largest solar markets, there has been only minimal changes in the ranking in 2024, with only two new entries – Greece, now ranked 7th, and Portugal, on 10th place – replacing Sweden and Belgium (see Fig. 13). In 2024, 2.0 GW of newly installed capacity was needed to enter the top 10, up from 1.5 GW in 2023. At the same time, 16 out of 27 EU Member States added more than 1 GW of solar capacity in 2024 – that's another all-time record and 2 more than in 2023 (see Chapter 5 for more details of the GW-scale markets in the EU).

Figure 13

Little changes among top 10 solar markets in 2024 with 3 leaders keeping their ranks

EU-27 top 10 annual solar PV additions 2023-2024



Source: SolarPower Europe

While most of the markets are influenced by common EU-wide energy price and energy market trends, such as lower electricity prices, limited energy storage capacity and insufficient system flexibility, each country is confronted with somewhat different local policy frameworks and a solar sector at a different evolutionary stage, thus experiencing its own unique set of challenges and drivers that shape its solar market dynamics. Box 2 provides an overview of key PV deployment statistics for each of the top 10 countries in 2024.

Box 2

Overview of top 10 PV markets 2024

1 (=)

2024 set a new record for newly installed capacity in the country. Annual growth slowed down, indicating that the low hanging fruits in the rooftop market have been largely captured, and that the energy-crisis momentum is fading out. Still, the market overperformed by 7% compared to our previous Medium Scenario, partly driven by strong participation in tenders, which were mostly oversubscribed.

Germany

2024 Annual market	16.1 GW +1.0 GW & +7% from 2023	63% Rooftop	37% Utility
2024 Cumulative market	99.2 GW #1 in Europe	70% Rooftop	30% Utility

2 (=)

The market marginally decreased from 2023 due to a slowdown in rooftop PV demand, while utility-scale remained stable thanks to its robust PPA market. Grid constraints and increasingly low solar capture prices indicate a lack of flexibility that poses a challenge to the economic viability of utility-scale solar projects.

Spain

2024 Annual market	9.3 GW -0.4 GW & -4% from 2023	18% Rooftop	82% Utility
2024 Cumulative capacity	46.7 GW #2 in Europe	22% Rooftop	78% Utility

3 (=)

The market registered the highest performance in over 10 years – but still below the record 9.2 GW added in 2011. The annual growth rate did not reach the very high levels of 2022-2023, as the residential and commercial segments decelerated, driven by lower electricity prices, the fade out of support schemes, and high interest rates. On the other hand, industrial and utility-scale installations registered an all-time high.

Italy

2024 Annual market	6.4 GW +1.1 GW & +22% from 2023	60% Rooftop	40% Utility
2024 Cumulative capacity	36.2 GW #3 in Europe	76% Rooftop	24% Utility

4 (+2)

France achieved much-awaited strong growth in 2024, with a sharp increase in rooftop installations, thanks to lucrative feed-in tariffs and the growing impact of solar mandates. Ground-mounted deployment also increased, despite permitting and land availability continuing to hinder expansion.

France

2024 Annual market	4.7 GW +1.6 GW & +50% from 2023	74% Rooftop	26% Utility
2024 Cumulative capacity	23.5 GW #5 in Europe	60% Rooftop	40% Utility

5 (=)

Poland experienced a decline in annual solar installations compared to the previous year, with reductions in both rooftop and ground-mounted capacity. Growth in the small-scale segment remains highly dependent on incentive schemes for which conditions worsened in 2023, while securing grid connections continues to pose the largest challenge for utility-scale projects.

Poland

2024 Annual market	4.2 GW -0.5 GW & -10% from 2023	53% Rooftop		47% Utility
2024 Cumulative capacity	21.0 GW #6 in Europe	72% Rooftop		28% Utility

6 (-2)

The Dutch market experienced the largest annual decline across the top 10, due to worsened policy conditions in its mature residential segment. C&I installations partially declined, while utility-scale growth stagnated. Next to land availability, a major issue for ground-mounted projects is grid connection times, as the network is subject to growing constraints. Persistent regulatory uncertainty on PV support schemes negatively impacted investors' visibility on the solar business case and damaged public perception on solar.

Netherlands

2024 Annual market	3.0 GW -1.8 GW & -38% from 2023	60% Rooftop		40% Utility
2024 Cumulative capacity	26.0 GW #4 in Europe	75% Rooftop		25% Utility

7 (+4)

Greece recorded the strongest market growth in the top 10, with increases across all segments and a doubling of annual capacity in the industrial sector. Developers rushed to meet the August 2024 deadline for securing feed-in premiums for industrial systems, although not all planned capacity was completed in the course of the year. The transition from net-metering to net-billing slightly dampened residential deployment, but overall growth remained robust.

Greece

2024 Annual market	2.9 GW +1.3 GW & +84% from 2023	69% Rooftop		31% Utility
2024 Cumulative capacity	10.0 GW #8 in Europe	68% Rooftop		32% Utility

8 (-1)

Austria's annual installations decreased, due to a significant slowdown of the rooftop market. Worsened economic conditions, coupled with lower electricity prices, led to a decrease of commercial installations, while the residential segment remained somewhat insulated from these challenges, supported by a notable VAT reduction. The absence of zoning and designated areas for utility-scale projects limits the growth of this segment.

Austria

2024 Annual market	2.5 GW	-0.4 GW & -14% from 2023	88% Rooftop	12% Utility
2024 Cumulative capacity	9.1 GW	#10 in Europe	93% Rooftop	7% Utility

9 (-1)

Hungary's solar market slightly contracted, with the residential segment seeing the steepest decline. The shift to net billing at the end of 2023, coupled with low regulated energy prices for residential customers, has hindered residential solar in 2024. Most of the capacity was installed in the utility-scale segment, developed under the KÁT feed-in scheme. Licensing and grid connection challenges for large PV installations persist, while financing difficulties – due to limited PPA uptake and the low bankability of merchant projects – further constrain growth.

Hungary

2024 Annual market	2.0 GW	-0.1 GW & -6% from 2023	64% Rooftop	36% Utility
2024 Cumulative capacity	9.3 GW	#9 in Europe	70% Rooftop	30% Utility

10 (+4)

Portugal had a record year in 2024, installing 2 GW of new solar PV capacity, with over 1 GW coming from large-scale projects, mostly from the previous pipeline. The rooftop market remained stable, with small-scale projects benefitting from the Environmental Fund support. Efforts to simplify permitting procedures have been ongoing for two years, but further progress is needed. Hybrid projects (PV+wind or PV+storage) are gaining interest, although only a few have been implemented so far.

Portugal

2024 Annual market	2.0 GW	+0.5 GW & +37% from 2023	43% Rooftop	57% Utility
2024 Cumulative capacity	6.4 GW	#11 in Europe	48% Rooftop	52% Utility

Then there were three: two further EU Member States surpass 1 kW per capita

The Netherlands remains the EU leader in solar PV installed capacity per capita, reaching 1,467 W per inhabitant in 2024, a 13% increase from 2023. With 19% annual growth to 1,192 W per capita, Germany keeps its second rank as it surpasses the 1 kW per capita milestone for the first time.

Another newcomer exceeding the 1-kW-per-capita threshold is Austria, which augmented its deployed capacity per inhabitant by 37% to 1,013 W per capita. This strong growth rate catapulted Austria by four ranks, replacing Denmark on the third rank. Assuming a rough average of 500 W per solar panel, this means The Netherlands, Austria, and Denmark host around 2 solar panels per citizen in their respective countries. Among the top 10 countries of solar per capita, nine boast capacities exceeding 900 W per capita by end of 2024, with Slovenia rounding out the group at 802 W per capita.

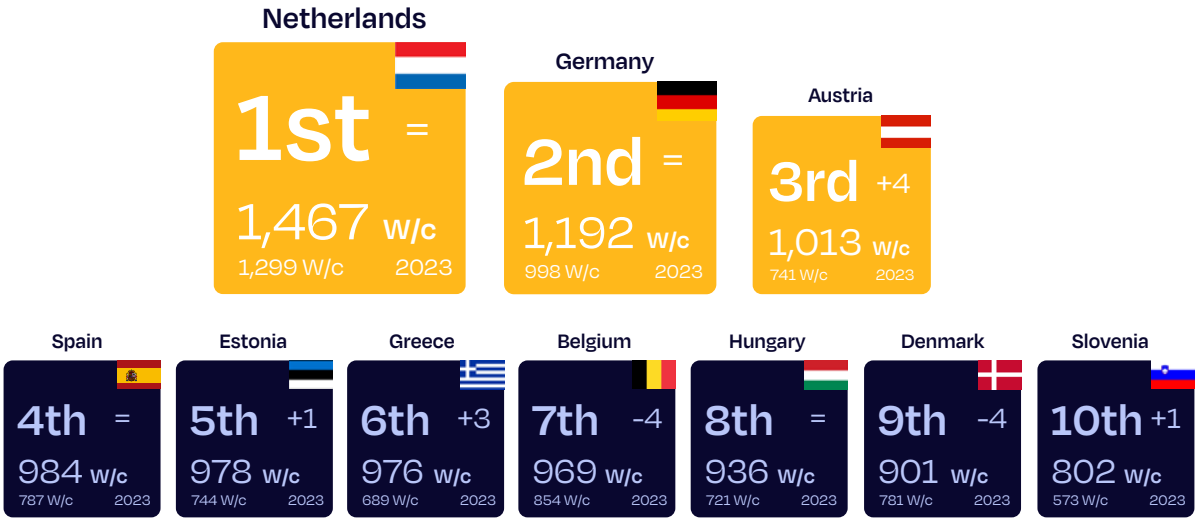
A look at annual per capita additions in 2023 shows a somewhat different picture. The two leaders are Ireland and Lithuania, which both presented strong growth rates, the first added 301 W per capita, and the second 297 W. But as the solar boom in these countries started rather recently, they have not reached the cumulative top ten rankings.

Overall, end of 2024, the EU average of total installed capacity per capita stands at 755 W, a 24% increase from 607 W in 2023. Eleven countries rank above this threshold, while sixteen countries are below. The least solarised EU population lives in Slovakia (211), Croatia (244), Romania (275), Finland (309), and Latvia (362).

Figure 14

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

EU-27 top 10 countries cumulative solar PV capacity per capita 2024



Source: SolarPower Europe

The bigger the better? Utility-scale mostly hops, while small rooftop PV mostly flops

After residential rooftop solar (systems below 10 kW) experienced strong absolute growth in 2022 and 2023 that was fuelled by the energy crisis, the end of this steep upward trend began in 2023 and ended abruptly in 2024. Demand in the household segment plummeted by nearly 5 GW to 12.8 GW, basically the same level seen in 2022.

Market dynamics varied across the EU, but almost all of the top solar markets experienced significant decreases in the solar homes segment, including Germany, Austria, Italy, Poland, the Netherlands, Belgium, Sweden, Spain, and Hungary. Among the larger EU solar markets, only France (+48%) and Romania (+43%) recorded notable growth in installed capacities for residential rooftops in 2024, though absolute capacities in this segment remain relatively low in these two countries. With only 13 of the EU Member States' solar home segment getting larger in 2024, the market share of residential rooftop in the EU fell to 20% in 2024, from 28% in 2023 (see Fig. 15).

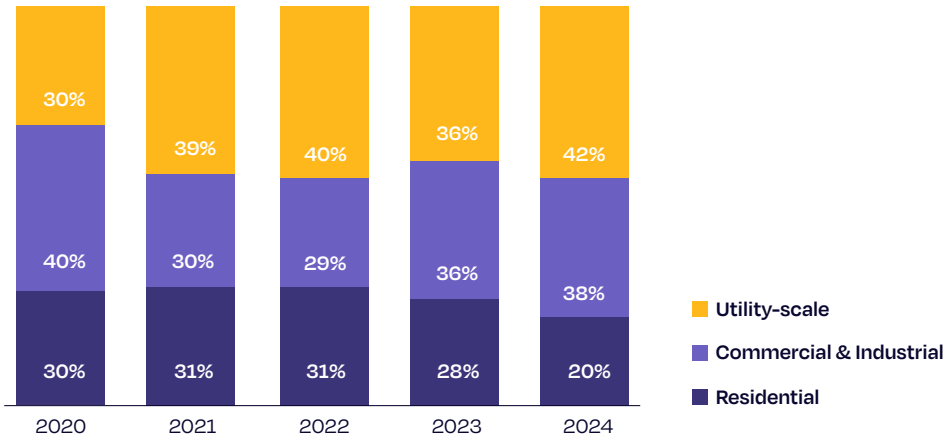
In contrast, the larger rooftop segment of commercial and industrial systems (10-1,000 kW) experienced slight growth. As 20 countries saw more capacity deployed on commercial and industrial rooftops, the market share increased slightly by 2% points to 38% in 2024, from 36% in 2023.

Utility-scale systems, mostly ground-mounted but also including some large rooftop system capacity above 1 MW registered growth too – in 16 out of 27 EU countries. Notable upswings include Germany with 5.9 GW (+29%), Italy with 2.6 GW (+123%), and Portugal with 1.2 GW (+100%). Bulgaria

Figure 15

Utility-scale drives new EU solar installations in 2024 as residential rooftop segment slumps

EU-27 annual solar PV segmentation 2020-2024



Source: SolarPower Europe

(-30%) was the only market with a significant market reduction for ground-mounted PV. In terms of annual market share, the utility-scale sector led the way in 2024, capturing 42% of the market, up from 36% in 2023. That is the best performance for the utility-scale segment in the last 5 years.

The post energy crisis downward trend for residential rooftops hasn't altered the overall picture for distributed solar power generation. Residential and C&I rooftop systems combined remain the largest source of new installations in the EU PV market, though their combined market share dropped from 64% in 2023 to 58% in 2024.

The performance of the different solar PV segments varies significantly across EU countries, influenced by individual challenges and local support mechanisms. As a result, certain segments thrive in specific countries while underperforming in others.

Positive developments have been observed across several solar PV segments in various EU countries (see Fig. 16). In the residential segment, **France** has benefited significantly from the advantageous so-called S21 Feed-in Tariff, which continues to incentivise installations up to 500 kW. **Romania's** Casa Verde programme remains a strong driver for residential and C&I, both tagged prosumer installations. **France** was also among the most notable performances in the C&I segment, with a 55% installation growth rate, supported by the S21 Feed-in Tariff as well.

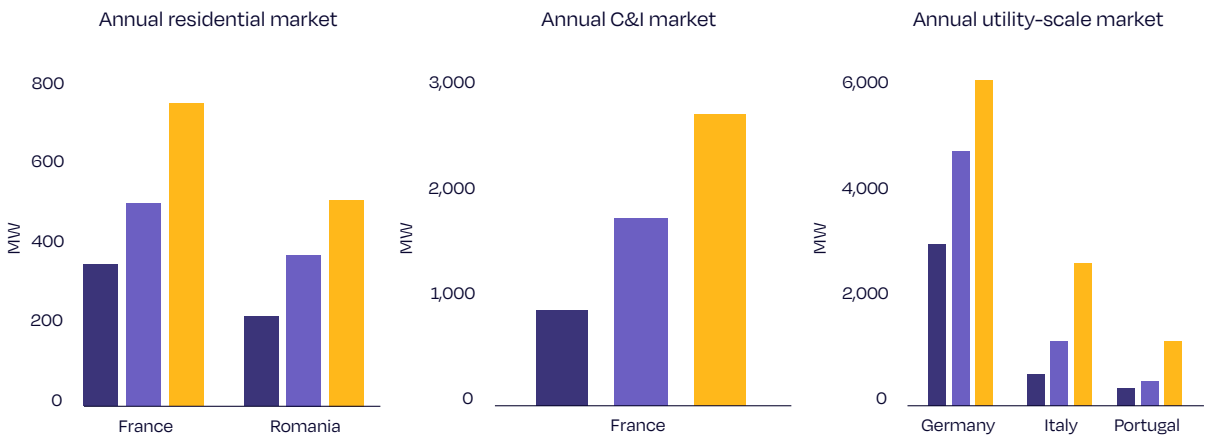
The **utility-scale segment** grew in several markets. In **Germany**, the segment reached 5.9 GW, a 29% increase supported by the government's auction programme. **Italy** also saw significant activity in utility-scale projects, improving by 123% to 2.6 GW in 2024. Another notable growth case is **Portugal's** utility-scale market, which expanded by 100%, driven largely by projects from its existing pipeline. As challenges persist in Portugal, including permitting delays and the lack of system flexibility, such as storage and grid capacity, the development of new projects will be lower in the near future.

In the **residential segment, Hungary** (-74%), the **Netherlands** (-65%), and **Belgium** (-60%) saw sharp reductions, primarily due to the phasing out of net-metering schemes. In the commercial and industrial segment, **Austria's** market contracted by 39%, mostly because inflation hindered business activity and investment in new solar installations. **Sweden** also experienced a 31% decline, as systems over 500 kW became subject to a self-consumption tax, reducing the development of large rooftop installations. Meanwhile, **the Netherlands** recorded a 21% decrease, reflecting the overall uncertainty in the rooftop regulatory framework.

Figure 16

Positive highlights in annual segment performance in 2024

Annual residential market; Annual C&I market; Annual utility-scale market



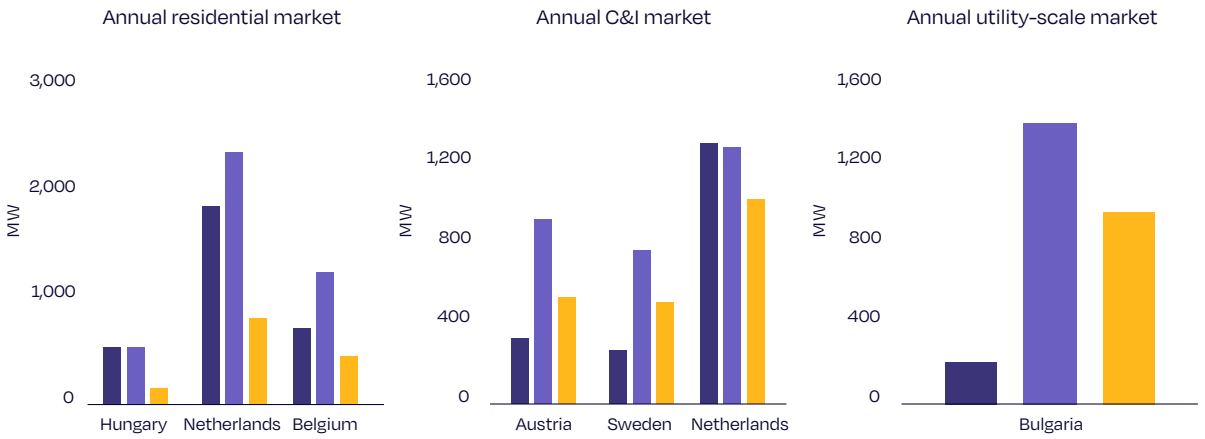
Source: SolarPower Europe

In the utility-scale segment, only **Bulgaria** saw a notable 30% decline, as many projects await the rollout of storage solutions tied to Recovery and Resilience Funds, which have yet to be disbursed.

Figure 17

Negative highlights in annual segment performance in 2024

Annual residential market; Annual C&I market; Annual utility-scale market



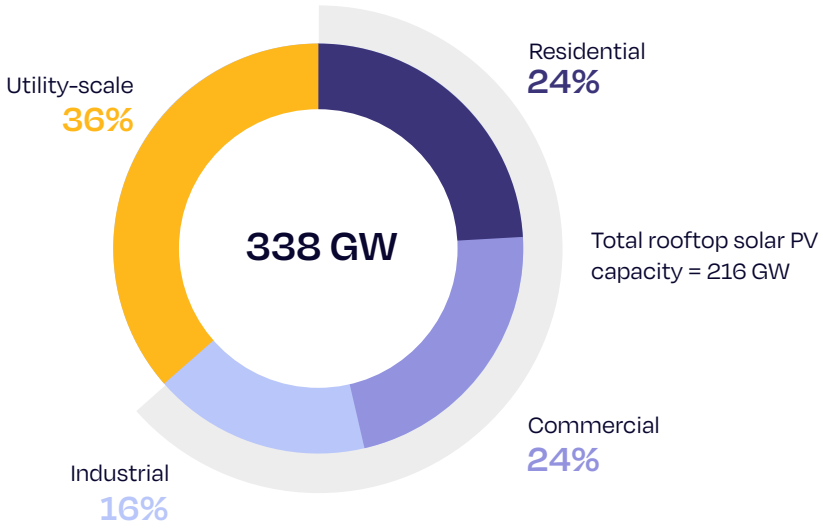
Source: SolarPower Europe

Despite the utility-scale segment's annual gains in 2024, its contribution to the entire EU solar power generation fleet has hardly changed, improving only by 1.5% points. Large solar systems now account for 36% of total EU's installed capacity, while total rooftop capacity makes up for 64%, with residential and commercial contributing 24% each, and the industrial sector representing 16% (see Fig. 18).

Figure 18

Two-thirds of the EU solar fleet is on rooftops

Segmentation of cumulative EU solar PV installations 2024



Source: SolarPower Europe

EU solar market prospects 2025-2028

The EU solar market is poised for further slow growth, reaching 82 GW in 2028 but facing significant challenges that could jeopardise solar bankability. Over 60% of the expected new capacity will come from just five countries. The sector is on track to meet the REPowerEU intermediate target of 400 GW by 2025. While utility-scale projects are growing faster, rooftop solar installations will continue to serve as the backbone of the EU's total operating PV power generation fleet.

Growth ahead, but looming challenges are putting solar bankability at risk

The EU solar PV market is set to grow further, but the times of explosive expansion seen during the early days of the modern solar power era and the energy crisis seems to be behind us. Over the next four years, most likely growth is expected to settle at a more modest annual rate of 3 to 7%. This slower growth reflects severe structural challenges, in particular in those Member States where adaptations of policy frameworks and infrastructure have been lagging behind the solar sector's rapid evolution into a notable pillar of power supply. It also remains to be seen what the changing political landscape to the right means for solar in the EU.

Rooftop capacity is hardly growing, and residential PV is hit the hardest

Residential PV, a driving force across the EU so far, will continue its downward path; the overall share of home solar capacity will further decrease in the coming years. Not only have many citizens interested in solar purchased such systems during the past energy crisis, leaving an educated customer gap to be filled; retail power prices have also quickly 'normalised' – and are not expected to spike anytime soon again. Additionally, several schemes to help citizens go solar as a protection measure from high prices during the energy crises already have run out or likely will in the near future. The incentive situation has exacerbated as net-metering or other very attractive schemes have been shelved or changed toward business models focused on pure self-consumption as countries are looking to save on budget in challenging economic times. This is happening without substantial improvements of regulatory conditions to enable incentive-free business models. Finally, grid congestion in low-voltage networks has become a limiting factor in many established solar markets.

A bright spot in residential solar has been the relatively new sub-segment of plug-in solar. Systems under 800 W_{AC} (2 kW_{DC}) that can be installed in apartment buildings (thus tagged balcony solar) or any other place in the urban environment by simple grid-connection with a regular plug in a home socket and without need for installers. Pioneered in Germany, this low-cost system has been very popular, adding over 220,000 systems in H1/2024 in that country alone. While plug-in solar has enabled tenants to go solar, home owners increasingly opt for this system type as well, resulting in increasing numbers of rooftop systems but lower capacities and lower sector revenue generation.

Lack of flexibility reduces utility-scale projects development pace

Larger ground-mounted projects are expected to lose some of their shine as the inflexibility of Europe's energy system is becoming increasingly problematic. Grid infrastructure and interconnectors are insufficient to balance supply and demand across borders effectively. These limitations prevent countries from transporting renewable electricity surpluses to areas of higher demand or sharing power during shortages. Grid congestion is becoming a serious issue, increasingly leading to negative electricity prices and higher curtailment rates, which diminish the financial appeal of solar investments.

Germany, for example, had a renewables power share of 47% in 2023, based to a large extent on wind and solar, and curtailed 10.5 GWh of renewable electricity, equal to 4% of total renewable generation that year. Through grid congestion it faced extraordinary grid management cost of over 3 billion EUR in 2023. Moreover, it experienced around 300 hours of negative electricity prices in 2023, a number that had increased to over 415 hours in the first 10 months of 2024.

To properly integrate renewable, battery storage capacity is necessary, but their deployment is still insufficient. Residential and grid-scale storage must play a central role, capturing excess daytime generation for use during evening peaks and improving overall system resilience.

Too slow electrification rate in the EU

At the heart of the slowdown is a systemic bottleneck – a sluggish electrification rate. Despite the rapid expansion of renewable capacity, Europe's electrification rate has been stuck at around 22–23% for the past five years. Key sectors such as industry, heating, and transportation are not transitioning to electricity quickly enough to keep pace with the growing volumes of renewable electricity being generated. Accelerating this shift is essential for the effective integration of solar electricity and achieve EU decarbonisation goals.

The permitting and land access bottleneck

Permitting and land access remain cumbersome across several Member States, delaying project timelines and hindering growth. Simplifying these processes and ensuring land availability are critical for sustaining momentum in utility-scale project deployment. Effective and swift transposition of EU legislation on the matter at the national level will play a key role.

European political developments less favourable to renewable energy

Several European elections resulted in significant shifts in political power, with right-wing parties, traditionally less supportive of renewable energy, making substantial gains. This political shift is echoed across several Member States, including Czech Republic, Finland, France, Germany, Italy, Netherlands, Romania, Slovakia, and Sweden, where right-leaning parties have gained influence. The overall support and the implementation of environmental law in general could be hampered. This risk has already materialised in Czech Republic where retroactive cuts to feed-in tariffs for PV are on the table. In addition, full implementation on the European Green Deal could be slowed down in several Member States.

6.5 MW Cerrione solar PV plant, Italy

The mounting challenges presented above have led to a downward revision of our growth projections. After we downgraded our Medium Scenario in the GMO 2024 six months ago, we are again lowering our growth expectations as flexibility, electrification, and policy issues weigh on the sector's prospects.

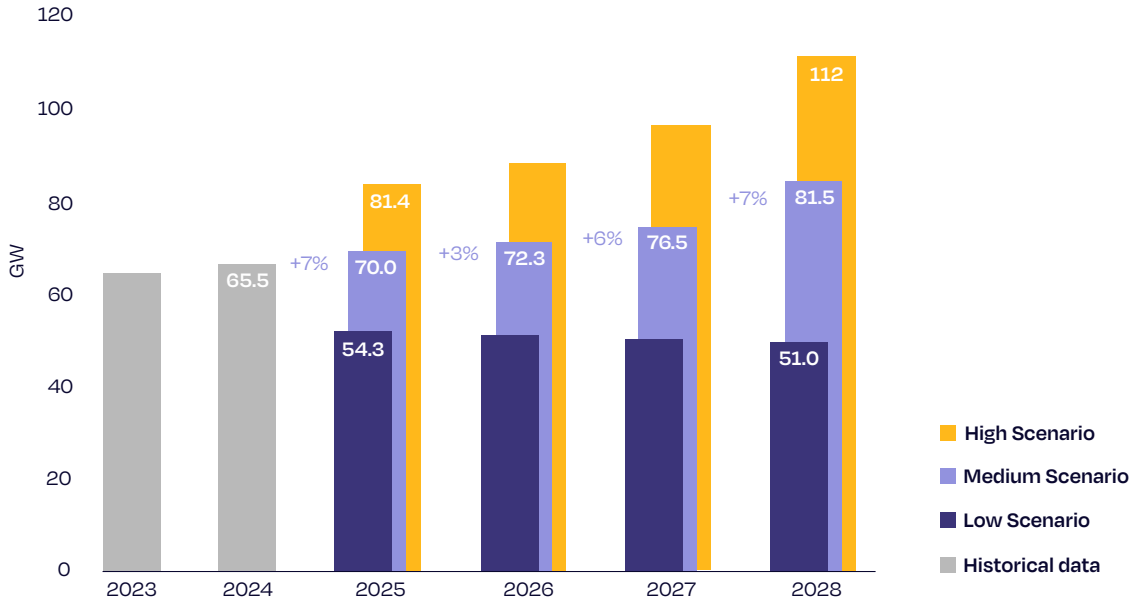
In 2025, the market is projected to add 70 GW of capacity, representing a 7% growth rate. This increase will primarily come from utility-scale projects initiated in 2023-2024 that benefitted from record low module prices. Growth rates will further drop in 2026, when we expect only 3% market growth to 72.3 GW, as we anticipated a downturn in project activity, with developers reacting to mounting grid constraints and market uncertainties. The EU market is forecasted to improve by 6% to 76.5 GW in 2027, and by 7% to 81.5 GW in 2028, according to our Medium Scenario. For 2027, that means a 15.2 GW or 16% lower forecast than published in the GMO in June 2024 (see Box 3). While we do see positive impacts from EU legislation driving the solar market, like the EPBD's requirements for installation of solar on buildings, we anticipate a decrease in political commitment at a time many Members States will have met their National Energy and Climate Plans (NECPs) solar targets.

Another notable shift from our June 2024 market assumption is the significant drop projected in our Low Scenario. Several countries are walking on a thin line between maintaining a stable market and experiencing a sharp decline as structural challenges intensify. On the one hand, rooftop solar markets in several countries have reached maturity, and, while no longer fuelled by high electricity prices, are facing reduced support as net-metering schemes phase out. Many countries, such as Belgium, Hungary, the Netherlands, and Slovenia, are still seeking viable alternatives to replace these programmes. On the other hand, grid saturation is becoming a critical issue, making it increasingly difficult to integrate additional renewable electricity from solar. This challenge, compounded by insufficient storage and interconnection capacity, has led to a rise in negative electricity prices across the EU and decreasing solar capture rates, undermining the financial viability of solar projects.

Figure 19

EU solar market expected to continue to grow but at slower pace

EU-27 annual solar PV market scenarios 2025-2028



Source: SolarPower Europe

While these structural issues are still in their early stages, they risk to become significant barriers to growth if not urgently addressed. On top, in a quickly defragmenting world, trade barriers for key industries are increasingly being implemented in many countries. In light of these challenges, our Low Scenario projects a 17% drop in the EU's annual installed capacity in 2025, falling to 54.3 GW. This decline is expected to be followed by years of slight contraction, with annual reductions of 1% to 3%. By 2028, the annual market size could shrink to 51 GW – a 22% decrease from 2024 levels.

By contrast, our High Scenario remains relatively optimistic but reflects a slower growth trajectory than before. While our June market update projected annual deployment to reach 112 GW by 2027, this milestone now appears achievable only by 2028. Since our last update, no significant structural changes – such as new and much more ambitious solar targets or a potentially brighter political outlook – have emerged to push the High Scenario further upward. Instead, as obstacles become increasingly apparent, our most ambitious outlook is also losing momentum.

In conclusion, the EU solar PV market is entering a phase of slower, more marginal growth. While the market will continue to expand, in the worst case its pace could even fall short to deliver of what is needed to meet the EU's climate and energy transition goals. Addressing systemic challenges – such as enhancing grid flexibility, accelerating electrification across key sectors, and simplifying permitting processes – will be essential to unlock the market's full potential. Without these improvements, the transition risks losing momentum, underscoring the need for sustained efforts to ensure solar can play its vital role in Europe's clean energy future.

11 MW floating solar plant in Gouts, France

Box 3

Looking back and forth

In the past, solar analysts used to revise their forecast numbers upwards – it seemed like growth had no limits. It appears that these times are over in the EU, as this year's analysis of previous market forecasts draws a drastically different picture.

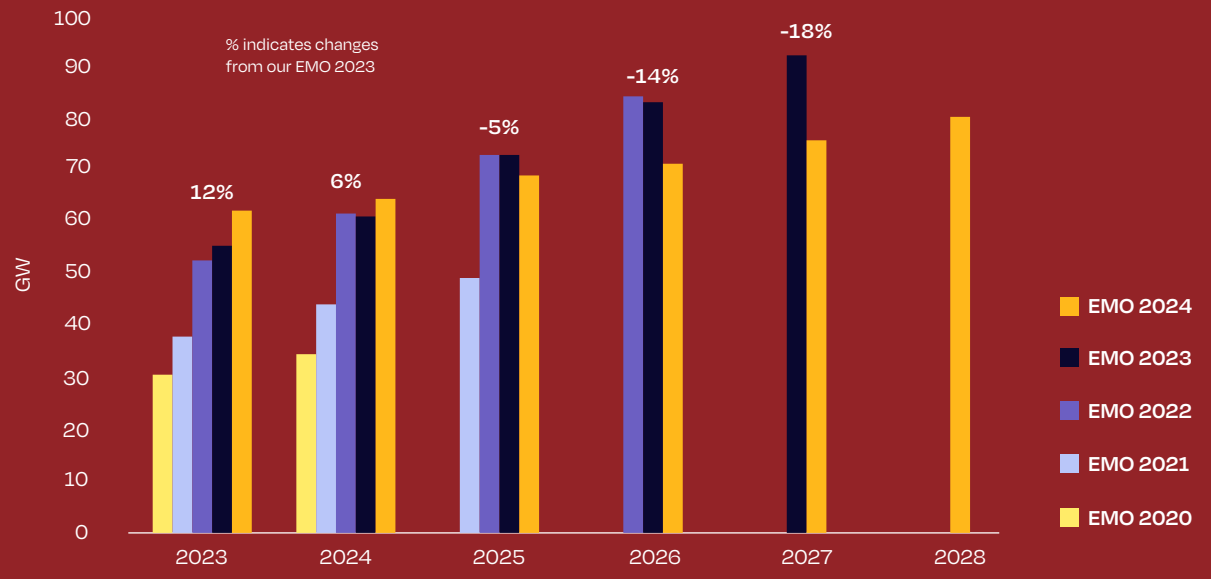
Compared to our **EMO 2023** (December 2023) projections, we have reduced our forward-looking projections for 2025, 2026, and 2027 by 5%, 14%, and 18%, respectively (see Fig. 20). This trend was somewhat already visible in December 2023, when we adjusted slightly downwards the forecasts for the years 2024-2026 compared to the previous predictions.

This decrease builds on the challenges outlined on p. 39 , which are not new, but their resolution remains slow, and some are becoming more urgent as the PV fleet expands. While some progress has been made in permitting and land access, administrative simplifications and procedural streamlining remain insufficient. This has left dozens of gigawatts of solar projects stuck in national approval pipelines. In addition, the lack of sufficient storage and grid infrastructure is increasingly problematic. As renewable electricity generation rises, integration challenges lead to supply surpluses and unsustainably low electricity prices, undermining the financial viability of new projects.

Figure 20

Annual market expectations are further decreased as existing challenges persist

Comparison medium scenario EMO 2024 vs previous EMO editions



Source: SolarPower Europe

By contrast, looking backwards at the EU solar market performance in 2024, we currently anticipate the year to close with 65.5 GW – this is 6% higher than our EMO 2023 projection, where we estimated the 2024 market size at 62 GW. Looking further back, our earlier forecasts were consistently more conservative, underscoring a systematic underestimation of the EU PV market potential (see Fig. 20).

In our **EMO 2022** (December 2022), we predicted the 2024 market would reach 62.3 GW. A year earlier, in our **EMO 2021** (December 2021), we forecasted just 44.1 GW for 2024. Even further back, in **EMO 2020** (December 2020), we projected only 35.1 GW for 2024. As a result, the actual 2024 market size is now expected to be 87% larger than what we anticipated four years ago.

This consistent underestimation of market growth, which is partly due to our bottom-up approach, is also evident in our backward-looking analysis of historical years. Forecasts from **EMO 2020**, **2021**, **2022**, and even **2023** underestimated the size of the 2023 market. Moreover, even in this year's **EMO 2024**, we revised the historical value for 2023 upwards as official statistics continue to be updated. These updates account for newly registered PV systems that were previously unrecorded or in the process of registration.

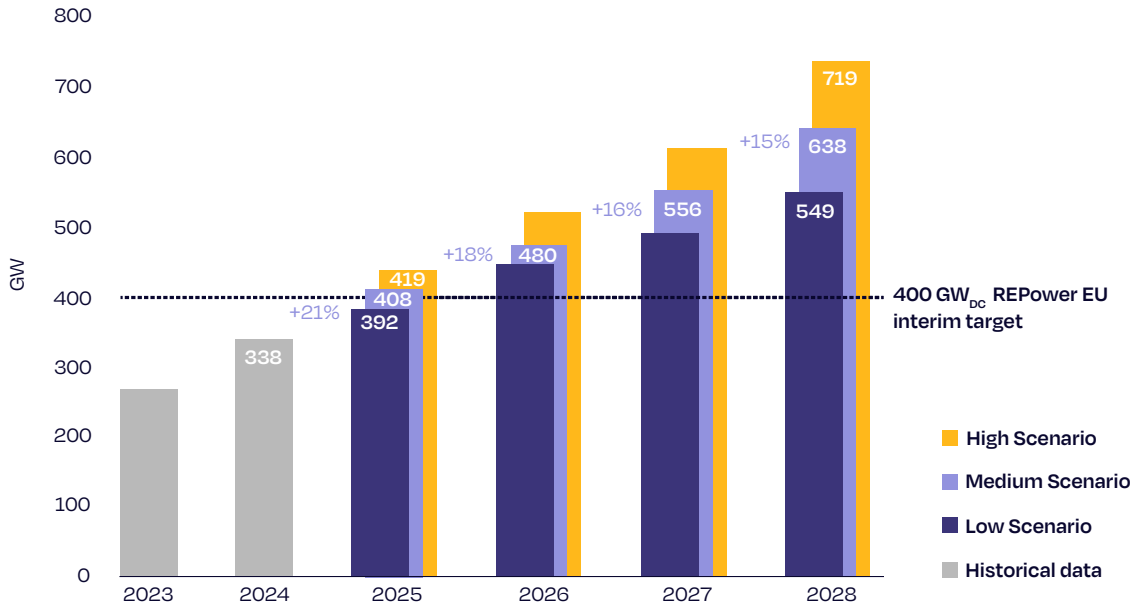
In terms of cumulative installed capacity, after reaching 338 GW at the end of 2024, the EU's cumulative solar PV capacity is expected to exceed the 400 GW level with 408 GW in 2025, 480 GW in 2026, 556 GW in 2027 and 638 GW in 2028, according to our Medium Scenario (see Fig. 21). This represents an addition of 300 GW over the next 4 years, nearly doubling the current installed capacity. In the short term, the EU remains on track to reach REPowerEU's intermediate targets of 320 GW_{AC} / 400 GW_{DC} in 2025 (see p. 54 for a more detailed analysis of the EU solar outlook to 2030 and towards the REPowerEU target).

The High Scenario envisions 27% higher net solar capacity additions of 382 GW by 2028 and pushing total solar capacity to 719 GW. In contrast, the Low Scenario projects 30% lower net capacity additions of 211 GW over the next 4 years, bringing total capacity to just 549 GW. Reaching only 392 GW in 2025, this path would also mean that the 400 GW REPowerEU solar target would be slightly missed.

Figure 21

EU solar market narrowly on track to reach REPowerEU 2025 target of 400 GW_{DC}

EU-27 cumulative solar PV market scenarios 2025-2028



Source: SolarPower Europe

More than 60% of expected new capacity will come from 5 countries alone

The distribution of future solar PV installations across the EU is expected to remain dominated by the current largest markets. Over the next four years, Germany is projected to lead with 73.1 GW of new capacity, followed by Spain with 36.8 GW, Italy with 29.1 GW, France with 28.1 GW, and Poland with 17.5 GW (see Fig. 22). In our Medium Scenario, the top 3 markets (Germany, Spain, Italy) are expected to add 139 GW between 2025-2028, representing 46% of the EU's new solar capacity. Including France and Poland, the top 5 markets' share increases to 61%.

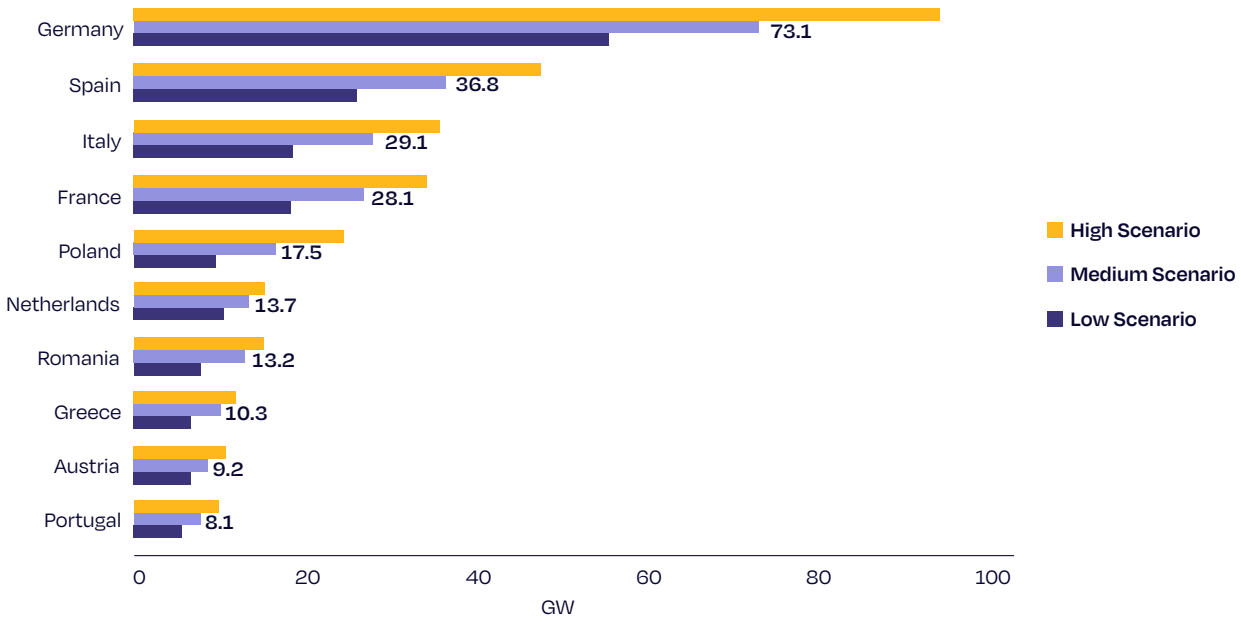
Individual projections reflect a more tempered outlook compared to our forecast from June 2024. Germany's anticipated additions are down by 16%, and Spain's by 4%. Italy is expected to grow more but very modestly by 2%, while France stands out with a 15% upward revision. Poland is revised downward by 5%. All other top markets have been downgraded too, except for Romania which is expected to grow 4% more.

An overview of anticipated market trends, drivers and challenges across the top 10 markets by net solar additions in the period 2025-2028 is provided in Box 4.

Figure 22

Germany, Spain, and Italy are the top EU solar markets toward 2028

Top 10 markets solar PV additions 2025-2028



Source: SolarPower Europe

Overview of top 10 PV markets 2025-2028

1

The utility-scale segment is expected to be the backbone of Germany's solar market growth, fuelled by auctions and PPAs. In contrast, the residential market faces the highest uncertainty as political support towards this segment may decline. While the overall annual market is still expected to grow, the pace will be significantly slower than previously anticipated.

Germany

Total capacity: **172 GW** — Medium scenario 2028, #1 in the EU-27

Cumulative CAGR[3]: **15%** — Medium scenario 2025-2028

Drivers

- Ambitious 215 GW solar target by 2030
- Planned auctions for large-scale PV and large rooftops
- National energy policy focusing on renewables, phasing out of coal

Challenges

- Signs of slowdown in the small rooftop market
- Increasingly less renewable-friendly political environment and subsequent uncertainty on future support to solar
- Storage capacity and flexibility solutions need to increase to integrate variable renewables and enable viable PV business models

*

2

Large-scale PPAs are driving the market, but curtailment and low solar capture rates are hindering developers' business models. Growth in the small-scale rooftop segment is limited due to a lack of support schemes. Overall, the market could shrink if adequate flexibility solutions aren't implemented.

Spain

Total capacity: **83 GW** — Medium scenario 2028, #2 in the EU-27

Cumulative CAGR: **16%** — Medium scenario 2025-2028

Drivers

- Large utility-scale project pipeline with expected support through auctions
- Updated 76 GW_{AC} solar target in NECP
- Energy communities to enable growth in the residential and commercial sector

Challenges

- Growing curtailment rates and negative electricity prices affect large-scale development
- Limited rooftop market development, due to absence of support schemes or long administrative delays
- Growing concerns on social acceptance towards large-scale PV

3 Compound Annual Growth Rate

3

Continuous market growth is expected until 2028, mostly from large-scale PV. The residential segment has lost momentum following the Superbonus phaseout. Changes in electricity price zones could drive C&I installations.

Italy

Total capacity: **65 GW**
Medium scenario 2028
#3 in the EU-27

Cumulative CAGR: **16%**
Medium scenario 2025-2028

Drivers

- Development of battery storage capacity via auctions to support solar market growth
- FER-X decree scheme expected to drive renewable development
- "Transizione 5.0" scheme to support self-consumption C&I installations

Challenges

- Ban of new PV on agricultural land and unclarity on go-to areas limits land availability
- Slowdown of small rooftop market after the energy crisis, Superbonus phaseout, and tax rebate decrease
- Administrative delays pose a challenge to permitting procedures

4

After a record-breaking 2024, the revision of national budget could reduce support to renewables and slow down further market growth. While the utility-scale segment is growing and supported by auctions, it faces challenges with permitting and land access. Agri-PV could unlock significant solar potential in the country, once the legislation is finalised.

France

Total capacity: **52 GW**
Medium scenario 2028
#5 in the EU-27

Cumulative CAGR: **22%**
Medium scenario 2025-2028

Drivers

- Current "S21" feed-in tariff drives PV installations below 500 kW
- Clear auction timeline for large-scale PV
- Largely untapped rooftop market with increasing installation momentum

Challenges

- Revision of national budget could decrease the support towards renewables, especially for rooftop solar
- Strict legislations make it hard to secure land for ground-mounted PV
- Legislation on Agri-PV and installation of PV on carports not fully ready yet

5

The Polish market is expected to remain stable in the next five years. Small-scale solar below 50 kW, supported by the net-billing scheme and the "Mój Prąd" programme, continues to be important. There is also a growing interest in larger solar parks, but grid and storage capacity needs to expand considerably to further grow the solar market.

Poland

Total capacity: **38 GW**
Medium scenario 2028
#6 in the EU-27

Cumulative CAGR: **16%**
Medium scenario 2025-2028

Drivers

- Net-billing scheme and "Mój Prąd" scheme drive small-scale solar
- Electrification of industrial processes is pushing demand for PV
- Large-scale storage rollout plan to support utility-scale solar deployment

Challenges

- Limited grid capacity to host new solar PV installations
- Increasing amount of solar electricity being curtailed by grid operators
- Lack of an appropriate framework for Agri-PV development

6

The residential market - traditionally the strongest most mature segment in the Netherlands - decreases further, as no new incentives are in sight to replace the net-metering scheme, poised to end in 2027. The larger rooftop and utility-scale segments are expected maintain a slow but steady growth, bringing a partial recovery to the overall annual market following the drop in 2024.

Netherlands

Total capacity: **40 GW**
Medium scenario 2028
#4 in the EU-27

Cumulative CAGR: **11%**
Medium scenario 2025-2028

Drivers

- Recognition of solar growth potential by grid operators, despite NECP solar target remains unambitious
- New category in SDE++ scheme to include subsidies for "weak roofs" and stimulate C&I in those buildings
- Public acceptance remains high

Challenges

- End of net-metering in 2027 and switch in government stance reducing electrification support strongly reduce the interest in residential solar
- Weak roof structures on many large buildings complicate the installations of C&I solar
- Grid congestion issues, especially at medium-voltage level

7

The prosumer market is expected to remain stable, supported by the successful Casa Verde programme, which funds up to 90% of installation costs and now also includes support to battery storage. Large-scale solar is expected to gain significant traction in the coming years, especially since the country concluded its first CfD tender at the end of 2024.

Romania

Total capacity: **19 GW**
Medium scenario 2028
#8 in the EU-27

Cumulative CAGR: **36%**
Medium scenario 2025-2028

Drivers

- Casa Verde programme supporting the prosumer segment
- CfD-based tenders and EU funding programmes driving the growth in the utility-scale segment
- Positive evolution on storage with removal of double taxation expected by early 2025

Challenges

- Challenging process to secure grid access, with a significant amont of projects already in the queue
- Limited amount of offtakers is reducing the development pace of PPAs
- Grid capacity auctions starting in 2026 might bring additional complexity

8

Driven by changes in the net-metering scheme that led to a rush in small- and medium-scale PV installations, the growth seen in 2024 is expected to continue in 2025 as delayed projects are completed. Utility-scale installations are set to grow faster as the government prioritises large-scale renewables to decrease electricity prices.

Greece

Total capacity: **20 GW**
Medium scenario 2028
#10 in the EU-27

Cumulative CAGR: **19%**
Medium scenario 2025-2028

Drivers

- Government roadmap for grid development
- Multiple measures taken to support storage development
- Large pipeline of new solar projects

Challenges

- Grid limitations are the main challenge to keep up with large-scale solar PV development
- Increasing amount of curtailed solar electricity
- Switch from net metering to net billing reducing residential PV growth

9

The market is expected to shrink further in 2025 after the demand pipeline built during the energy crisis has been fully installed. While few solar power plants are under development, in particular small-scale solar continues its decline. A partial rebound is expected in the following years, driven by solar mandates and improvements in the utility-scale segment.

Austria

Total capacity: **18 GW** — Medium scenario 2028, #9 in the EU-27

Cumulative CAGR: **19%** — Medium scenario 2025-2028

Drivers

- Reduction of VAT from 20% to 0% for residential customer with system up to 35 kW
- Increasing attachment rate for storage in residential and C&I segments
- Ambitious NECP solar target, ensuring market stability

Challenges

- Absence of zoning and designated areas for solar projects, coupled with delays in passing of renewable energy legislations
- High inflation environment, hurting the C&I segment
- Lack of adequate grid capacity for future renewable expansion

10

The momentum seen in 2024 continues in 2025, with several ground-mounted projects connected. However, the lack of flexibility and the low solar electricity price decrease the economic viability for large-scale PV. Without any changes, a market stagnation is expected.

Portugal

Total capacity: **15 GW** — Medium scenario 2028, #11 in the EU-27

Cumulative CAGR: **23%** — Medium scenario 2025-2028

Drivers

- High NECP solar target of 20.8 GW by 2030
- Environmental Fund is supporting residential PV, though its continuity remains uncertain
- 2 GW battery capacity target by 2030, supporting renewable deployment

Challenges

- CfD schemes and PPA frameworks need to be developed to counter electricity price fluctuations and offer more business certainty
- Slow permitting processes, partly caused by a staff shortage in administrations
- Lack of flexibility and storage capacity deployment is hampering future prospect for utility-scale development.

Utility-scale grows faster, but rooftops remain the backbone of EU solar PV installed capacity

After years of rapid growth, the EU rooftop solar market has reached a plateau. While rooftop PV has achieved a high level of maturity, the key drivers behind its recent expansion – such as high electricity prices and generous support schemes – have largely disappeared.

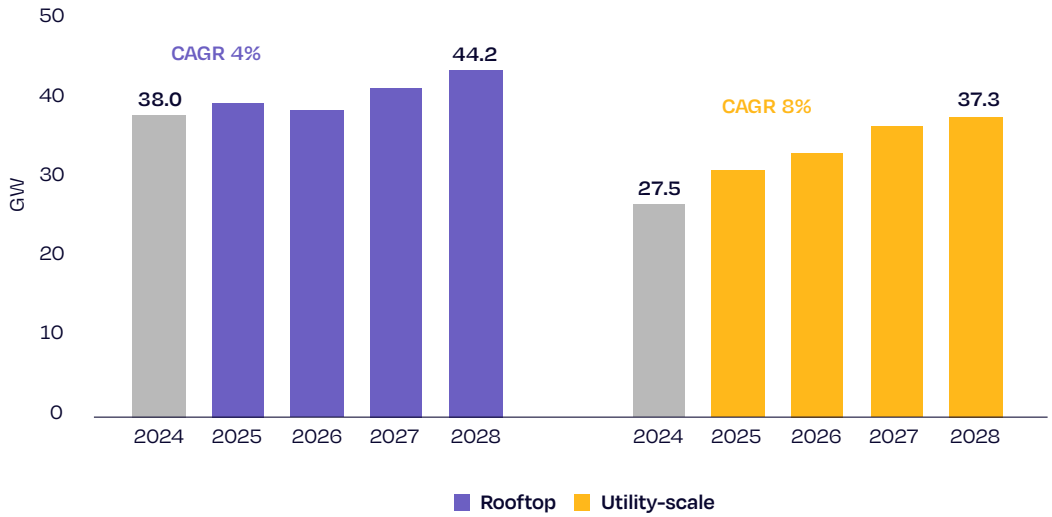
The rooftop market, however, is not expected to decline, but will likely remain stable over the next three years, partially shifting towards larger system sizes. To unlock further growth, new business models focusing on enhanced self-consumption will need to be developed. Starting in 2027-2028, we anticipate a modest uptick in growth, driven by the solar mandate included in the revised Energy Performance of Buildings Directive (EPBD). Overall, the rooftop market is expected to grow from 38.0 GW in 2024 to 44.2 GW in 2028, following a compound annual growth rate (CAGR) of 4% growth during this period (see Fig 23).

By contrast, the utility-scale segment is projected to continue growing, though at a slower pace than previously anticipated. The market is forecast to expand from 27.5 GW in 2024 to 37.3 GW in 2028, with a CAGR of 8%. However, persistent challenges such as limited grid capacity, insufficient storage and flexibility infrastructure, and slow permitting processes remain major obstacles. These issues, while not new, are becoming increasingly impactful as the market grows and solutions remain elusive, tempering our outlook for the segment.

Figure 23

Annual rooftop market will remain larger, but growth prospects are marginal

EU-27 annual solar PV rooftop and utility-scale segments scenarios 2024-2028



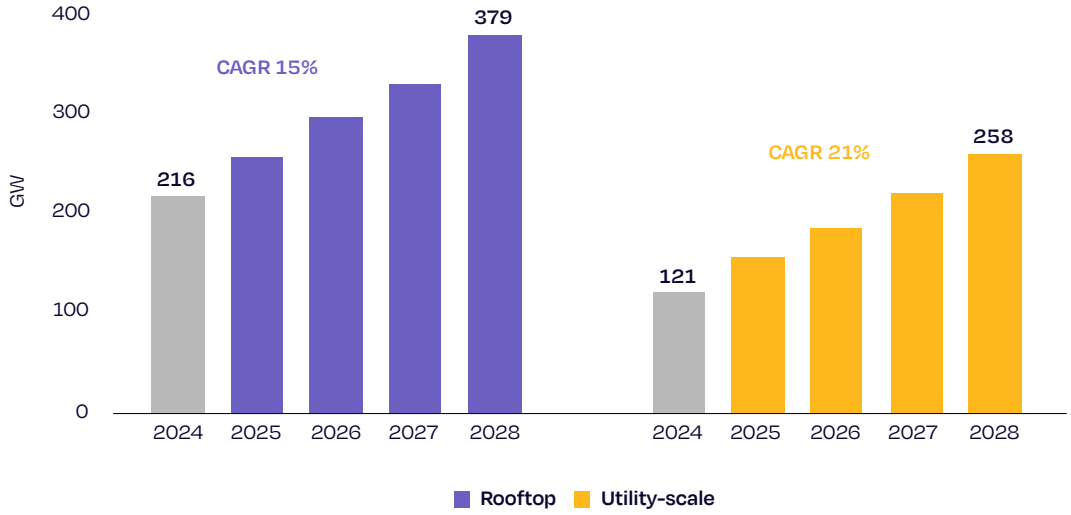
Source: SolarPower Europe

From a cumulative perspective, the rooftop market will see a more moderate growth with a CAGR of 15%, rising from 216 GW to 379 GW over the same period. Meanwhile, the utility-scale segment is expected to expand from 121 GW in 2024 to 258 GW in 2028, with a CAGR of 21%. While rooftop solar will remain the largest contributor to overall capacity, its cumulative share is projected to decline from 64% in 2024 to 59% in 2028, reflecting the faster growth rate of utility-scale installations.

Figure 24

By 2028, total rooftop installed capacity remains 47% larger than utility-scale

EU-27 annual solar PV rooftop and utility-scale segments scenarios 2024-2028



Source: SolarPower Europe

EU solar market outlook to 2030

With many Member States still having to submit their final 2030 NECPs, most solar targets will be met ahead of 2028, although an increasing number of countries are expected to fall short of their target. The EU average solar per capita level is expected to surpass 1.5 kW per person by 2030. Despite continued growth, 2030 annual installation volumes have been revised downward, now expected to fall below 100 GW. Total solar capacity projections by 2030 remain above the REPowerEU target, but have been reduced by 72 GW compared to earlier estimates.

Many Member States have not submitted their final 2030 NECPs; while most solar targets will be met before 2028, the number of countries falling short is growing

By 30 June 2024, Member States were due to submit their final updated National Energy and Climate Plans (NECPs) to the European Commission. These plans had to take into account the Commission's feedback on their 2023. However, several of these plans are significantly delayed. As of November 2024, only 14 out had submitted their final NECPs; while nearly the same amount of 13 were still missing.

NECPs are important pieces of information to assess Member States' commitment towards decarbonisation. In our analysis, we have compared national PV targets under the latest NECPs available, with our most-likely scenario estimates and their projections until 2030.

113 MW Tsenovo solar plant, inaugurated in October 2024, Bulgaria

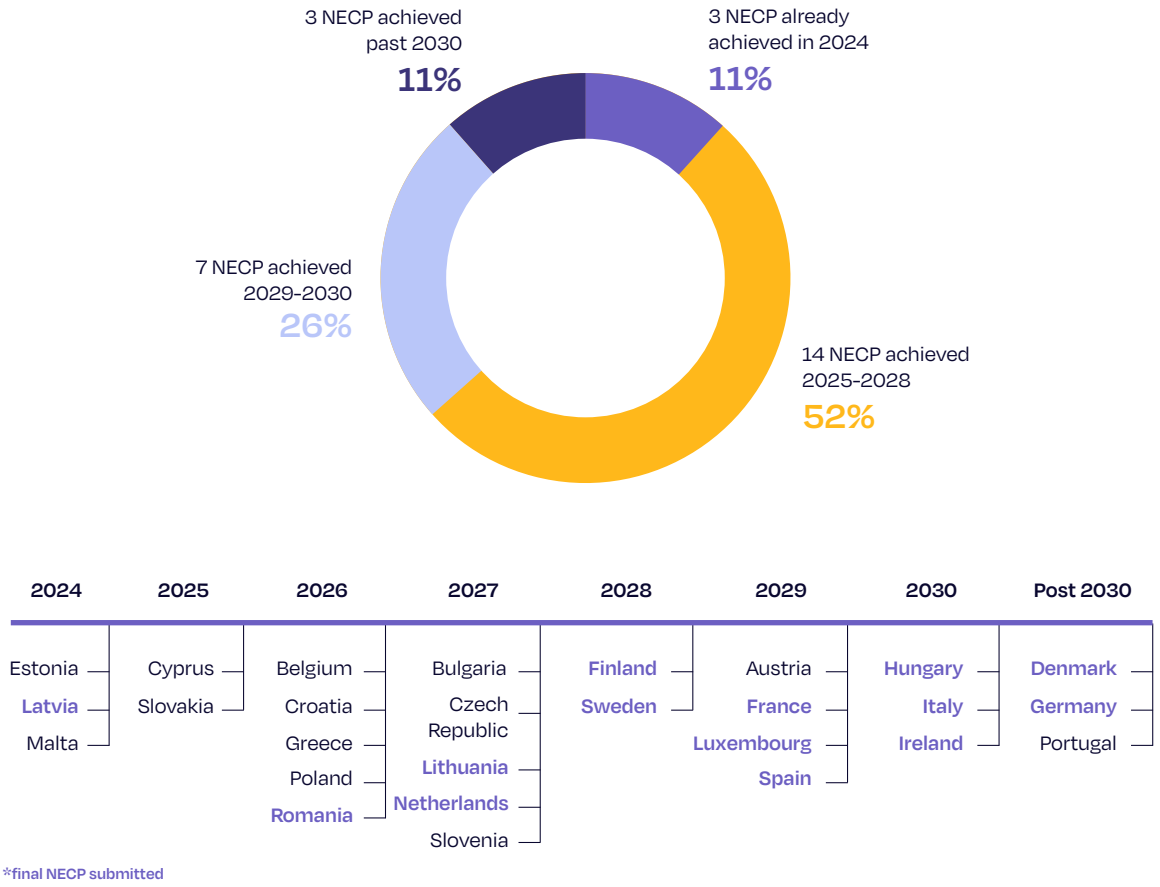
It's worth clarifying that not all NECPs provide clear solar targets in GW of installed capacity, as several Member States only outline annual solar production targets in TWh, or net additions to existing installed capacity, or rather general RES targets without a clear technology breakdown. Further, it is often unclear whether the targets are expressed in AC or DC volumes, requiring assumptions on conversion ratios. Lastly, while targets might have been informally decided at national level, not all of them have been officially submitted yet. For all these reasons, the values presented in this analysis might somewhat differ from those presented in the NECPs.

According to our updated market analysis, 3 Member States (11%) have already achieved their 2030 NECP solar target in 2024; 14 Member States (52%) will reach it before 2028; 7 Member States (26%) are expected reach it by 2030; and lastly, 3 Member States (11%) are not on schedule to meet their 2030 solar target at all, given the current market and policy conditions (see Fig. 25). This outlook is less bright than the previous edition, when only one country was expected to miss its target by 2030. The increased NECP targets and worsening market dynamics for solar across the EU have contributed to this dimmer prospects.

Figure 25

In most EU countries, 2030 solar targets will already be met by 2028

Projected timeline of EU-27 countries achieving solar PV goals under their National Energy and Climate Plans (NECPs)



Source: SolarPower Europe

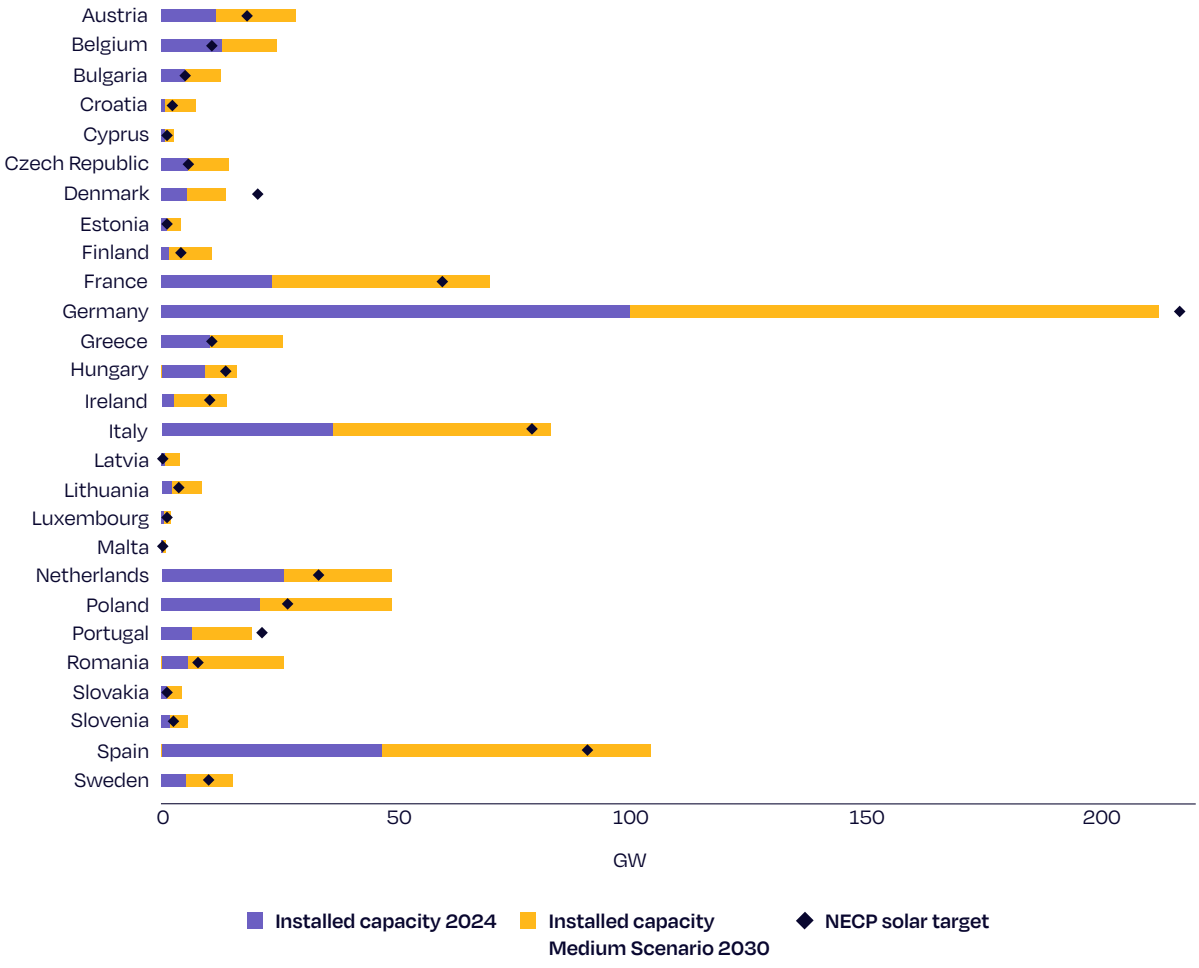
Most solar targets will be exceeded by market dynamics, but the number of Member States expected to miss their target has increased

Figure 26 displays each Member State's most recent NECP target, compared to the current installed capacity and to the Medium Scenario projection to 2030 based on expected market evolution. The chart also illustrates the size of individual countries' contributions to the aggregate NECP target.

Figure 26

EU countries' national solar targets set to be largely surpassed by the market

EU-27 total solar PV capacity 2024 and Medium Scenario 2030 forecast, compared to National Energy and Climate Plan (NECP) targets



Source: SolarPower Europe

The analysis outlines that solar market dynamics are projected to largely exceed most of the NECP targets. This means that the great majority of national solar targets are easily within reach, and our Medium Scenario anticipates that Member States will attain their solar aspirations on time.

At the same time, three Member States – Denmark, Germany, and Portugal – are expected to miss their solar target by 2030 under current policy conditions, unless corrective action is taken. Our 2030 capacity forecast for Germany has decreased by over 20 GW compared to last year's EMO considering political uncertainty after the government coalition collapse in November 2024, the negative outlook for residential PV, and the less optimistic forecasts on large-scale solar. Anticipating now total deployment of 214 GW by 2030, Germany will just miss its solar goal by 0.4%. In Portugal, installation rates remain 8% below the needed annual additions to achieve the ambitious 20.8 GW target. This is especially true for large-scale projects, which face worsened investment conditions, slow permitting and grid constraints. In Denmark, the large increase of the solar target to 17.8 GW_{AC} is at odds with the dire situation for utility-scale solar, a segment heavily impacted by the introduction of high grid connection fees that severely hamper new projects. Denmark is the only country expected to miss the 2030 target by a large margin of 43%.

Improvements in NECP solar targets raises 2030 solar per capita levels, with EU average over 1.5 kW per person by 2030

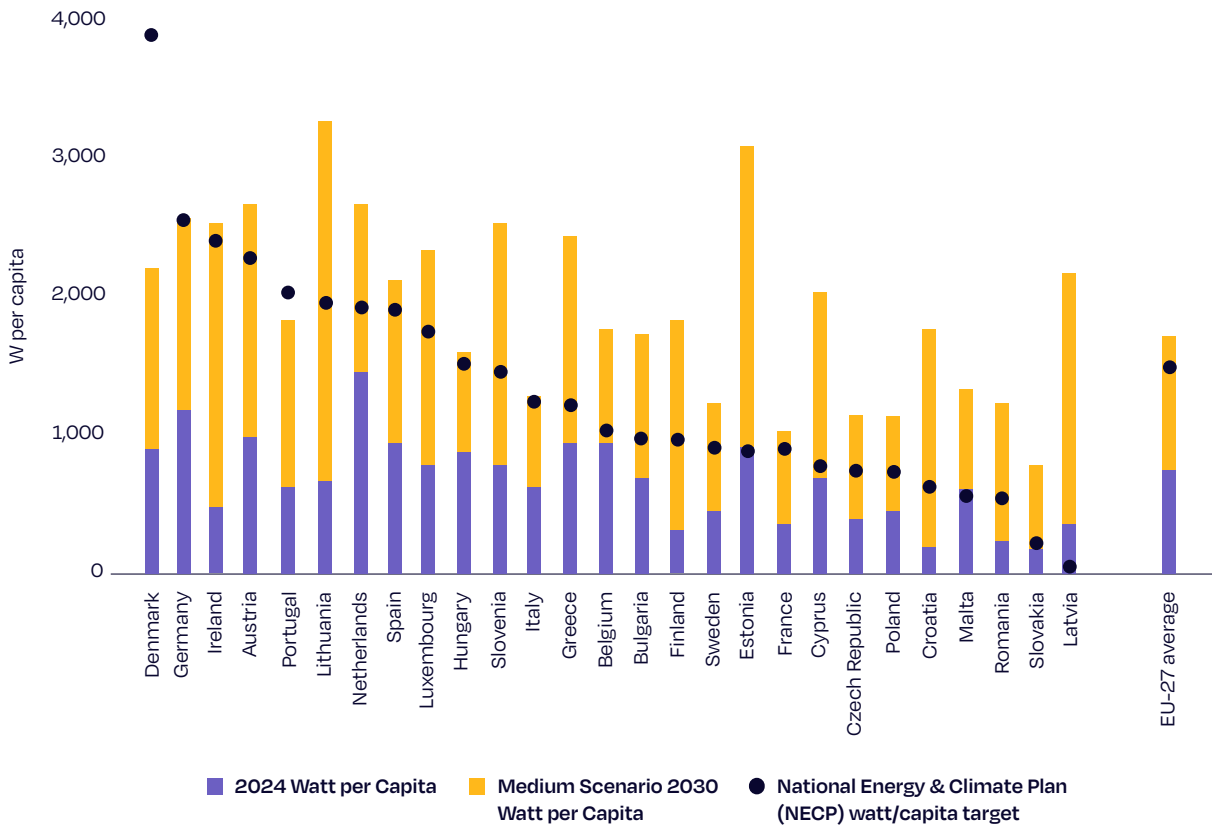
By comparing solar targets and cumulative capacities per person, we have analysed countries of different sizes and their solar ambitions. Figure 27 shows current installed PV capacity, projected 2030 installed capacity and solar NECP targets for each Member State.

Denmark now has the highest solar target per capita in the EU, surpassing Germany. This is due to a significant increase in Denmark's NECP target to 17.8 GW_{AC} or 24 GW_{DC}. Ireland has also made notable progress in its solar ambitions, moving up to the third position with a solar target of 8 GW_{AC}.

Figure 27

EU countries' NECPs average a 1.5 kW target solar per person by 2030, while the market is set to deliver 1.8 kW by then

EU-27 solar PV cumulative capacity 2024 and Medium Scenario 2030 forecast compared to NECP target



Source: SolarPower Europe

Looking at the countries' individual performances, all Member States but one – Slovakia – are projected to reach the milestone of 1 kW of solar capacity per person by 2030. On average, the EU is expected to reach 1.8 kW per inhabitant by the end of the decade, with the average solar capacity under NECP targets now exceeding 1.5 kW by the same year.

3.3 EU annual solar PV market outlook 2030

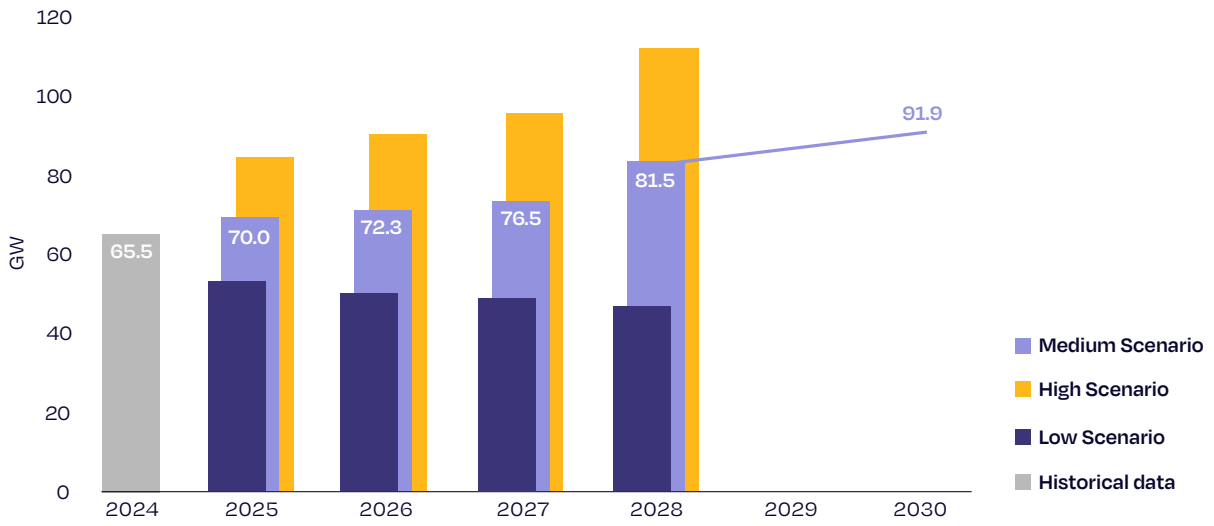
Further market growth still expected, but significantly lower than previous estimates

Our Medium Scenario projects a 91.9 GW annual market in 2030, a 6% increase from 2028 levels and a 40% surge from 2024. While we expect continued growth until the end of the decade, these projections are significantly lower than our previous estimates. Just half a year ago, in the June-released GMO 2024, we anticipated an annual 114 GW EU market in 2030, a value that has now been revised downward by 19%. Additionally, we previously expected a 97 GW EU market in 2028, which is 5 GW larger than our current 2030 forecast.

Figure 28

EU solar growth continues but annual installations no longer likely to reach 100 GW by 2030

EU-27 annual solar PV market scenarios 2024-2030



Source: SolarPower Europe

Medium Scenario projections to 2030 are still above the REPowerEU target, but went down 74 GW compared to GMO 2024

Our Medium Scenario suggests that the EU solar market is still on track to meet the REPowerEU target of 750 GW_{DC} (600 GW_{AC}) by 2030.

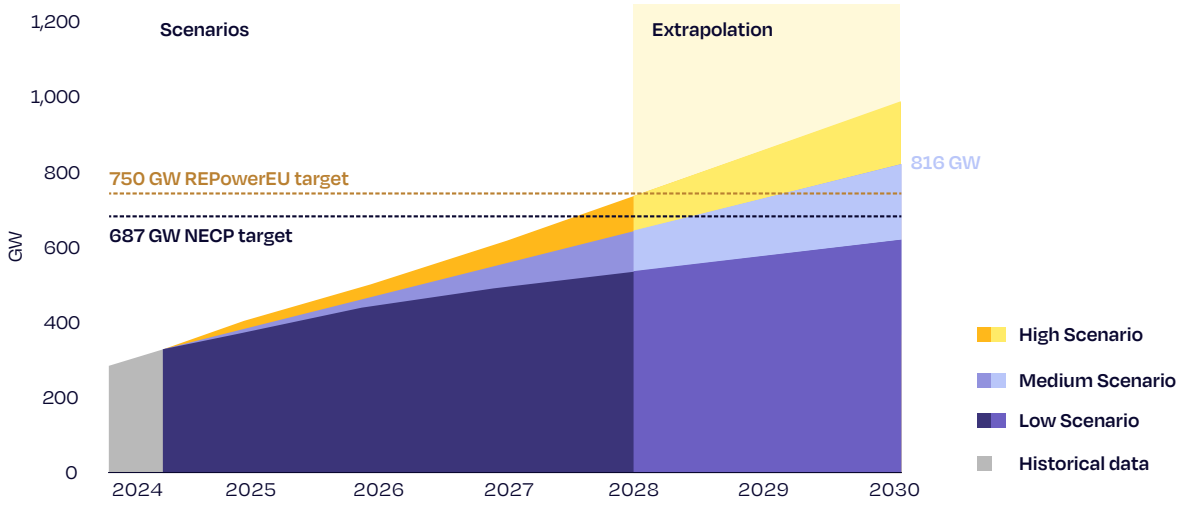
The most likely total operating solar capacity deployed in the EU by 2030 is projected to reach 816 GW, which is still 9% above the EU Commission's target. However, our forecast has decreased by 8% or 74 GW from our previous analysis. This decline, which exceeds the volume of new solar PV installations in the entire year of 2024, has intensified a downward trend that began with a 12 GW reduction in the 2030 EU total capacity outlook from 902 GW to 890 GW half a year ago. A further slowdown in the solar market in the coming years could jeopardise Europe's solar commitment. The Low Scenario, estimating 644 GW by 2030, falls significantly short of the REPowerEU target by 14%.

When analysing direct and indirect solar targets outlined in NECPs, EU Member States are expected to control 687 GW of solar capacity by 2030. That represents an 8% improvement compared to our last analysis, driven by both upward revisions of national targets, and improvements in our methodology for converting AC based targets to DC values for a number of climate plans.

Figure 29

NECP and REPowerEU targets will be reached under the Medium Scenario, despite the outlook being lowered by 8%

EU-27 total solar PV market scenarios 2024-2030



Source: SolarPower Europe

EU solar hot topics

In 2024, there have been numerous hot topics in the EU solar sector: important legislative changes for solar at the EU level; expectations about the new EU Commission; the landscape of European solar manufacturing; trends in auctions and corporate PPAs; the link between solar and flexibility, and solar and battery storage; and solar job creation in the EU. In this chapter, we delve into the details of each of these key topics.

4.1 Policy Wins in 2024

EU legislative highlights from 2024

2024 has been a very eventful year for solar and renewable energy policy at European level. As this dense period is coming to an end, we can look back at the legislative activity that is poised to influence the future of the solar sector. The most important EU solar policy updates in the last twelve months are highlighted in the table below, together with an assessment of their outcome for the sector.

Legislation	SolarPower Europe assessment	Entered into force	Description
Revised Renewable Energy Directive (RED III)		20 November 2023	The Revised Renewable Energy Directive creates a new target for renewables at 42.5% with a voluntary additional 2.5% of renewables. It lays a framework for renewable hydrogen for the first time, including rules for renewable hydrogen (RFNBOs) production and industry and transport targets for RFNBOs consumption. It finally develops a framework for permit-granting procedures for renewables, including the definition of 'renewable acceleration areas' within which renewables access shorter permitting timelines (Article 15c) and establishment of Overriding Public Interest for all RES projects (Article 16e).
European Solar Charter		15 April 2024	In April 2024, 23 Member States signed the European Solar Charter setting a series of voluntary actions to support the European solar PV sector. Amongst others, Member States commit to pilot resilience auctions at an early stage to provide the demand pull for solar manufacturing in Europe. Several Member States have acted on that commitment with national support schemes like the Pacte solaire declaration in France, the financial support with PERTE in Spain, the tax credit scheme Piano Transizione 5.0 in Italy or the resilience bonus in Austria.
Energy Performance of Buildings Directive (EPBD)		24 April 2024	The Energy Performance of Buildings Directive entered into force in April 2024, with a requirement for countries to implement by 29th May 2026. Article 10 of the EPBD requires all new buildings to be "solar-ready", meaning that they have to be designed in order to optimise their solar energy generation potential. In addition, the law require solar installations on all new public and commercial buildings by 2026, on all new residential buildings by 2029, on non-residential buildings that undergo a relevant renovation by 2027, and on all existing public buildings in a stepwise approach by 2030. Member states still have room to define exemptions to this requirement.

Legislation	SolarPower Europe assessment	Entered into force	Description
Critical Raw Materials Act (CRMA)		23 May 2024	The Critical Raw Materials Act will ensure EU access to a secure and sustainable supply of critical raw materials, enabling Europe to meet its 2030 climate and digital objectives. The Act sets the following benchmarks along the strategic raw materials value chain and for the diversification of the EU supplies: • at least 10% of the EU's annual consumption for extraction; • at least 40% of the EU's annual consumption for processing; • at least 25% of the EU's annual consumption for recycling; • no more than 65% of the EU's annual consumption from a single third country. The CRMA recognises the role of Strategic Projects, namely projects across the strategic raw material value chain covering extraction processing or recycling. The first round of applications for Strategic Project with deadline on 22nd August 2024 was a great success with 170 applications, of which 121 within Europe.
Net-Zero Industry Act (NZIA)		13 June 2024	In June 2024, the EU adopted the European Net-Zero Industry Act, setting a goal of at least 30 GW of European solar manufacturing, at each stage of the value chain, by 2030. It creates a number of measures to support domestic manufacturing, the most prominent being allowing Member States to add non-price criteria in a part of their auctions, public procurements and other support schemes. Such criteria include elements of sustainability, resilience and cybersecurity. The details will be approved in an Implementing Act expected by March 2025, with public consultations scheduled before that in Q1 2025.
Electricity Market Design Regulation and Directive (EMD)		17 July 2024	The revised Electricity Market Design Regulation and Directive further defines the framework of energy crisis and the measures that can be taken, removing the inframarginal caps on market revenues. Instead, it focuses on developing further long-term contracts for renewables, such as Power Purchase Agreements (PPAs) through state-backed guarantees and voluntary Contracts for Difference (CfDs) for new investments. The directive establishes a right to energy sharing, providing the right conditions for collective self-consumption models. It also includes significant wins on the grid side: it mandates smoother grid connections, notably thanks to the publication of grid hosting maps, and require grid operators to assess their flexibility needs on the basis of an EU methodology.

Legislation	SolarPower Europe assessment	Entered into force	Description
Corporate Sustainability Due Diligence Directive (CSDDD)	N/A	25 July 2024	The Corporate Sustainability Due Diligence Directive requires companies to conduct thorough due diligence on human rights and environmental impacts across their entire value chain, both upstream and downstream. The aim is to identify, prevent, and eliminate negative effects. Article 19 of the Directive contains a long list of guidelines to be developed by the European Commission, which announced at the beginning of November the opening of a public consultation on the guidelines. The aim is to get feedback on what guidelines to prioritise, especially on best practices on how to conduct due diligence, sector specific guidance, model for contractual clauses, multi-stakeholder initiatives and quality criteria for third-party verifications.
EU Hydrogen and Gas Decarbonisation Package		4 August 2024	The EU Hydrogen and Gas Decarbonisation Package, consisting in a revised Regulation and a revised Directive on the Gas Market rules, updates the regulatory framework for gas market and infrastructure and creates a new regulatory framework for hydrogen. On the bright side, it paves the way for an independent regulation of hydrogen, thanks to a new independent European Network of Network Operators for Hydrogen (ENNOH) tasked to plan the hydrogen infrastructure (the EU Ten Year Network Development Plan) from 2026. It also opens third party access' to gas and hydrogen networks from 2033. However, the text also defines low-carbon hydrogen (so called blue hydrogen), which should achieve a 70% GHG emissions reduction compared to conventional hydrogen. It also creates some conditions for blending (tariff discounts for hydrogen injection in gas grids and a maximum 2% blending rate acceptable at borders).
Forced Labour Regulation (FLR)	N/A	TBD	The Forced Labour Regulation was approved by the European Parliament on 24th April 2024, under the corrigendum procedure, and formally on 21st October 2024. The Council of the EU is expected to formally approve the legislation, after which it will take effect 36 months following its entry into force. The FLR lays down rules prohibiting economic operators from placing or exporting from the Union market products made with forced labour. Article 11 of the Regulation provides a full list of guidelines on due diligence and information on risk indicators that the European Commission shall publish in 2025.

4.2 New EU Commission

In December 2024, a new European Commission took office, led by Ursula von der Leyen. A college of 27 Commissioners have been appointed by Member States and validated by elected members of Parliament in November. During the next five years, they will head the EU administration and propose new policies.

What's on the agenda of the next European Commission?

The work programme of the new European Commission has been defined progressively over the last months, as part of the campaign efforts of the new President of the European Commission ahead of the EU elections and with the input from EU Heads of States. The main political proposals relevant for solar are the following:

A Clean Industrial Deal will be proposed in the first 100 Days. The deal is meant to provide the right conditions to turn the Green Deal into a competitiveness and industrial strategy for Europe. This will mean supporting industries, especially heavy industries, to remain competitive while keeping their decarbonisation course, while at the same time helping clean technology manufacturers innovate and keep growing in Europe. This is a major breakthrough, and a consequence of SolarPower Europe's leading efforts in different coalitions for example with the Solar Impulse Foundation, gathering 500+ organisations around a call for a Clean Industrial Deal (see here), and with the Electrification Alliance (see here).

While we are awaiting further detail, some elements are becoming clearer and could translate into a number of initiatives. First, **an action plan on Affordable Energy Prices** to provide policy solutions that give European industries access to competitive energy supply solutions. The Commission is expected to make proposals related to the use of energy taxes and the ETS levies to lower the electricity bill. Second, the Commission will present an **Industrial Decarbonisation Accelerator Act** to support lead markets and the production and diffusion of clean technologies in industry and speed up related planning, tendering and permitting processes. This could be linked to a review of the Public Procurement Directive to allow a more strategic use of public procurements. Finally, the European Commission will also make a greater use of **Important Projects of Common European Interest** (IPCEIs), a tool for Member States to bundle national funding to support strategic industrial projects and optimise impact (similar to the approach some Member States used to create Europe's Airbus). Interestingly, IPCEIs will be supported by EU funds, too, via a new **Competitiveness Fund** that will be presented as part of the new European budget. SolarPower Europe sees the newly invigorated IPCEI approach as a great opportunity to support smart and secure electrification to guarantee EU's leadership in the critical communication components of the future energy systems, like solar inverters.

An Affordable Housing Action Plan, to tackle the affordable housing crisis that is taking place in several member states, coupled with a crisis in the construction industry. This file will be led by the first-ever Commissioner on Housing, Dan Jørgensen, who – interestingly – combines this portfolio with the Energy portfolio. The Plan will aim at helping member states and local authorities implement the newly adopted Energy Performance of Buildings Directive. It will also aim at unlocking private investments into construction and renovation, by reviewing state aid rules to improve the framework for housing support measures, particularly affordable energy efficient housing, allow for member states to double the regional funding they can allocate to investments into housing and by creating a pan-European investment platform for affordable and sustainable housing with the European Investment Bank.

An Electrification Action Plan will be presented by the European Commission. This is a major success for SolarPower Europe and the Electrification Alliance and a result of a quality campaign since the beginning of this year. The electrification action plan will present measures and recommendations to accelerate electrification of the energy system, and should in particular focus on measures aimed at accelerating electrification of industrial processes. SolarPower Europe is also working on attaching financial tools to this plan, namely an Electrification Bank aimed at supporting the further electrification of energy intensives as well as a Grids Facility that could unlock further financing and funding to support grid expansion, but also grid digitalisation and modernisation, notably by mobilising existing regional development funding. It will be important to link the action plan to the Clean Industrial Deal and Industrial Decarbonisation Accelerator Act.

An Action Plan to exit Russian energy dependence has been announced by Commissioner designate Dan Jørgensen during his hearing, following similar calls in the Energy Council. It will aim at providing a pathway to reach the target of being independent from Russian energy imports by 2027, set in the REPowerEU Plan.

An initiative on demand response and storage will also be presented by the Commissioner for Energy Dan Jørgensen. This is excellent news and echoes strong calls by SolarPower Europe on the need to prioritise flexibility investment, notably through our Let's Flex campaign. The content of the plan is still to be defined, but much could be done on the availability of economic incentives through the State aid framework as well as the grid connection and permitting processes.

A Clean Energy Investment strategy will also be ironed out by the European Commission, in a context where both the Ursula von der Leyen and Mario Draghi have stressed the need to facilitate private capital flows in the EU. The details have not yet been disclosed, but it is likely that the financing of grids is going to be high on the agenda of the plan.

A 2040 Climate Target will be presented following the communication and impact assessment published beginning of the year by the former Commission. During the hearings, Commissioner-designate Hoekstra committed to proposing a greenhouse gas emissions reduction target of 90% by 2040. Potential sub-targets will be evaluated, though no guarantees have been made .

A **Vision for Agriculture and Food** has been announced by Ursula von der Leyen during her presentation at the European Parliament ahead of the presidential elections back in July 2024. The new Vision for Agriculture and Food policy has been then announced by the Agriculture Commissioner-designate Christophe Hansen, stating that this action will be developed and presented during his first 100 days in office. The objective of the vision is to look at how to ensure long-term competitiveness and sustainability of European farming sector within the boundaries of our planet. However, the topic of solar or agrisolar was not raised by Hansen during his hearings.

Who to watch?

Teresa Ribera

Teresa Ribera, a Spanish member of the Socialist and Democrats party, has been appointed Executive Vice-President for the European Green Deal and Climate Action. A prominent member of Spain's Socialist Party, Ribera previously served as Spain's Minister for the Ecological Transition, overseeing energy and environmental policies from 2018 to 2023. Ribera also chaired the Energy Council during Spain's presidency of the European Union in 2023, using the platform to advocate for urgent reforms in the European electricity market, emphasising the need for greater efficiency, fair pricing, and sustainability. She is a staunch supporter of renewable energy.

Stéphane Séjourné

The Frenchman Stéphane Séjourné has been appointed Executive Vice President on Prosperity and Industrial Strategy, and in that role will work on the Clean Industrial Deal and on the revision of the Public Procurement Directive. He has been nominated in replacement of Thierry Breton, a controversial figure in the last European Commission. He is used to Brussels political scene, as the leader of the Renew Group in the European Parliament in the last mandate. In the first part of 2024, he was also the French Minister for European Affairs.

Dan Jørgensen

Dan Jørgensen, affiliated to the Socialists and Democrats party, has been designated Commissioner in charge of Energy and Housing. He was a member of the European Parliament for ten years between 2004 and 2013, before taking a role in the Danish government as Minister for Climate and Energy. He has reiterated his support to renewables, particularly wind, and expressed his personal support to a 2040 renewable energy target.

Wopke Hoekstra

Wopke Hoekstra, Dutch member of the European People's Party, has been appointed as Commissioner for Climate. He already held this role in the last Commission, as a replacement for Frans Timmermans, who left the European Commission in 2023 to pursue a career in national politics. Following his hearing, he has received a wide support from the European Parliament.

Maroš Šefčovič

The Slovak Maroš Šefčovič, member of the Socialist and Democrats party, is also another veteran of the Commission. For a third mandate in the European Commission, he has been appointed Commissioner for Trade and Economic Security, working directly with Ursula von der Leyen. He knows well the field of clean technologies, having sponsored the first-of-a-kind Battery Alliance in 2018, while the Commission just approved trade tariffs on electric vehicles.

4.3 Manufacturing Update

Solar manufacturing in Europe faced a challenging year in 2024. After another solar boom year in 2023, with demand growing by over 50%, market dynamics changed in 2024. While demand hardly grew in Europe, PV product prices continued its steep down-hill trajectory. The global surge in new manufacturing capacities coming online in 2023 and 2024 have been causing unseen supply-demand imbalances, forcing module and other component prices to plummet to unsustainable levels. This has put immense pressure on EU and global PV manufacturers, with announcements of closures and bankruptcies, particularly in the module segment during 2024.

Among those European manufacturers that haven't stopped production, many are operating at very low utilisation rates. This has been significantly reducing the actual output of EU manufacturers compared to their stated capacities, further exacerbating the current strain on the solar industry. Amidst these difficulties in Europe, many manufacturers are looking to the US and other markets to establish production in more favourable conditions than currently exist in the EU, for instance through the US Inflation Reduction Act (IRA).

In June 2024, the EU adopted the European Net-Zero Industry Act (NZIA), which set a goal of reaching at least 30 GW of European solar manufacturing, at each stage of the value chain, by 2030. This key milestone recognises the crucial need to strengthen resilience in European PV supply chains, and to implement the Green Deal Industrial Plan. The following section takes stock of the state of EU solar manufacturing in 2024 across the silicon-to-module and inverters value chain.

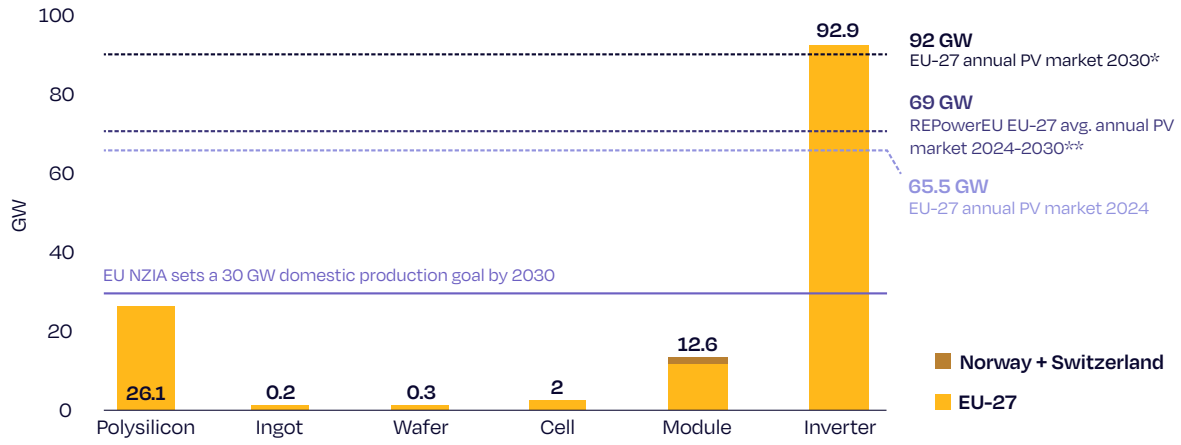
From inverters and polysilicon, all the way to modules, not all segments are equal in the EU solar value chain. Looking at total current capacities (Figure 30), the 30 GW milestone has been already reached for inverters years ago, thanks to a mature European industry in the segment, mostly active domestically but well established also in international markets like the US and Australia. In the module value chain, the polysilicon segment is the closest to the 30 GW mark, with one single established company holding the entirety of the capacity, some of which is bound to semiconductor products.

The least developed segments for PV production in Europe are the middle stages of ingot and wafer manufacturing, with no capacity running in 2024 as key suppliers in Norway have suspended or closed production in 2023. For the next stage in the value chain, the 2 GW annual production of European PV cells now relies on non-European wafer imports. Lastly, module manufacturing capacities are barely halfway to the 30 GW goal – even if fully utilised they would currently supply only 19% of EU demand.

Figure 30

Most PV manufacturing segments are far from reaching the 30 GW manufacturing target, and far below meeting current and future market demand

Existing and targeted manufacturing capacity in Europe, compared to existing and targeted annual installations



* SPE Medium Scenario Projection to 2030.
** Based on REPowerEU target of 750 GW (600 GW_{AC}) installed PV capacity in EU-27 by 2030.

The current context further highlights the urgent need to support domestic production of solar PV technology. In April 2024, 23 Member States signed the European Solar Charter, setting a series of voluntary actions to support the European solar PV sector, such as committing to pilot resilience auctions at an early stage to provide the demand pull for solar manufacturing in Europe. A number of Member States including Austria, France, Italy and Spain have already introduced support schemes aimed at promoting EU manufacturing. A comprehensive analysis of the different support tools available to EU manufacturers is provided in SolarPower Europe's State of Play Report on Support for European Solar Manufacturing.

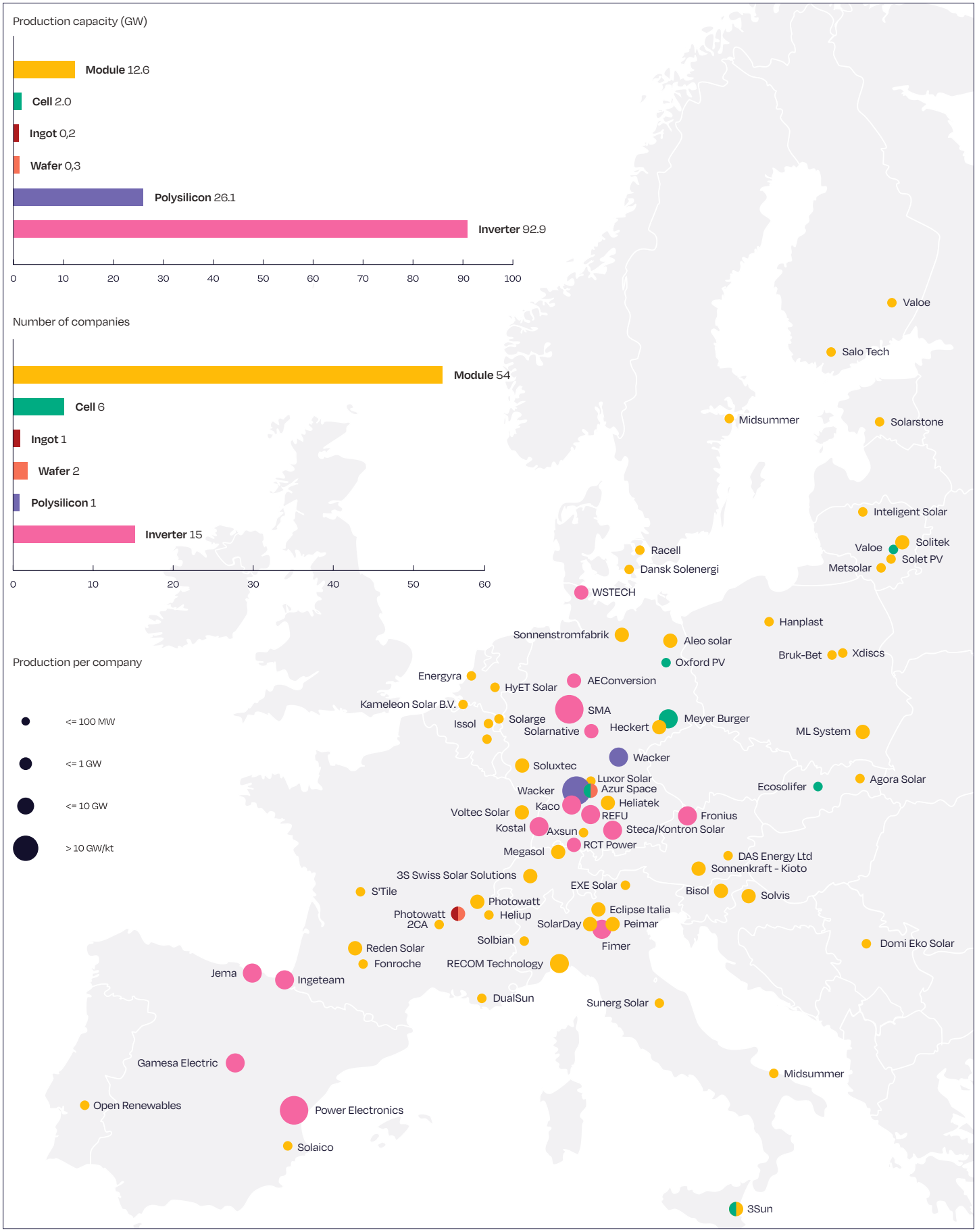
While these initiatives are positive news for solar manufacturing in Europe, there is still no adequate framework in place to enable the development of a well-integrated and scaled EU manufacturing value chain. This is crucial to improve the investment conditions for European silicon-to-module and inverter manufacturing (see our Policy Recommendations at p. 14).

European Solar Manufacturing Map

The map of the solar manufacturing landscape in the EU, Switzerland and Norway has been updated, based on the industry developments that took place throughout 2024. The objective of this map is to illustrate today's production capacities across key segments in the solar value chain in the region. The companies actively involved in silicon, ingot/wafer, cell, module, and inverter manufacturing, including both late-stage start-ups and those offering commercial products in 2024, are illustrated on our solar manufacturing map (see Fig. 31).

Figure 31

Solar Manufacturing Map - EU-27 countries, Norway, and Switzerland



Source: SolarPower Europe

Looking at the PV module value chain – from silicon to module, Wacker Chemie remains the largest and only EU manufacturer of **polysilicon** for the solar industry. It operates at two sites in Germany, with combined capacities of 60,000 metric tons, equivalent to more than 26 GW worth of ingot/wafer/cell products; although not all of this capacity is dedicated to solar PV manufacturing, as a share goes to the semiconductor sector. The only other solar silicon producer in Europe, REC Solar Norway, closed down its small production site in November 2023, stating the unviability of producing polysilicon in Norway.

The **ingot** and **wafer** segments are the most vulnerable stages in the PV value chain and continue to be negatively affected by current market conditions and lack of policy support. The year 2023 saw both Norwegian solar ingot/wafer producers Norsun and Norwegian Crystal suspend or stop their operations in Europe entirely – reducing wafer production in Europe to zero. Unable to secure funding, Norsun now looks to the US. Attracted by the promise of IRA subsidies, it plans to open a 5 GW fab in 2026 in Oklahoma. A ray of hope in the wafering segment is German start-up Nexwafe, which secured funding in 2023 to develop next-generation solar wafer production in Bitterfeld-Wolfen, Germany, which, in its first stage will have 250 MW of yearly production capacity. The first wafers are planned to be produced in 2025. Backed, among others by India's Reliance, Nexwafe announced in 2024 plans to also build a 6 GW factory in the US.

The **cell** segment maintains its 2 GW capacity, with seven companies active in the segment in 2024, unchanged since last year. The largest PV cell manufacturer in Europe, Meyer Berger, with 1.4 GW of capacity, did have plans to move its cell production from Germany to the US, after closing its European PV module production in March 2024. However, recent restructuring of the company halted these plans and Meyer Burger's existing cell production site in Thalheim, Germany, will continue to form the backbone of the company's solar cell supply. In positive news, Enel 3Sun's ambitious project for a 3 GW module manufacturing plant with internal cell capacities in Catania, Sicily, is set to start scaling up production in 2025, succeeding a former first 200 MW HJT cell/module line. Another promising development in the cell segment involves Dutch MCPV cell and module manufacturer, which recently secured 4.2 million EUR from the Dutch government to support the construction of a 4 GW solar cell plant, with plans to open the first phase of production in 2026.

Oxford PV integrated cell production line in Brandenburg, Germany

The **module** segment has seen the most changes in 2024. First, module production in Europe has decreased, from 14.6 GW in 2023 to 12.6 GW in 2024, with several closures and bankruptcies announced this year. The biggest impact for this segment comes from the closure of Meyer Burger's 1.4 GW module production facility in the spring of 2024, to avoid further losses in Europe, counterbalanced by an expansion of production in the US. Prior to the decision to close the Freiberg factory, Meyer Burger was targeting around 3 GW of new annual production capacity in Germany by the end of 2024, including 1.4 GW of additional module production capacity in Freiberg. In addition, other European module manufacturers including Solarwatt, Exasun, and Systovi had to stop their activities in 2024. Furthermore, although there were many announcements made in 2023 for new module production facilities to open in 2024, the majority of these projects have been shelved completely, delayed or not yet materialised. This resulted in only 300 MW of additional production capacity in 2024, out of more than 4 GW originally announced. Of this new capacity, Heliup, a French solar startup specialising in lightweight modules for large rooftops in the C&I segment, opened a 100 MW production line in 2024 in Le Cheylas, France, to complement their existing pilot line in Le Bourget du Lac, France.

The biggest module producer is still RECOM Technology, maintaining its 3.2 GW capacity after moving production from France to Italy in 2024. One noteworthy development for the module segment in France concerns the sale of Photowatt in September 2024, from EDF Renouvelables to Carbon, a French start-up which plans to develop a vertically integrated solar gigafactory by 2026. Carbon announced it will invest 44 million EUR to support and integrate Photowatt's cell and module activities to its project. The projected capacity of the gigafactory by 2026-2027 includes 5 GW each for the ingot/wafer and cell stages, and 3.5 GW for modules. For a start, Carbon will begin with a 500 MW pilot module assembly line scheduled to open by the end of 2025. In Nov. 2024, Chinese PV module manufacturer DAS Solar announced it will invest 109 million EUR to start production at its newly built 3 GW module factory in Mandeure, France in 2025. Repurposing a former automotive subcontractor site for their activities, this would be their first production site in the EU. Solar manufacturing was among the 82 winners of the European Commission's 4th Innovation Fund round for 4.8 billion EUR in grants. The solar PV manufacturing projects include a 1.5 GW HJT module plant in Spain from China's Trina Solar and a module assembly project in Italy by Italian company FuturaSun.

The EU is also home to world-leading players in the field of **Balance-of-System (BOS)** components, the hardware and infrastructure products needed to support the operation of a solar PV system, beyond solar panels. This includes inverters, mounting structures, wiring and cabling.

Production of the PV system's brain, **inverters**, keeps its leading position as the largest European solar manufacturing segment by far. EU inverter production capacity reached close to 93 GW in 2024, about 12% more than the 82 GW in 2023. Inverter manufacturers are still the backbone of solar employment in the EU, as shown in our latest EU Solar Jobs Report 2024. With at least 14 organisations employing more than 66% of all manufacturing jobs in 2023, several of these European companies are also international leaders like SMA from Germany and Fronius from Austria. Despite this segment's strong industrial base in the EU, relatively to other solar PV segments, it is also facing serious challenges due to fierce global competition. After strong expansion in 2022/23, Fronius, a leading residential inverter manufacturer, announced strong job cuts in 2024, while SMA has postponed plans to double its production capacity to 40 GW in 2024, due to internal restructuring. The cost pressure has forced several to have their products increasingly made in China. In this makes for a very difficult market environment, and European inverter makers have been dramatically losing market shares in their home markets: SolarPower Europe's Inverters Explained 2.0 report indicates that only 20% of PV systems installed in the EU use inverters made by EU manufacturers.

The field for **mounting structures** for solar panels has been mostly overlooked but is one of few fields that is dominated by western, and often even local players in Europe. While fixed mounting structures are used on rooftops and mostly for smaller or central/northern European PV power plants, structures following the path of the sun, so called trackers, are traditionally used for large PV power plants situated in southern countries. European leaders in the fixed segment are Enstall from the Netherlands and K2 from Germany, among several other companies, while a number of internationally active solar tracker suppliers are based in Europe too, such as Trina Solar's TrinaTracker in Spain. There are mounting specialists offering both fixed and tracking devices, like Germany's Schletter, which was recently acquired by Enstall.

Many **cables and connectors** for solar systems come from Asian companies, but one of the global leaders is European, Stäubli from Switzerland, which is also very well known for its robotics and automation business, that has products on offer for solar module manufacturers as well. Traditionally, global leaders in PV production equipment originated mostly from Europe, but this part has been almost fully taken over by China, though a number of companies are still active, and few in leading global roles, among them cell production equipment provider Von Ardenne from Germany, which has specialised in vacuum coating deposition equipment for advanced thin-film and crystalline technology.

A sleeping but upcoming giant will be the **PV recycling sector**. Towards the end of the decade, the industry will see large volumes of the long-living solar products coming to the end of their service life – and these numbers will only go up for many years. Among others, several European start-ups are working on retrieving as many materials as possible from recycled PV panels to re-use in PV production or for other industrial uses. One of them, Solar Materials, won SolarPower Europe's Solar Start-up Award 2024.

Europe's solar technology research and innovation capacity is built around a knowledge network of well-connected **research and development (R&D)** ecosystems. Europe's solar manufacturers work in close partnership with specialised PV research institutes disseminated across several countries, such as AIT in Austria, Germany based Fraunhofer ISE & CSP, ISFH, FZ Jülich, or ZSW in Germany, CEA-INES and IPVF in France, TNO in the Netherlands, EURAC in Italy, CENER and Tecnalia in Spain, and CSEM in Switzerland, among others. These institutes support the production of European research outcomes across the entire PV value chain and for various PV applications. They are also a key part of the organisation of the European PV manufacturing ecosystem, accompanying companies to maintain their competitiveness in a rapidly changing technology landscape, and supporting the guarantee of quality. Negative signals in the PV manufacturing landscape also impact research institutes which depend on public-private partnerships for their financial stability - this represents a threat to maintaining innovation capacity on PV. The European PV community did however deliver key milestones in 2024, most notably the commercialisation of the first perovskites tandem modules by Oxford PV, which operates a pilot factory in Brandenburg, Germany, and announced first commercial shipments of its perovskite-silicon tandem module to a client in the US in September 2024, marking the commercial start of its tandem products, a technology that is anticipated the next big thing in the solar module value chain.

Box 5

EU Solar Manufacturing in the Innovation Fund

A key financing tool for new solar manufacturing projects in the EU is the Innovation Fund, a fund for climate policy, with a focus on energy and industry. The aim of the fund, equivalent to 50 billion EUR to be allocated between 2021 and 2030, is to bring to market solutions to decarbonise European industry and to support its transition to climate neutrality while fostering its competitiveness. Most recent EU PV manufacturing projects have been trying to access these funds, as little other financial support has been available.

The European Commission announced the results of the 4th round of the Innovation Fund (IF23) in October 2024. A total of 85 innovative net-zero projects were selected for a total 4.8 billion EUR in grants, including 10 additional manufacturing projects in renewable energy. Of those 10 manufacturing projects, 2 are for solar manufacturing, representing a combined 3 GW of additional production capacity. While a European entity of Chinese manufacturer Trina Solar was chosen for a 1.5 GW heterojunction PV module factory in Spain, Italy's FuturaSun was also selected for its FENICE (Futurasun advanced italiaN manufacturing Centre) manufacturing project in its home country. Awarded projects need to sign their grant agreements in Q1/ 2025. The next Innovation Fund call (IF24) is scheduled for the end of 2024.

Prior to IF23, the European Commission held several calls for large-scale and small-scale proposals to the Innovation Fund. Out of a total 127 awarded projects between 2021 and 2023, only 8 were allocated to solar PV manufacturing (SeeTable on following page). According to the EU Commission, these projects are expected to create 6.8 GW of additional solar PV manufacturing capacity in the EU. The only large-scale PV project successfully financed and implemented through the Innovation Fund so far is the TANGO project for the expansion of 3SUN's heterojunction (HJT) Gigafactory in Catania, Italy. The factory is the first in Europe to produce mass bifacial panels with HJT technology. Production was launched in Q2/2024 with full 3 GW capacity scheduled to be reached in 2025.

Out of all received applications, few solar manufacturing projects are financed via the Innovation Fund. It's also worth noting that some companies, such as REC Solar, which had been awarded funding for a HJT cell fab in France, later withdrew their proposal and didn't sign the grant agreement, as the award alone was considered not attractive enough for a competitive project. Additionally, in light of recent challenges to the EU market and manufacturing landscape, there is some uncertainty as to whether some of the projects will still go ahead. For instance, NorSun was awarded 54 million EUR to expand its ingot and wafer production capacity in Årdal, Norway, by 3 GW (SunRISE project), around the same time that it announced the suspension of its production capacity in the country - since then, NorSun has been focusing on developing a larger production project in the US.

Although the Innovation Fund remains the most used mechanism at EU level for PV manufacturing, today's demise of the European solar manufacturing sector shows, the fund alone hasn't properly created a level-playing field for EU manufacturers so far (State of Play Report on Support for European Manufacturing).

Project Name	Tender	Project	Manufacturer	Grant amount	Country	Awarded	Status	Estimated entry into operation[1]
MOD4PV	IF23Call (2023)	1.5 GW HJT PV module assembly plant	Trina Solar (LU) Holdings	TBD	Spain	Oct. 2024	Selected	TBD
FENICE[2]	IF23Call (2023)	PV module production plant	FuturaSun	TBD	Italy	Oct. 2024	Selected	TBD
HOPE[3] project	3rd call for large-scale projects (2022)	3.5 GW of heterojunction (HJT) solar cell and module manufacturing capacity in Europe	Meyer Burger Technology AG (DE)	200 million EUR	Germany and Spain	Dec. 2023	Ongoing	Feb. 2027
DAWN project	3rd call for large-scale projects (2022)	200 MW plant for lightweight & flexible thin-film solar cells and panels	Midsummer (SE)	32 million EUR	Sweden	Dec. 2023	Ongoing	Originally Dec. 2025, now 2026 (Midsummer, 2024)
SunRISE[4] project	3rd call for large-scale projects (2022)	3 GW ingot and wafer manufacturing plant	NorSun (NO)	54 million EUR	Norway	Dec. 2023	Ongoing	Dec. 2025
SHEEFT[5] project	2nd call for small-scale projects (2022)	100 MW production capacity for lightweight PV panels for C&I	Heliup (FR)	3.2 million EUR	France	Q2 2023	Ongoing - active	Oct. 2024
TANGO[6] project	1st call for large-scale projects (2020)	Expansion of 3Sun's HJT bifacial cell and module factory in Catania, Italy into a 3 GW Gigafactory	3SUN S.R.L. & Enel Green Power (IT)	117 million EUR	Italy	Apr. 2022	Ongoing	Originally Sept. 2023 – now 2025 (Enel, 2024)
Helexio	1st call for small-scale projects (2020)	BIPV factory	ArcelorMittal (LU)	3.7 million EUR	France	Dec. 2021	Ongoing	Oct 2024
RISE[7]	2nd call for large-scale projects (2021)	2 GW HJT production site in France	REC Solar Pte. Ltd. (Singapore), CEA (FR), REC Solar France (FR)	X	France	X	Withdrawn	X
Maxair	1st call for small-scale projects (2020)	Stick-on solar panel production site	SunPower Manufacturing De Vernejoul SAS a subsidiary of Maxeon Solar Technologies (FR)	X	France	X	Withdrawn	X

1 According to EU Commission project factsheet – unless stated otherwise
2 Futurasun advancEd italiaN manufacturIng Centre
3 High-efficient Onshore PV module production in Europe
4 NorSun AS: Resource efficient and highly Innovative n-type mono-Silicon wafers for Europe
5 Solar HEliup Energy for Flat roofTop
6 Towards a New Generation of Photovoltaic Modules for the European Solar Market
7 REC Innovation at Sarreguemines Enterprise

4.4 Solar auctions and corporate PPAs

Auctions and tenders

The solar sector is fully aligned with the EU's ambitious energy and climate targets and beyond, supporting its global commitment to tripling renewable energy capacity by 2030. Auctions and tenders continue to play a crucial role as a market pathway for solar developers, alongside rising power purchase agreements and merchant projects.

Since 2021, over 51 GW of solar PV capacity has been awarded through auctions and tenders in the EU-27 (see Fig. 32). The bulk of this capacity (80%), has been granted to projects in the ground-mounted segment, while rooftop auctions/tenders have delivered 10.4 GW over the same period.

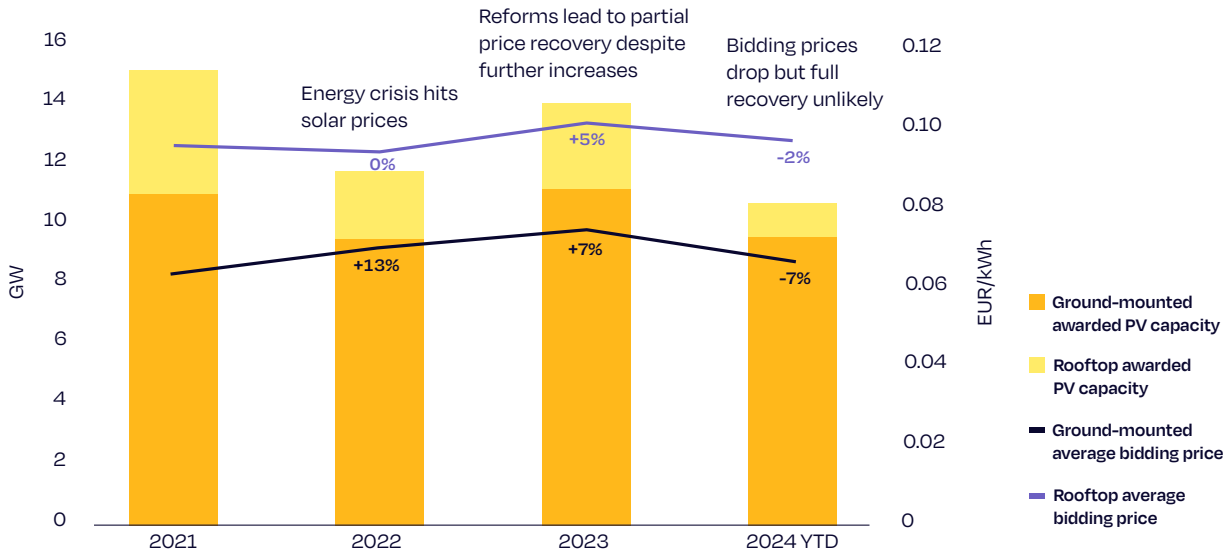
In 2021, the EU-27 granted an all-time high of nearly 15 GW of solar PV capacity. At that time, awarded volumes were spread across several Member States, with the Netherlands leading the with 3.5 GW. Except for a few specific cases like Spain, offered volumes were fully allocated, as auction and tender designs reflected economic conditions.

The energy crisis that erupted in early 2022 significantly altered the landscape. In that inflationary environment, which caused PV equipment prices to soar, bidding levels also increased. In 2022, average bids increased by 13% for ground-mounted PV projects compared to 2021. In contrast, ceiling prices were on average 14% lower than price bids and were generally not indexed to inflation. This made the business case less attractive for developers, who either refrained from bidding or sought alternative routes to develop projects.

Figure 32

After the record capacity awarded to PV in auctions in 2021, the energy crisis made developers explore alternative routes to market

EU-27 awarded solar PV capacity in auctions 2021-2024



Source: SolarPower Europe

Consequently, total awarded PV capacity was 21% lower in 2022 compared to the peak reached in 2021. However, major scheme reforms in leading markets like Germany and France last year spurred a partial recovery in 2023 (+17% compared to 2022), with close to 14 GW awarded. Significant increases in ceiling prices (+25% on average) helped accommodate worsening economic conditions, but resulted in a high concentration of capacity: Germany, France, and the Netherlands collectively accounted for 85% of the EU's awarded PV fleet. Outside these countries, undersubscription was the primary obstacle to optimal solar PV project allocation, with nearly half of the rounds held in 2023 undersubscribed, resulting in a considerable missed opportunity for PV deployment. Additionally, several countries decided to dismantled their schemes, further reducing the EU-27's awarded capacity.

In 2024, less than 11 GW of solar PV capacity has been contracted through auctions across the EU-27, with Germany maintaining an even more dominant position. The country awarded almost 60% of the total PV capacity to date (6 GW) and attracted double the submitted capacity. Only 5 more countries have reported auction/tender results in 2024, a stark contrast to the total of 10 in 2023 and 14 in 2022. This trend has led to lower total awarded capacity and will likely result in a final awarded volume level below that of 2021.

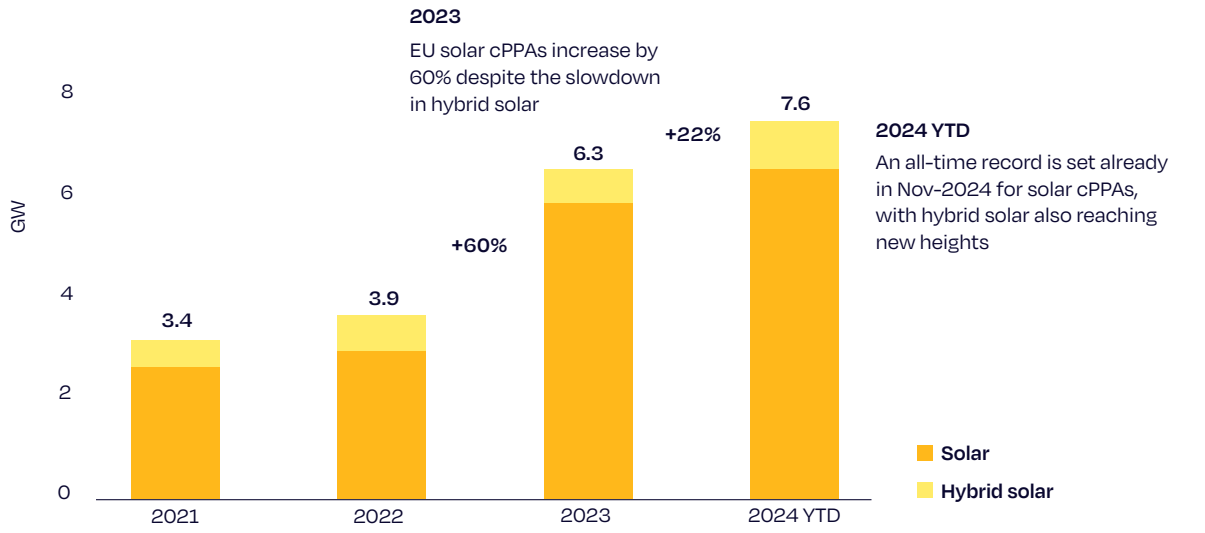
Corporate PPAs

In parallel to the auction pathway, corporate power purchase agreements (PPAs) have become an increasingly popular route to finance, develop and remunerate solar projects. Over the past 3 years, PPA signed capacities for solar assets have steadily increased, both in number of deals and signed capacities, indicating that industry decarbonization is a significant driver of solar deployment in the EU (see Fig. 33).

Figure 33

Corporate PPAs on track to break new capacity record in 2024

Corporate solar and hybrid solar PPA signed capacity 2021-2024



*2021 & 2022 are showcasing figures from the RE-Source Platform.

In 2023, the symbolic milestone of 10 GW of signed corporate PPAs across all renewable energy technologies was reached, with solar accounting for 6.3 GW (5.9 GW for stand-alone assets). The EU PPA market has evolved from being driven by a few major tech companies to a more diverse landscape. In 2023 and 2024, data centres and telecommunications together accounted for less than 30% of the market.

In terms of asset location, Spain has been a dominant force in the solar PPA market due to its favourable policies and resources. However, France and Italy are gaining traction, with significant growth observed in 2024 (3x more deals in Italy, 4x in France). Today, 18 EU Member States have seen corporate PPAs being signed for solar assets within their territory.

Another notable trend is the emergence of multi-technology PPAs, gaining increasing interest from corporate buyers. The complementarity between solar PV and other technologies, such as wind turbines or battery storage, has driven this innovative procurement approach, particularly for corporate buyers seeing specific production profiles. Multi-technology agreements became a GW-sized segment of the PPA market in 2021, and, after a pause in 2023, are regaining momentum in 2024, with 1.3 GW signed in the first 11 months of that year. This trend is expected to develop further over the coming years as market participants gain more experience with holistic renewable energy sourcing models.

4.5 Solar and flexibility

Projected to reach an operating solar fleet of 338 GW by end of 2024 and assumed our updated medium scenario holds until 2030, the EU is in due course to have around 816 GW of solar capacity connected to its electricity grids by the end of the decade (see Chapter 3). This and other market dynamics in the EU power system, coupled with EU climate and energy policy targets towards 2030 and 2040, indicate that variable renewable energy sources like solar PV and wind will provide the major share of EU electricity supply in the future. Already in the first half of 2024, wind and solar produced more electricity than all fossil fuels combined.[1]

However, the deep integration of variable renewables, in particular solar energy, into the power system does not come without challenges. Already today, some Member States with notable levels of solar PV penetration are starting to face issues related to the smooth integration of variable renewable generation in their power mixes. These issues include both challenges of technical nature (integration of solar projects into the grid, increasing level of curtailment) and financial nature (market structure, investment attractiveness and remuneration of renewable producers).

To better understand the challenges ahead and explore the potential of flexibility solutions, SolarPower Europe published the study Mission Solar 2040: Europe's Flexibility Revolution in June 2024. Through modelling simulations of energy infrastructure investments and hourly EU power system operations over a full year, the study analysed three scenarios with increasing levels of solar PV and flexibility solutions, namely flexible capacities and flexible demand from electrification.

8.7 MW Cintegabelle solar park, France

The study results highlight the fundamental role of flexibility solutions in a power system characterised by a strong penetration of variable renewable generation. Tapping flexibility potential not only enables the deployment of more solar as the key to meet climate targets and security – it also allows to make better use of abundant, clean and cheap electricity. The analysis shows that:

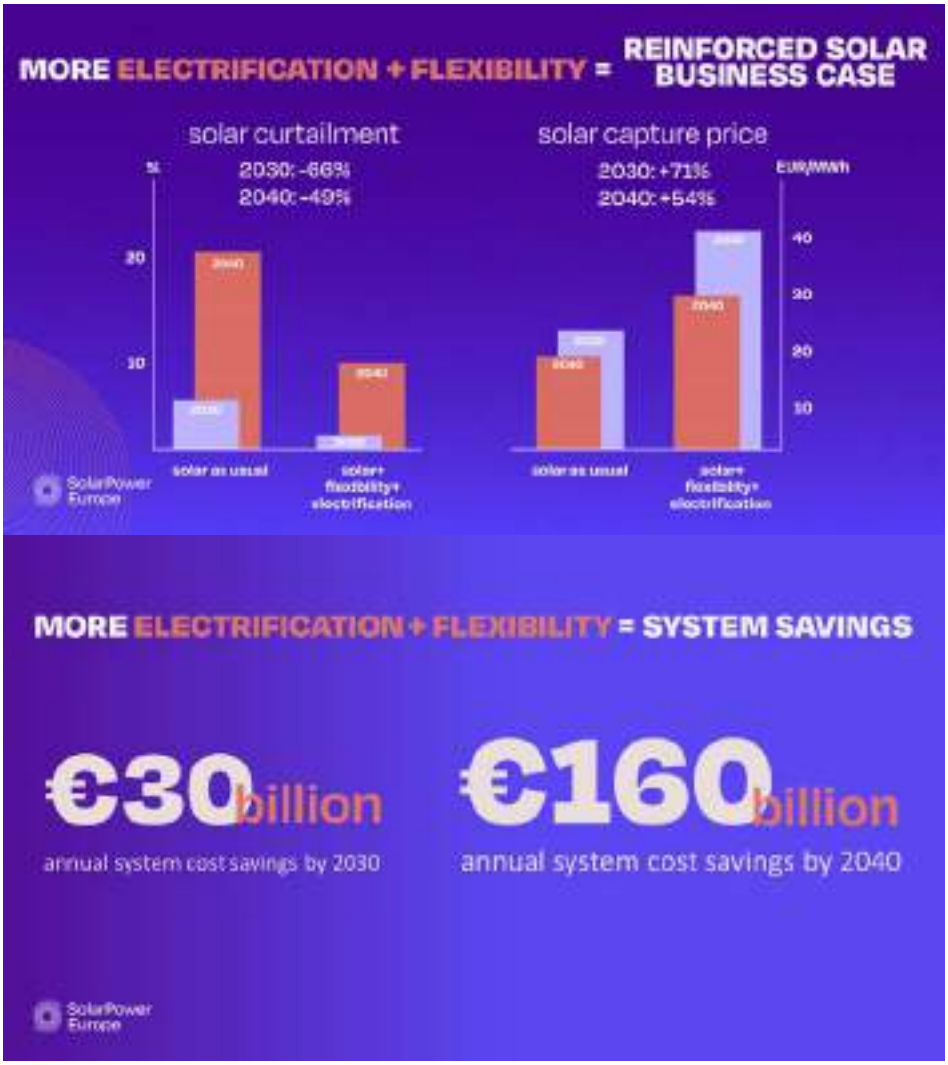
1. Unlocking flexibility solutions enables further PV deployment, resulting in additional solar electricity into the EU power mix. Solar capacity exceeds 1.2 TW in 2030 and 2.4 TW in 2040, providing 32% and 39% of EU power demand respectively.

2. Unlocking flexibility solutions reinforces the PV business case. In 2040, solar curtailment rates are reduced by 49% and solar capture prices increase by 54% compared to the baseline. Despite the increase in power demand from cross-sectoral electrification, average day-ahead electricity prices in 2030 and 2040 are 25% and 33% lower than in 2023.

Figure 34

The business case for solar is reinforced

Solar curtailment and solar capture price



3. Unlocking flexibility solutions reduces total energy system costs, thanks to the massive cost savings from the electrification of the heat, transport and hydrogen sector. Annual net system cost savings amount to 32 billion EUR in 2030 and 160 billion EUR in 2040.

4. Unlocking flexibility solutions lowers total GHG emissions. Carbon emission linked to the additional power demand from electrification are largely counterbalanced by cross-sectoral emission savings from the reduction of carbon-intensive alternatives. Annual net GHG emission savings amount to 151 $MtCO_2eq$ in 2030 and 555 $MtCO_2eq$ in 2040.

The Mission Solar 2040 report finds that building a clean energy system based on renewables, flexibility and electrification is the best way to bring the benefits of the energy transition to Europe's businesses and citizens and secure Europe's overall competitiveness and prosperity. To do so, the study emphasises the importance to:

1. Set political goals for renewables and clean flexibility for 2030 and 2040;

2. Improve energy system planning and assessing capacities for system operators, regulators and policymakers;

3. Unlock investment in clean flexibility across the energy system;

4. Adopt an EU Electrification Action and Investment Plan, as part of a new EU Energy Security strategy.

For more insights on the interplay between solar and flexibility, check SolarPower Europe's Mission Solar 2040.

Figure 35

SolarPower Europe Mission Solar 2040 policy recommendations

4.6 Solar and battery storage

The EU energy transition, with solar PV at the forefront, faces distinct challenges in effectively integrating variable renewable sources into the power grid (see p. 8). Traditionally, power systems have managed demand variability. The ascent of renewables has introduced supply variability, dependent on weather conditions. Balancing supply and demand now requires increased flexibility across various timescales - daily, weekly, and monthly. With solar PV being the fastest growing power source in the European Union for years, it is increasingly driving these flexibility needs, especially over shorter timespans such as daily and weekly cycles.

In the EU-27, near-term flexibility needs are projected to rise from 249 TWh in 2021, to over 924 TWh by 2030.[4] If solar is coupled with increased flexibility and electrification, near-term requirements would increase almost 5-fold reaching 1,160 TWh by the end of the decade. Notably, 64% to 70% of these flexibility demands will emerge on a daily basis, providing an opportunity for battery storage to play a critical role by shifting excess daytime generation to meet evening demand peaks.

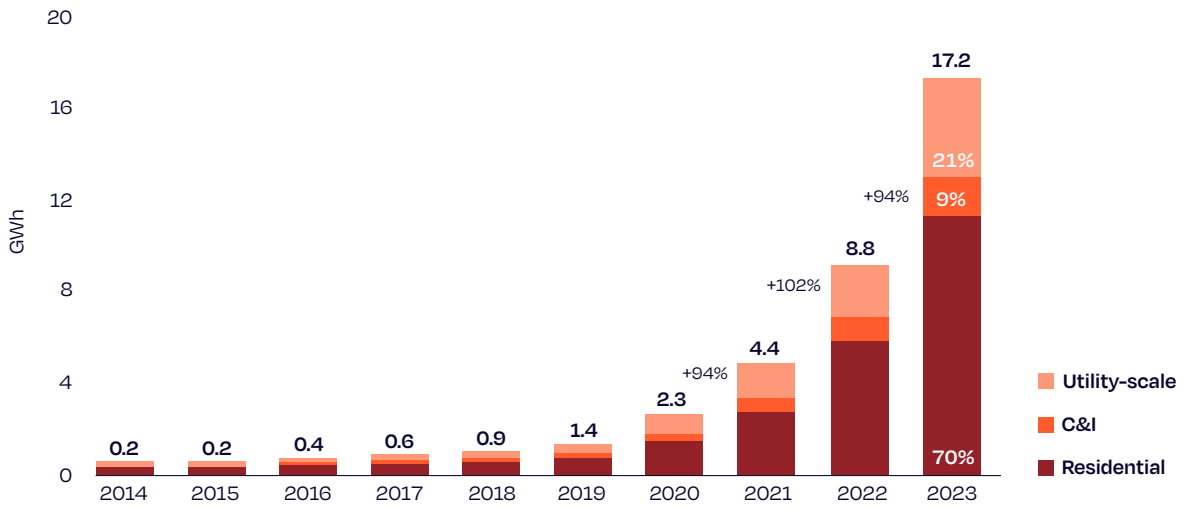
Battery storage is a proven technology to reduce price volatility and lower system costs at peak demand and supply times. Batteries allow the grid to be operated more efficiently and enable better utilisation of existing power networks. Co-locating batteries with solar PV can also increase the market value of solar electricity, which declines as more solar is added to the system.

In 2023, Europe installed 17.2 GWh of new battery energy storage system (BESS) capacity,[5] representing very strong growth of 94% year-on- year and marking the third consecutive year of doubling annual market capacity (see Fig. 36).

Figure 36

The European battery market doubled each year between 2021-2023

Europe annual BESS installed capacity 2014-2023



Source: SolarPower Europe

4 SolarPower Europe (2024): Mission Solar 2040
5 SolarPower Europe (2024): European Market Outlook for Battery Storage 2024-2028

This leap, closely linked with solar PV adoption, was primarily driven by the residential sector as households sought relief from high electricity prices and aimed for greater energy independence. In 2023, residential installations reached 12 GWh, accounting for 70% of the newly added capacity. The C&I battery segment, still largely untapped but showing strong potential, added 1.6 GWh (9%), while grid-scale batteries contributed 3.6 GWh (21%).

By the end of 2023, Europe's total operational BESS capacity reached 35.8 GWh, with the residential sector making up the majority of this capacity at 63%. Grid-scale battery systems accounted for 27%, while the C&I segment contributed 10%.

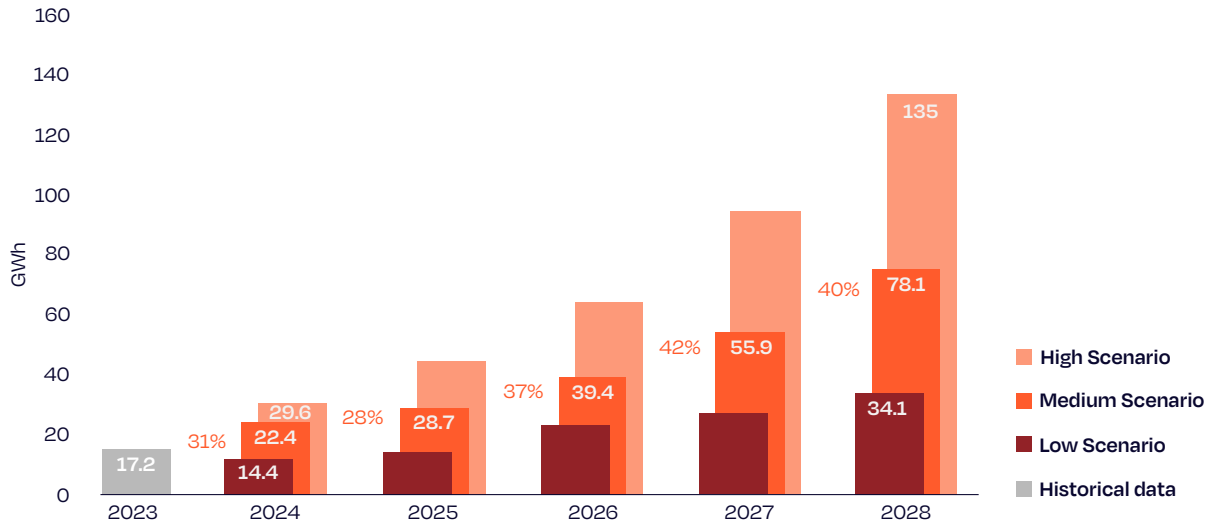
The outlook for battery storage expansion is promising, as growth accelerates alongside the energy transition. The increasing adoption of renewables, electrification of transport and heating, and the need for grid modernisation all depend on battery storage for clean, flexible energy. Advances in technology and significant cost reductions are expected to further drive BESS deployment. To support this momentum, policy and regulatory frameworks should focus on establishing a strong, stable foundation for battery storage expansion.

With the leading home battery markets Germany and Italy experiencing declines after the record levels registered in 2023, the residential segment is poised to shrink 26% in Europe in 2024. Despite this considerable reduction, we forecast that the total European BESS market will keep growing (22.4 GWh and 31% growth), as the space left by residential BESS is being filled by larger batteries in the C&I (+63%) and utility-scale segment (3X increase) (Fig. 37).

Figure 37

The annual battery market is expected to grow to 78 GWh by 2028, over four times the capacity installed in 2023

Europe annual BESS installed capacity scenarios 2024-2028



Source: SolarPower Europe

The BESS market is expected to sustain its upward trend from 2025 through 2028, with annual growth rates between 30% and 40%. By 2028, our Medium Scenario projects annual installations across Europe to reach 78.1 GWh, which would lead to 260 GWh operating at the end of 2028.

The move toward utility-scale batteries is expected to solidify, capturing over 45% of new installations in 2028, while the C&I segment will absorb 25% of additions in 2028, and household BESS installations will add 29%.

To support this momentum, policy and regulatory frameworks should focus on establishing a strong, stable foundation for battery storage expansion. Policymakers must effectively assess the demand for battery storage, create suitable price signals and financial incentives, remove existing barriers to storage deployment (such as double charging), and modify the grid connection framework to facilitate the rollout of all types of battery storage.

For additional insights about the dynamics, drivers and challenges of battery storage in Europe, check SolarPower Europe's European Market Outlook for Battery Storage 2024-2028.

4.7 EU Solar Jobs

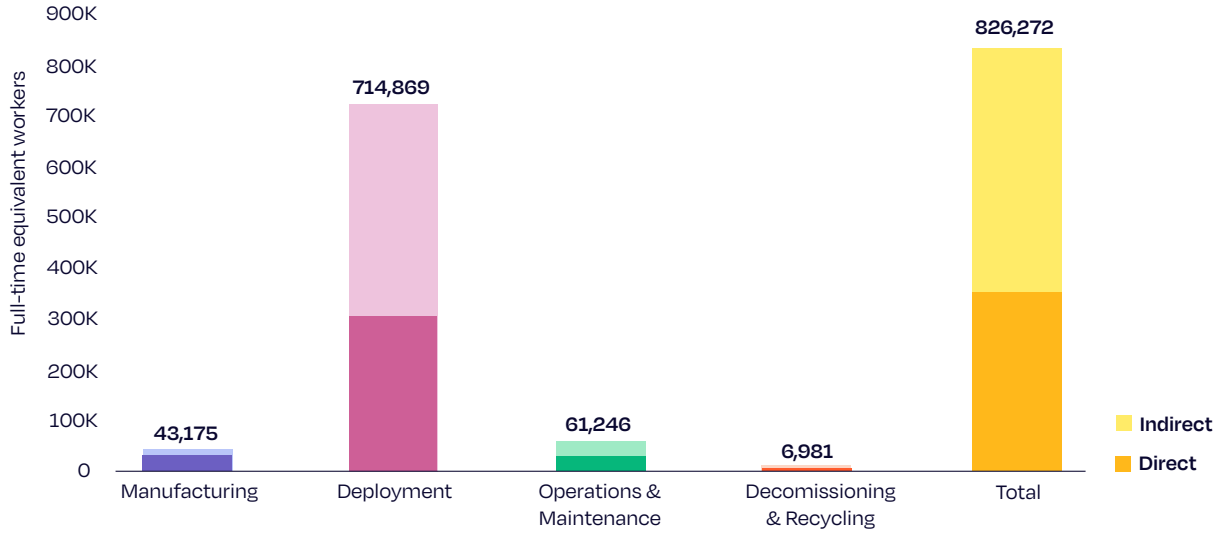
Solar employment in the EU has been steadily on the rise in the last few years, and that trend continued in 2023, when job creation increased by about a third, thanks to large project pipelines and strong product demand caused by the energy crisis.

At the end of 2023, the solar sector employed 826,000 full-time equivalent workers (FTEs) in the European Union (see Fig. 38). Compared to the previous years, the majority of jobs in the solar industry concentrated even more in the deployment phase, accounting for 715,000 FTEs, or 87% of the total jobs. The steep growth in installed solar capacity in recent years also drove Operation & Maintenance activities, which generated 61,000 jobs, representing 7% of the total end of 2023. Conversely, the EU's manufacturing sector experienced several factory closures and job cuts due to intense international competition, resulting in a 5% share and 43,000 FTEs, a decline of 11% from 2022 levels. Finally, due to the long lifetime of solar modules, with performance warranties of about three decades, Decommissioning & Recycling jobs remained a minor component, comprising less than 1% of total employment.

Figure 38

Out of the 826,000 workers employed in the EU solar sector in 2023, the large majority was active in PV deployment activities

EU-27 solar job market in 2023



Source: SolarPower Europe

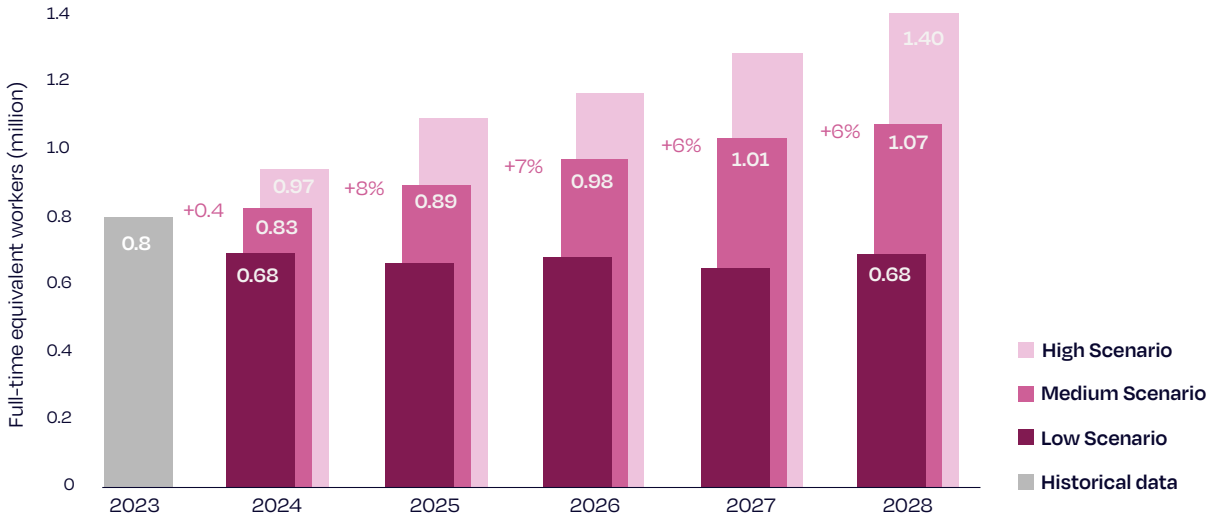
After a year of gigantic solar market growth and the subsequent enlargement of the solar workforce to enable that rapid development, a very moderate increase in the solar PV market is expected in 2024, leading to a negligible rise in solar jobs. In our most recent job study, published in October 2024 and based on market estimates from June, we estimated that the PV market would grow by 5%, reaching 63.9 GW and resulting in a less than 1% increase in solar jobs due to a changing market environment, bringing the total to approximately 830,000 FTE positions[6] (see Fig. 39). By 2025, the trajectory suggests 895,000 solar jobs – down from the 1 million previously forecast for that year. Looking ahead to 2028, solar jobs could surpass 1 million under the Medium Scenario, and up to 1.4 million in the High Scenario.

For more insights on employment in the EU solar industry, check SolarPower Europe's EU Solar Jobs Report 2024.

Figure 39

The number of solar workers in the EU is expected to grow by 6-8% every year to surpass 1 million by 2027

EU-27 solar PV job market scenarios 2023-2028



Source: SolarPower Europe

6 The employment figures in the EU Solar Jobs 2024 report are based on market research published in our Global Market Outlook 2024, released in June 2024. While our overall EU PV market estimates have been revised for this EU Market Outlook, our expectation of a 5% growth rate for 2024 remains unchanged, meaning that our job creation projections for this year remain largely accurate

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GW-scale solar markets

In 2024, 16 EU-27 markets installed over 1 GW of solar capacity in a single year, compared to 14 markets in 2023. The 2024 GW-scale markets are Germany, Spain, Italy, France, Poland, the Netherlands, Greece, Austria, Hungary, Portugal, Romania, Belgium, Ireland, Bulgaria, the Czech Republic, and Sweden. For the second consecutive year, more than half of the EU countries achieved GW-scale installations.

5.0 GW-scale solar markets

16 EU-27 markets installed over 1 GW of solar capacity in a single year, compared to 14 markets in 2023

In our December 2023 EU Market Outlook, we projected 15 markets would reach GW-scale in 2024, and all succeeded. Following a forecast revision in June 2024, Ireland was added to the list, bringing the total to 16 markets. All the countries that reached GW-scale in 2023 repeated this milestone in 2024, while Ireland and the Czech Republic were the new entrants. However, several markets experienced a decrease in installation volumes, including Spain, Poland, the Netherlands, Austria, Hungary, Belgium, Bulgaria, and Sweden.

Looking ahead to 2025, we anticipate that again 16 markets will reach GW-scale, but the composition will change (see Fig. 40). Hungary and Bulgaria are expected to fall short of that level, with Hungary's installations projected to drop sharply from over 2 GW in 2024 to 960 MW in 2025, and Bulgaria reducing from 1.2 GW to 970 MW. In contrast, Lithuania and Denmark are set to join the GW-scale list. Lithuania will become the first Baltic country to achieve this milestone, while Denmark, after missing the threshold in 2023 and 2024 due to challenges in utility-scale projects and grid tariffs, will rejoin.

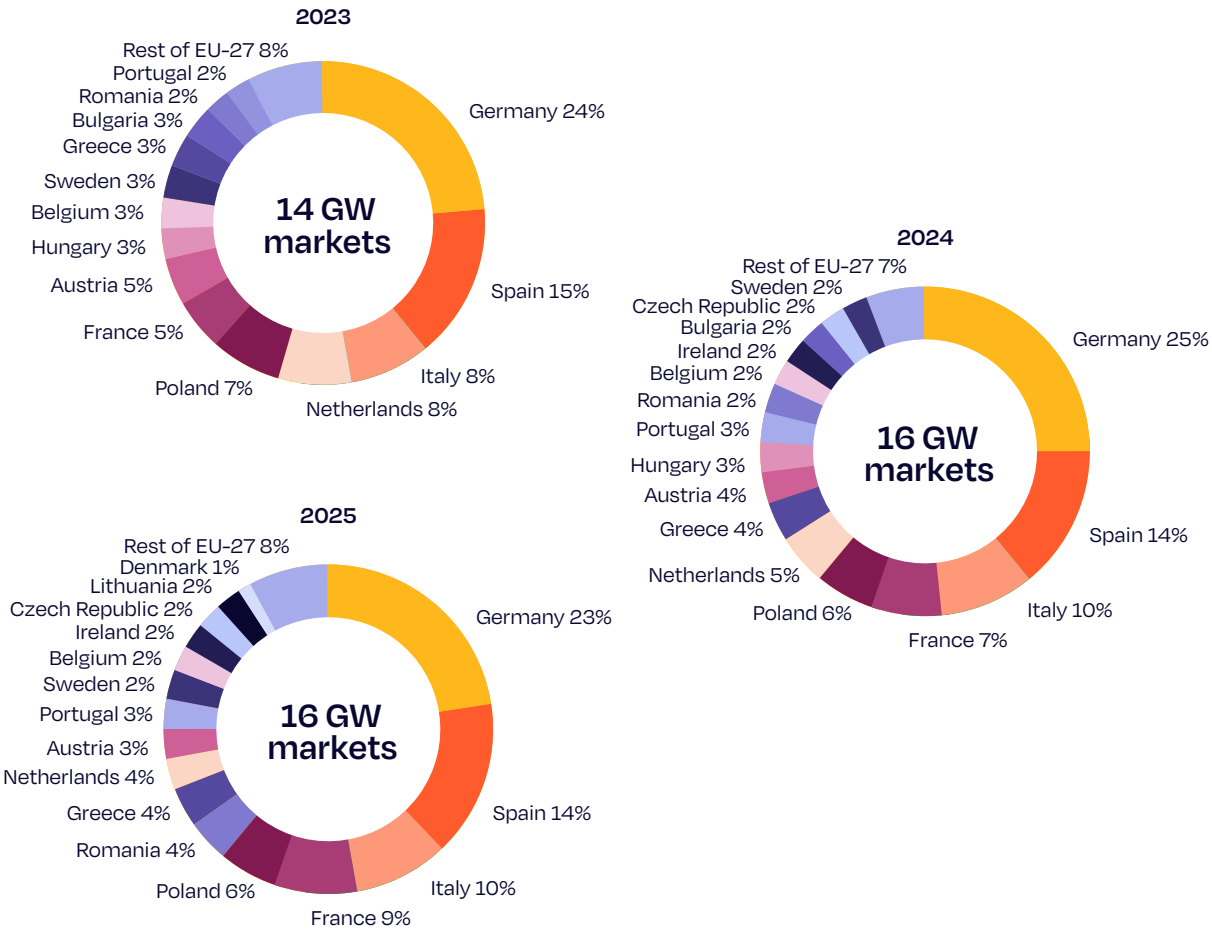
Germany's dominance will strengthen in 2025, with its market share increasing from 23% to 25% of the EU solar market. It will remain the only country to install over 10 GW annually. Spain will represent 15% of the EU market and Italy 11%. All together the top 3 markets will cover 50% of the EU market in 2025. Looking at all GW-scale markets combined, they are projected to represent 98% of the total market share in 2025, up from 93% in 2024, underscoring the faster growth of larger markets compared to smaller ones.

In this GW chapter, we traditionally invite our national solar/renewables association members to provide their local expert views on their home countries (which sometimes slightly differ from our estimates, which are based on several sources). For this edition, we have received contributions from national associations of all GW-markets in the EU-27.

Figure 40

EU GW-scale markets

EU-27 GW-scale solar markets 2023-2025



Sources: SolarPower Europe

5.1 Germany

2024 deployment breaks records again in spite of residential segment slowdown and government woes

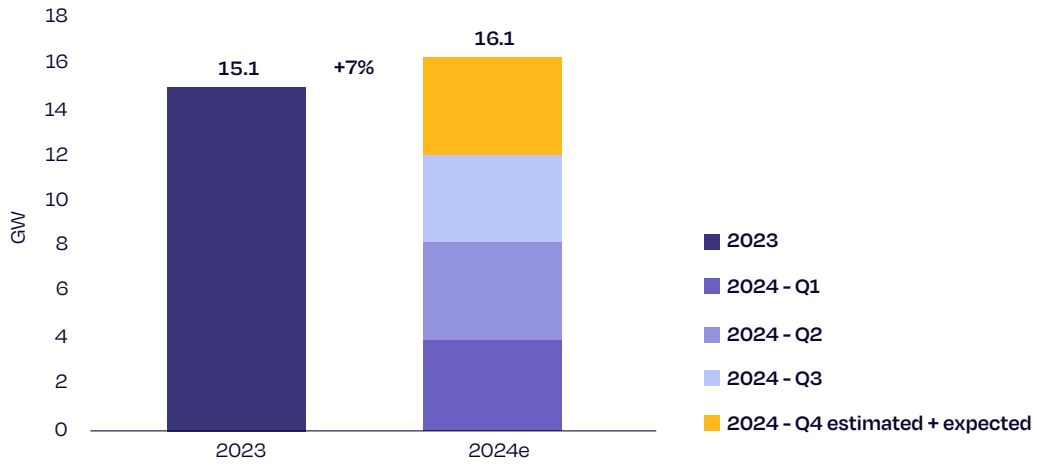
Overview of PV developments

Over the first three quarters of 2024, nearly 12 GW of reported solar installations have been connected to the grid—a figure likely underestimated due to late registrations in the market master data register. SolarPower Europe projects the German market to reach a total size of 16.1 GW for the year, a 7% increase over the record-breaking 2023 (GW Fig. 1.1). While this is a notable increase, it's slow in comparison to the record year 2023, when installations doubled from 7.4 GW to 15.1 GW. The third quarter of 2024 alone contributed over 3.5 GW, with September marking a high point at 1.2 GW of newly commissioned PV systems, a significant increase compared to August.

GW Figure 1.1

Germany GW-scale markets

Annual solar PV installed capacity 2023-2024e



Sources: BNetzA, SolarPower Europe

Battery storage has also seen significant activity, albeit with slower growth in 2024 compared to the exceptional surge in 2023. By the end of Q3 2024, Germany had reached an estimated total installed battery storage capacity of 17.3 GWh, spread across approximately 1.7 million systems. While new installations in the first three quarters amounted to 4.54 GWh of capacity—just 1% above the previous year—commercial and large-scale storage systems have shown notable momentum. The third quarter alone saw 170,000 new storage systems installed, with commercial systems growing by 9% and large-scale systems expanding by 90% compared to Q3 2023. These developments highlight the increasingly critical role of storage in supporting Germany's renewable energy transition.

As of Q3 2024, Germany's solar market remains firmly on track to sustain its leadership position in Europe, driven by strong performance in larger-scale systems and the continued integration of storage solutions.

PV market drivers

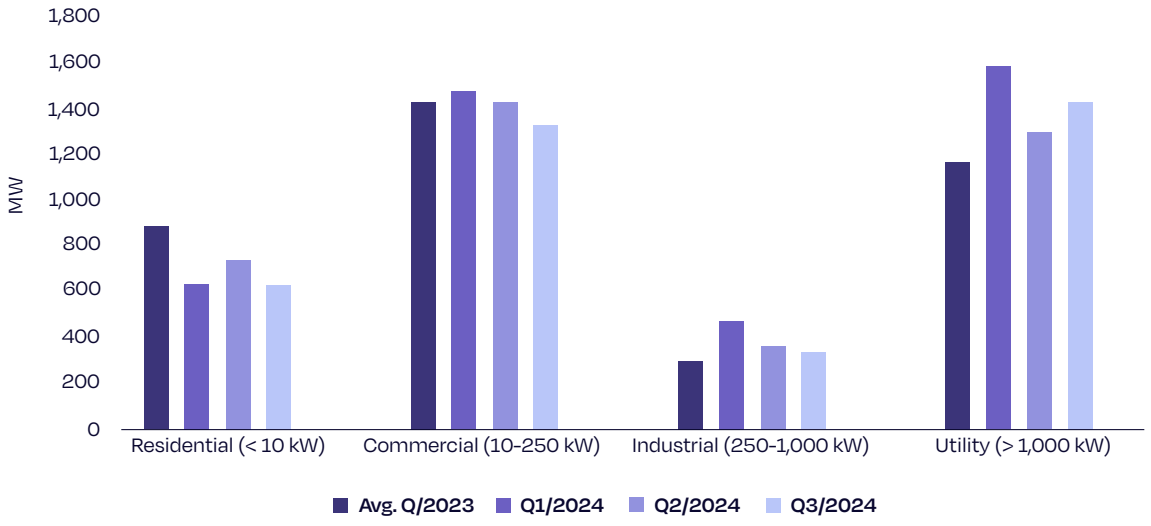
This growth has been driven by robust expansion in ground-mounted and commercial rooftop systems. Ground-mounted systems added 4.2 GW during the first nine months of 2024, a 50% increase year-on-year, with unsubsidised projects accounting for 1.27 GW. Commercial rooftop systems (>30 kW) expanded by 36% during the same period. In contrast, the residential segment (≤30 kW) declined by 12% compared to the same timeframe in 2023, reflecting the end of the peak installation pace fuelled by the energy crisis and pandemic, as well as a broader stabilisation in the segment.

Germany's solar market has historically been driven by robust policy frameworks and ambitious targets. The "Easter Package," adopted in 2022, set the stage for aggressive expansion, aiming for 215 GW of installed capacity by 2030 and 22 GW annually by 2026. This framework simplified grid connection procedures, incentivised innovative solar applications like agri-PV and floating PV, and provided VAT exemptions for small systems under 30 kW. These measures were a catalyst for record-breaking installations in 2023. Today, the market still partially benefits from the aftermath of these decisions. GW Fig. 1.2 highlights a significant drop (~20%) in the pace of installations within the residential segment, which was offset by a notable ~25% increase in the utility-scale sector.[7]

GW Figure 1.2

Germany GW-scale markets

2023-2024 quarterly PV installations per segment



Sources: BNetzA, SolarPower Europe

7 Data for residential systems employs SolarPower Europe's standard segmentation (<10 kW) to ensure comparability with other countries in this report.

The sustained larger installations can be attributed to the strong government support for these. Today's connections follow a relatively stable policy environment with, amongst other tools, auctions for industrial and utility-scale installations. The decline in the residential market stems from multiple factors. Stabilising energy prices have reduced the perceived urgency to install solar, while the intense growth of recent years has partially saturated the market, especially amongst 'early adopters' in solar deployment. Furthermore, a shift in public perception regarding the business case for residential solar—due to evolving policies and less favourable economics—has also contributed to the slowdown. Finally, it's important to note that this is a slowdown against the high baseline of 2023. While the sense of urgency has diminished, today, the market finds a more measured pace of adoption.

Challenges and outlook

Germany's solar market is navigating a period of uncertainty amidst significant political and regulatory changes. The recent collapse of the German government has heightened concerns about the future direction of renewable energy policy, particularly regarding solar PV. This uncertainty disproportionately affects the residential and C&I segments. This uncertainty partly results from the outstanding state aid approval of key aspects of the Solar Package I on behalf of the EU Commission and a general slowdown of the economy. On the other hand, the approval of the Solar Package I earlier this year has been widely recognised as breakthrough legislation and a potential catalyst for positive impulses within future solar market development. As the government coalition broke up in November in the wake of contentious budgetary debates, market participants are left speculating about the long-term implications. Potential reforms regarding the electricity market design have been postponed as of the writing of this article, and it remains uncertain whether legislation can be passed before the preponed elections in early 2025, since any proposal will require consent from parts of the opposition in Parliament. The potentially available coalition constellations resulting from the public vote will also have an impact on future legislation. All of these factors combined lead to significant uncertainty in the short run and both the election results and successful legislative initiatives could influence investment decisions in the near term.

15.9 MW, Kreuth, Germany

Uncertainty for rooftop installations surged even before the collapse of the government, after a draft proposal was released by the Federal Ministry for Economic Affairs and Climate Action (BMWK) presenting options for the structural reform of renewable energy incentives. The proposed changes include an extension of the abolition of subsidies for new solar PV systems during periods of negative electricity prices, which currently only applies for PV installations above 400 kW. This is intended to stabilise the system balance in times of low demand and lower the cost for the federal budget. It also encourages the adoption of energy storage systems to better integrate solar energy into the grid. Moreover, the obligation for direct marketing, currently applicable to systems over 100 kW, might expand to include installations as small as 25 kW. While systems below the threshold will retain feed-in tariffs, this draft legislation signals uncertainty for systems between 25 kW and 100 kW, which currently benefit from the feed-in scheme.

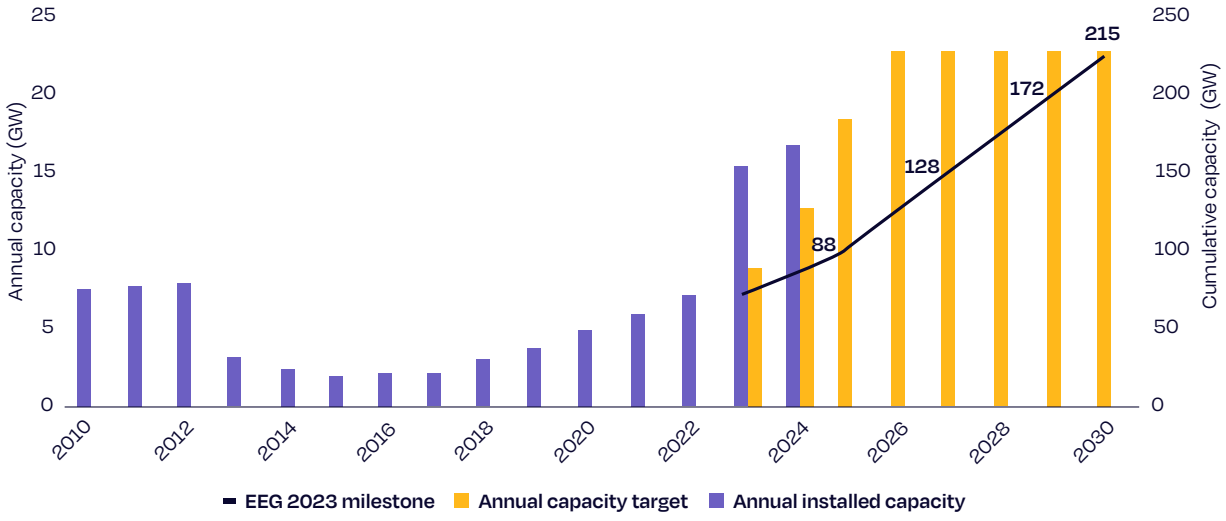
These reforms aim to address the challenges of electricity surpluses and pricing volatility while accelerating the rollout of smart meters and stabilising the federal budget. However, they also introduce complexities for stakeholders navigating the transition. The reform's broader objective is to increase renewables' share of electricity consumption to 80% by 2030, up from 55% in 2023. Yet, achieving this will require balancing market integration with sufficient incentives and ensuring that uncertainty does not stifle investment, particularly in smaller-scale systems and storage solutions.

At the small-scale system capacity level, the observed market developments in 2024 will put the brakes on the outstanding roll-out of residential batteries over the last three years, which led to Germany building the largest operating fleet in Europe. Remarkably, the residential segment has added 80% of the existing battery storage capacity in the country. However, alongside the residential PV market, the household battery market is also at risk of contracting this year. The fade out of the energy crisis boosting effect on deployment at the residential level has had a substantial impact on the growth prospects of the segment. These considerations exclude micro/balcony battery systems, which have gained a significant market share in 2024 and have become a new market tranche for the industry.

GW Figure 1.3

Germany GW-scale markets

Annual solar PV installed capacity 2010-2024 and targets 2023-2030



Sources: BNetzA, SolarPower Europe

Going forward, the segment will continue to significantly contribute to the expansion of battery storage, but to a lesser extent, as larger batteries gradually take over. In order to cope with negative prices, avoid congestion at the distribution and transmission level, mitigate solar curtailment and increase solar capture rates, a massive expansion of the C&I and utility-scale battery segments is needed. Both segments present bright outlooks as both profitability and feasibility radically improve thanks to declining battery prices, lucrative energy arbitrage operations, and the likely inclusion of a capacity market supporting the deployment of large-scale BESS. Additionally, the innovation tenders will continue to support the expansion of co-located battery storage with renewables, even though the existing tender design and adjacent legislations remain to be amended, to allow operators to charge from the grid and provide flexibility services to the grid as mandated by the Solar Package I.

Besides these uncertainties and limitations to electrification, ambition remains high, thanks to the annual capacity targets of 18 GW for 2025 and 22 GW for each year between 2026-2030 (see GW Fig. 1.3). The attainability of reaching the targets, however, will rely heavily on continuously supportive frameworks as well as government stability and investment security in the wake of Germany's upcoming elections, taking place in early 2025.

Authors: *Jonathan Gorremans,* SolarPower Europe; Special Thanks to the *Bundesverband Solarwirtschaft e. V.* (BSW-Solar) for valuable input. BSW-Solar market data is available here: https://www.solarwirtschaft.de/en/press/market-data/

5.2 Spain

The challenges to our future

Overview of PV developments

In 2023, Spain achieved maturity in the solar PV market, with an annual installation of almost 9 GW in capacity, surpassing the total installed capacity in 2022 by 5.8%. This milestone positioned Spain as the second-largest solar market in Europe, just behind Germany. The ground-mounted segment grew by more than 26% compared to 2022, while the residential sector contracted by 32%. These trends appear to be continuing in 2024. In the first three quarters of the year, around 5 GW of solar capacity was installed

Last year, solar PV technology accounted for 14% of Spain's electricity mix, a four-percentage point increase from 2022. So far in 2024, PV's share of the energy mix has risen to 18%. Additionally, Spain has maintained its status as a net exporter of electricity, with a total net export balance of 8.4 TWh as of 2024.

Drivers of solar growth

The approval of the new objectives in Spain's **National Energy and Climate Plan (NECP)** in the summer of 2024 marks a significant milestone in the country's energy transition. The European Commission has ratified ambitious yet achievable targets that lay the groundwork for a transformative shift in Spain's energy matrix. These new targets align closely with the draft proposed last year, establishing a clear roadmap for Spain's photovoltaic sector.

5 MW self-consumption PV plant, salt company Jumsal, Jumilla, Spain.

The updated NECP sets a goal of reaching a total installed photovoltaic capacity of 76 GW_{AC} by 2030, with 57 GW_{AC} from ground-mounted facilities and an additional 19 GW_{AC} from self-consumption units. This solar target is equivalent to 91 GW_{DC} using a 1.2 conversion ratio (see GW Fig. 2.1). This target reflects a solid commitment to expanding solar energy as a key component of Spain's renewable energy portfolio.

Moreover, the new NECP demonstrates increased ambition regarding energy storage targets. The goal for storage capacity has been raised by 0.5 GW, from 22 GW to 22.5 GW by 2030, and the hydrogen storage capacity target for 2030 has also increased by 1 GW, from 11 GW to 12 GW. These adjustments underscore the importance of flexible energy storage systems in supporting a renewable energy transition.

With these targets in place, renewable energy is expected to gain further momentum within Spain's energy mix, contributing significantly to the decarbonisation and electrification of the economy. The NECP's revised goals signal a strong commitment to a sustainable energy future and highlight the growing role of solar energy and storage technologies in achieving Spain's climate objectives.

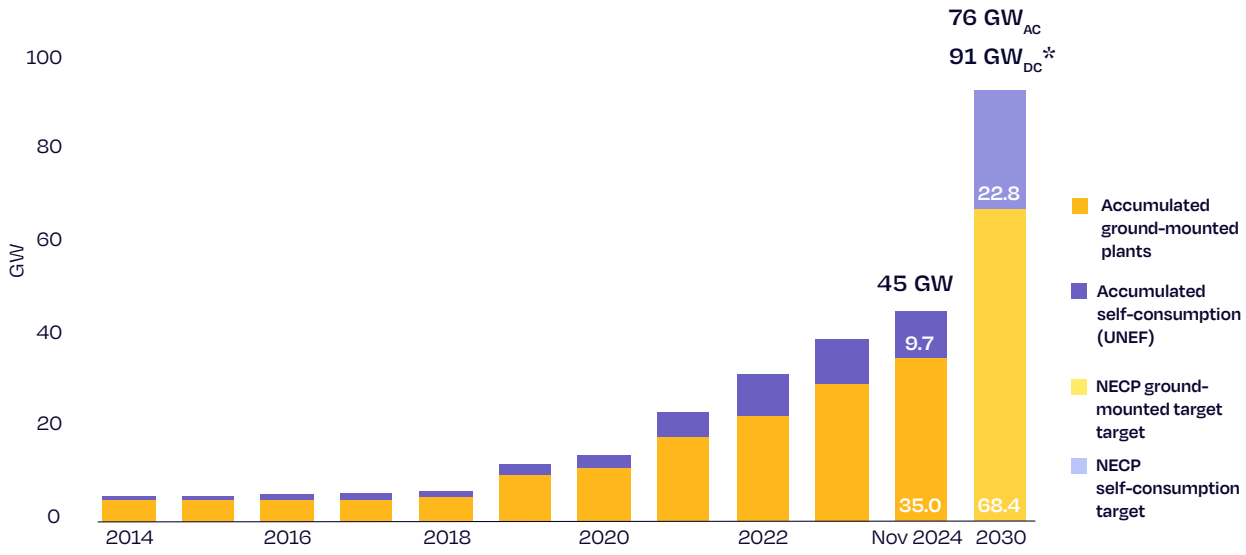
The growth of the PV market in Spain is driven by its competitiveness, both in ground-mounted installations and in the self-consumption sector.

Regarding ground-mounted plants, around 7.3 GW of capacity was installed in 2023, representing a 30% increase compared to 2022. So far in 2024, according to the TSO, an additional 3.8 GW has already been installed (updated by October 2024) – a conservative estimate, given that available data for 2024 is not always up to date. This capacity has been developed without any aid or subsidies for ground-mounted plants. Auctions have been postponed, and due to current price misalignments, it is now more necessary than ever to call for auctions that provide certainty to stakeholders. This suggests that the ground-mounted market is evolving based on Power Purchase Agreements (PPAs) and spot market prices.

GW Figure 2.1

Spain GW-scale markets

Cumulative solar PV installed capacity 2014-2024 and NECP target



*Official NECP target in AC converted to DC using a ratio of 1.2
Sources: UNEF & Red Electrica

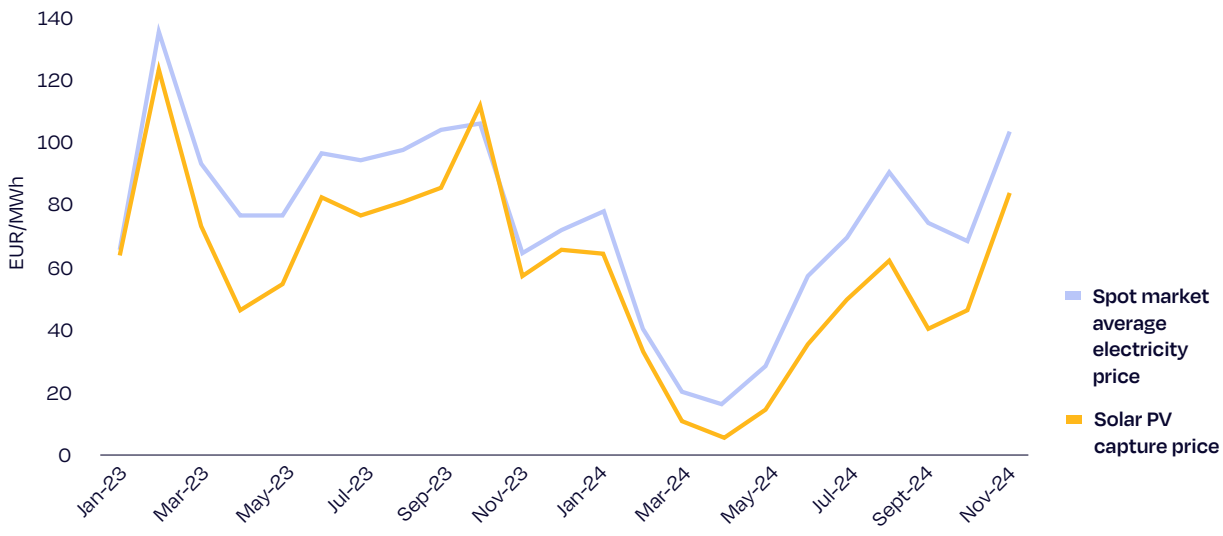
The volume of PPAs has grown significantly over recent years, though a slight decline was observed in 2023. In 2020, 3.5 GW of renewable PPAs were signed, increasing to 4.3 GW in 2021, and peaking at 5.3 GW in 2022. Last year, however, the total dropped to 4.6 GW. Despite this decline, a large proportion of newly signed contracts were for solar PV energy, largely due to competitive PPA prices in Spain, which averaged 38.5 EUR/MWh in 2023, one of the lowest in Europe. In contrast, the spot market price was significantly higher, with an average of 87.1 EUR/MWh, according to OMIE, the nominated electricity market operator (NEMO) for the Iberian Peninsula. As in many other European countries, Spain's wholesale electricity market in 2024 experienced zero-euro prices per megawatt-hour (EUR/MWh) during certain hours of the day on multiple occasions. While this phenomenon has occurred over several months throughout the year, minimum prices have not fallen below -2 EUR, demonstrating a remarkable market balance compared to other EU countries. Weighted average prices captured by PV energy have also been significantly lower than **the spot market average**, which has supported the deployment of installed capacity (GW Fig. 2.2).

The **self-consumption segment** has also changed significantly throughout 2023 and the beginning of 2024. Although 2023 was the second-best year on record in total installations, they dropped by 32% compared to 2022, with the declining trend continuing in 2024. In 2023, a total of 1.7 GW of self-consumption capacity was installed in Spain, pointing to a stabilisation of the sector after experiencing a peak of annual installations in 2022. By segments, the residential segment for self-consumption has been the most affected, contracting by 53%, from an annual installation of 963 MW in 2022 to 446 MW in 2023. This decline is driven on the one hand by inflation and high interest rates, which have directly impacted household economies, and on the other, by the general perception that energy costs are lower (although still currently at 46 EUR/MWh). Meanwhile, the industrial sector has remained relatively stable, registering a 13% decrease compared to the previous year, from a yearly installation of 1.4 GW to 1.2 GW. These figures suggest that it might be a challenge to sustain the 1.9 GW of annual installations required in this segment until 2030 to meet NECP targets. In 2023, the self-consumption market is showing signs of stabilisation. From a historical perspective, especially when compared to the disruptions caused by the "sun tax," the market has remained steady, experiencing a soft landing.

GW Figure 2.2

Spain GW-scale markets

Spot market average electricity price versus solar PV capture price, 2023-2024



Sources: REE, OMIE & UNEF

Challenges

Implementing the NECP in Spain poses multiple challenges that require a strong and coordinated response from the institutions and stakeholders involved. These include **complex administrative procedures, grid integration, social acceptance, and the inadequacy of the current pricing system** that does not adequately reflect the renewable energy market.

While the **permitting process** for renewable energy projects remains a significant challenge, recent legislation introducing a semester-based system for plant electrification offers a structured framework for developers. This system requires developers to commit to a specific semester for grid connection, which, if efficiently managed by the TSO and the Ministry of Industry, could streamline the electrification process. However, effective coordination will be critical to avoid potential bottlenecks that may impact the timely deployment of pipeline capacity.

On the other hand, there are serious concerns regarding the handling of administrative **procedures for capacity tenders**, both for demand and supply. These procedures are critical to ensuring an efficient energy transition. Without clarity and efficiency in these processes, the risk of delays and complications increases, potentially hindering the deployment of renewable energy projects and impacting the overall progress of the energy transition.

The **integration of renewable energy into the grid** is another technical challenge of crucial importance. As Spain increases its installed capacity, ensuring adequate and efficient grid connectivity becomes a priority. This challenge requires substantial investments in infrastructure, particularly in storage mechanisms and green hydrogen technologies that provide flexibility and stability to the electrical system.

Furthermore, **social acceptance** of renewable energy projects remains a delicate issue, particularly in rural areas where large-scale installations often face local opposition. This challenge is exacerbated by the growing influence of opposition platforms spreading misinformation, heightening public concern and opposition. To address this, it is crucial to improve communication and transparency processes from the early stages and promote local economic integration and biodiversity excellence of such PV projects. Involving local communities will not only reduce opposition but also strengthen the social and economic structure of the regions.

The **energy pricing system** is another area which urgently requires reform, as the market does not adequately reflect renewable energy prices. In order to provide predictability and stability for both investors and consumers, auction schedules should be stable, and volumes should be set based on NECP goals.

Finally, there is a major challenge concerning the **electrification** of the Spanish economy. There is significant room for improvement, as fossil fuels dominate Spain's energy consumption, with petroleum products accounting for 52% of the total while electricity represents only 23.8%, according to the Ministry for Ecological Transition's energy balance. Overcoming these obstacles will require fiscal incentives, the removal of administrative barriers, and a coordinated effort to ensure that both large industries and small consumers can actively participate in the energy transition.

Furthermore, Spain requires political incentives not only to align its pricing system with renewable energy generation but also to address the growing issue of energy curtailment, which could compromise the efficiency and economic viability of renewable projects and ultimately slow down the ecological transition.

Conclusions

The misalignment of the pricing system with the characteristics of the market creates challenges that could hinder the pace of the ecological transition if timely measures are not taken.

Spain's solar PV market has reached maturity in recent years, positioning the country as one of the leaders in Europe's renewable energy transition. The rapid growth in ground-mounted installations, driven by competitive market conditions and without the need for subsidies, demonstrates the market's resilience and adaptability. However, challenges in the self-consumption sector, particularly in the residential segment, highlight the need for continued support and policy adjustments to maintain momentum toward the ambitious targets set in the NECP.

The NECP has set clear and ambitious goals for solar PV expansion and energy storage, signalling Spain's commitment to a sustainable energy future. However, the country must address several key challenges, including complex administrative processes, the need for enhanced grid integration, and social acceptance of large-scale projects. Additionally, reforms in the energy pricing system and improved communication strategies will be essential to foster public trust and ensure a smooth transition to renewable energy sources.

Ultimately, Spain has a significant capacity to absorb solar PV electricity, as it currently makes up only 18% of the electricity mix, and electricity itself represents less than 50% of the country's final energy consumption. This indicates considerable potential for renewable energy growth, especially solar PV, within Spain's energy transition.

Authors: *Jose Donoso,* General Director*; Martín Behar,* Director of Research and Environmental Affairs, Unión Española Fotovoltaica (UNEF)

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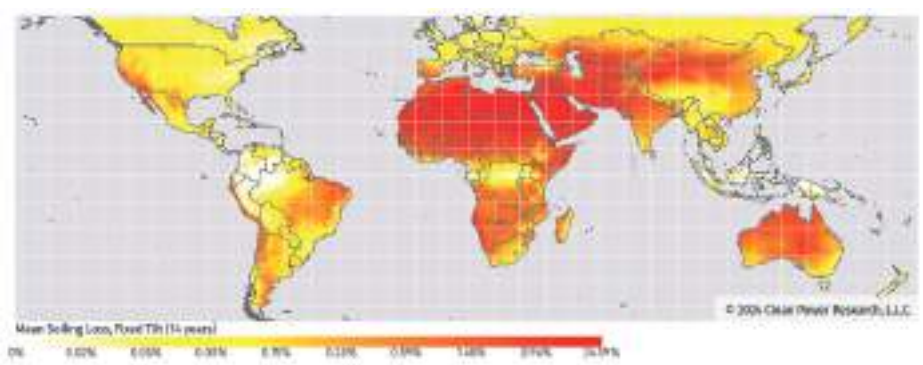

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5.3 Italy

PV installations continue to increase in a challenging normative framework

Overview of PV developments

After two years (2022-2023) of growth in new solar PV installations in Italy, the first half of 2024 saw a new significant increase of 44% compared to the first half of 2023. A total of 3.3 GW was installed between January and June 2024, bringing the country's solar fleet to a cumulative capacity of 33.6 GW, with a total of over 1.75 million PV systems.

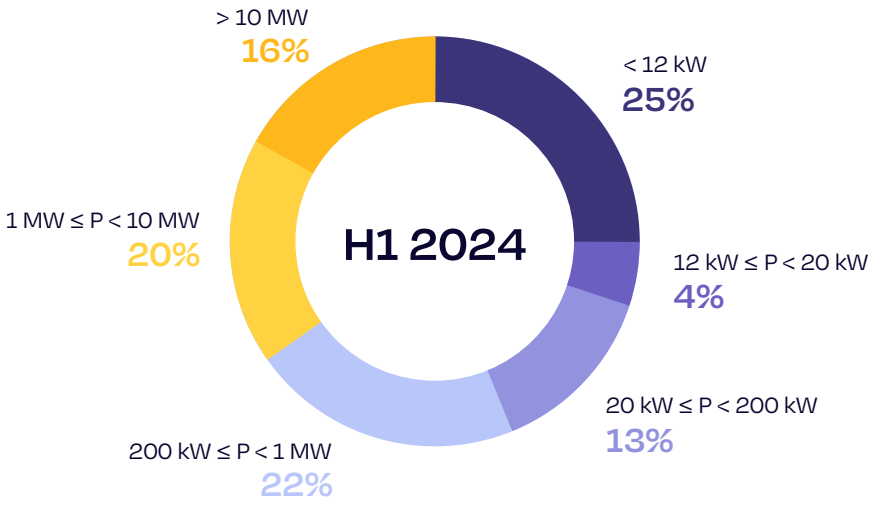
If we consider individual segments (see GW Fig 3.1), the bulk of new installations in H1 2024 continues to come from residential systems (839 MW) with 25% of the total additions, followed by medium-size PV systems between 200 kW and 999 kW (731 MW) with 22%. Solar plants above 10 MW registered an acceleration in the first half of 2024, reaching 16% of the new installations over the considered period (540 MW).

The regions with the highest operating capacity are Lombardy (4.6 GW) and Veneto (3.49 GW), which in H1 surpassed Apulia (3.48 GW), while those with the lowest installed capacity are Molise (223 MW), Liguria (208 MW), and Aosta Valley (39 MW).

GW Figure 3.1

Italy GW-scale markets

Segmentation of new solar PV installations in H1 2024



Source: Tema

Considering the latest data available for Q3 2024, the prospects for the second half of 2024 are for more moderate growth over the year, expected at around +20%, to reach a total of 5.5-6 GW of annual installations in 2024. While this confirms the upward trend seen in the last years, it remains far from the pace of growth in new PV installations required for Italy to meet REPowerEU targets (+8 GW/year).

Public solar PV targets

The updated draft National Energy and Climate Plan (NECP), sent to the European Commission in June 2024, sets a target of 54 GW of new PV power capacity in the 2022-2030 period out of the total 70 GW target for new renewable power capacity. This would lead to a total solar capacity of 79 GW by 2030.

The Italian associations ANIE Rinnovabili, Elettricità Futura, and Italia Solare agree that Italy must install at least 57 GW of new photovoltaic power in the 2024-2030 period in order to achieve its REPowerEU targets. This translates to at least 8 GW of new solar PV power per year in the 2024-2030 period, and solar PV representing 68% of Italy's total renewable capacity by 2030. It will be critical that the bulk of deployed capacity be comprised of utility-scale plants to minimise costs, whilst ensuring security for the energy system, all while also considering synergies between the energy and agricultural sectors. Moreover, the repowering of PV plants must be facilitated, as they contributed an important addition to the overall increase in total PV installations in 2023. The associations also believe that Italy must install 80 GWh of new large-scale storage capacity in order to effectively integrate new power into the grid.

Reaching the RES 2030 targets in Italy will mobilise 320 billion EUR of overall investments and 540,000 new jobs in the electricity sector and associated supply chain in the 2022-2030 period, according to the "Piano Elettrico 2030" produced by Elettricità Futura. The deployment of solar capacity together with the other RES technologies will also lead to a reduction of 75% of CO_2eq emissions in Italy by 2030, compared to 1990 levels.

Key challenges and drivers for the solar market in Italy

To reach the +57 GW solar target for the 2024-2030 period, key obstacles will have to be overcome. Permitting for large-scale solar projects remains a crucial challenge, as well as grid congestion – especially in the southern regions. The identification of suitable areas for project construction should be supported by regional actors. The policy framework for PPAs and self-consumption must also be improved.

51.4 MW PV plant, Tarquinia, Italy

The main challenges for further development and acceleration of new solar capacity are:

- A fragmented and uncertain normative framework for the definition of "suitable areas" for new and already-in-development renewable plants, which has been delegated by the central government to the regions (DM Aree Idonee);
- The need to simplify authorisation procedures for new plants and repowering projects (Testo Unico);
- Disruptions or sudden law changes, which destabilise market operators' plans, in some cases also retroactively (such as the Testo Unico on repowering, Sardinia's moratoria on projects already in development, tax deductions for the residential segment, tax credit for businesses);
- Norms and rules which increase investment costs for renewables, i.e. prohibiting the installation of ground-mounted solar on agricultural lands, limiting technologies and entities suitable for the installations and restricting the criteria for new PV plants (DL Agricoltura, Sardinian design of law on "suitable areas criteria"):
- The delayed development of a dedicated mechanism which allows RES auction bases to be adjusted according to the LCOE (DM FER X);
- Implementing support measures for energy communities and self-consumption (DM Energia Condivisa);
- Facilitating the development of PPAs, especially long-term renewable energy purchase contracts;
- Improving support schemes for storage systems in all market segments (Implementation art. 18 Dlgs 210/2021);
- Reviewing the connection regulations to overcome the "virtual grid saturation";
- Strengthening the European PV and BESS technological supply chain for improved energy resilience and decreased dependency from non-EU countries;
- Accelerating the reform of electricity market rules to enable greater penetration of RES, storage, and demand-side response.

Against this background, the drivers which could favour new installations in the next months and years are:

- In the residential sector: the expectation of maintaining a tax deduction mechanism (50%) only for a first house, new norms on buildings' energy performances (linked to Directive (EU) 2024/1275) and the development of energy communities;
- In the commercial-industrial sector: the "Transizione 5.0" scheme and the energy release mechanisms that support the adoption of energy efficiency and renewable energies for self-consumption;
- In the utility-scale segment: auction mechanisms which encourage new renewable installations (DM FER1, DM FERX).

Authors: *Michelangelo Lafronza*, Secretary, ANIE Rinnovabili; *Paolo D'Ermo*, Head of Studies and European Affairs, Elettricità Futura; *Federico Brucciani*, General Secretary, Italia Solare

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5.4 France

Solar Energy in France: Is the Boom Finally Here?

Overview of solar PV developments

In the first three quarters of 2024, an additional 3.5 GW of solar capacity was connected, compared with 2.3 GW during the same period in 2023 (GW Fig. 4.1). This growth is being driven by the 'S21' feed-in tariff for power plants below 500 kW. The 100-500 kW segment is the main driver, accounting for 1.3 GW of completed connection agreements in the second quarter of 2024, out of 2.4 GW for all capacities below 500 kW (GW Fig. 4.2).

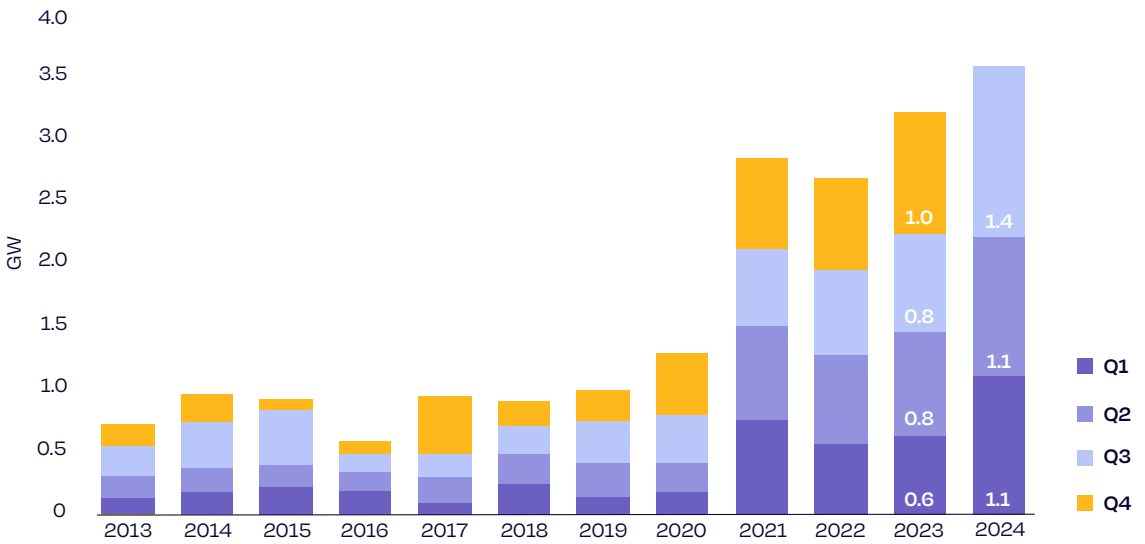
Smaller PV plants are also contributing to this dynamic. In Q3 2024, a total of 618,000 residential installations were self-consuming, representing a 74% increase year on year.

PV power plants generated a total of 21.1 TWh of electricity in the first three quarters of 2024, up by 9% compared with the same period in 2023; outside of self-consumption, this represents 6% of French electricity consumption over this period, powered by a cumulative installed capacity of 23.7 GW at the end of Q3 2024.

GW Figure 4.1

France GW-scale markets

Connected solar PV capacity per quarter, 2013-2024

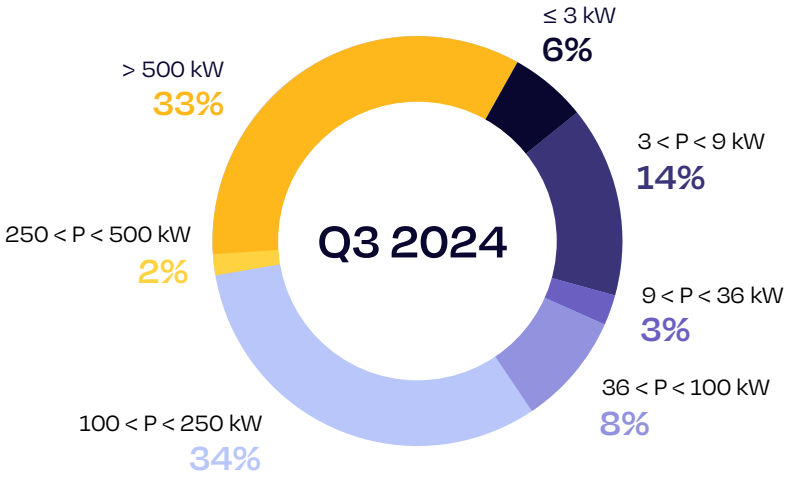


Source: French Ministry of Ecological Transition

GW Figure 4.2

France GW-scale markets

Segmentation of new solar PV installations in 2024, up to Q3



Source: French Ministry of Ecological Transition

Solar PV targets in France

The upcoming Multi-Annual Energy Planning (MAEP) is expected to include an increase in PV development with a similar ambition to the one set in the French NECP submitted to the European Commission at the end of 2023. These targets would range from 54 to 60 GW by 2030, compared with 35 to 44 GW by 2028 in the previous MAEP, and development targets of between 75 to 100 GW by 2035. As of writing this article, a public consultation on the current draft of the MAEP is planned for November 2024, while a draft law on energy planning is currently being examined in parallel in the Parliament.

The French Renewable Energy Trade Association (SER) also updated its regional roadmap for 2030, with the aim to prepare the regional implementation of the MAEP, expected for 2025.

Drivers for solar growth

One first driver for solar growth can be found in a clear industrial ambition for PV, which was confirmed by the government last April via the "Solar Pact" ("Pacte Solaire"). This "Pact" encourages developers to buy a minimum volume of PV panels produced within the European Union, with increasing commitments between 2024 and 2027.

To ensure support for both existing industry and future gigafactories, and as part of the application of the Net Zero Industrial Act (NZIA) resilience criterion, the French government is also considering a bonus for made-in-Europe PV projects in future support mechanisms.

In addition, in order to raise awareness of European panels among consumers, an "Induscore" should also be introduced : an Induscore rating is correlated to the level of integration in Europe of different PV production stages. The more stages involved, the higher the Induscore will be.

A second potential driver for solar growth will come from the deployment of agrivoltaics projects. Indeed, 2024 saw the publication of several regulations on agrivoltaics, after the term had been defined by Article 54 of the 2023 Renewable Energy Acceleration Act. A few texts on contracts between solar developers and farmers and on value sharing should soon complete this framework.

Finally, other factors could also drive PV development such as the obligation to install solar on buildings and car parks, which have been strengthened in the Renewable Energy Acceleration Act, published in 2023.

Challenges

Still, the French solar industry is facing some challenges. The first of these relates to France's economic downturn which could impact the level of political and financial support to the sector, especially on leading segments (below 500 kW).

Access to land remains another bottleneck, with increasing pressure to prioritise projects on already-artificialised areas.

Permitting times are still too long and complex, in particular given the increasing number of demands to be treated by an understaffed administration.

Finally, the increasing number of hours of negative prices is a challenge for solar in the French power market. Although this challenge needs to be tackled in a systemic approach, changes in the regulatory framework may enable more effective management of this issue. This could involve, for instance, allowing for the development of hybrid power plants which combine solar and storage, in order to improve the control of PV production and support the provision of system services.

Author: *Salomé Durand*, Responsable solaire, Syndicat des Energies Renouvelables (SER)

Voltec Solar module production site in Dinsheim sur Bruche, France

5.5 Poland

Total solar PV capacity expected to pass 20 GW milestone by the end of 2024

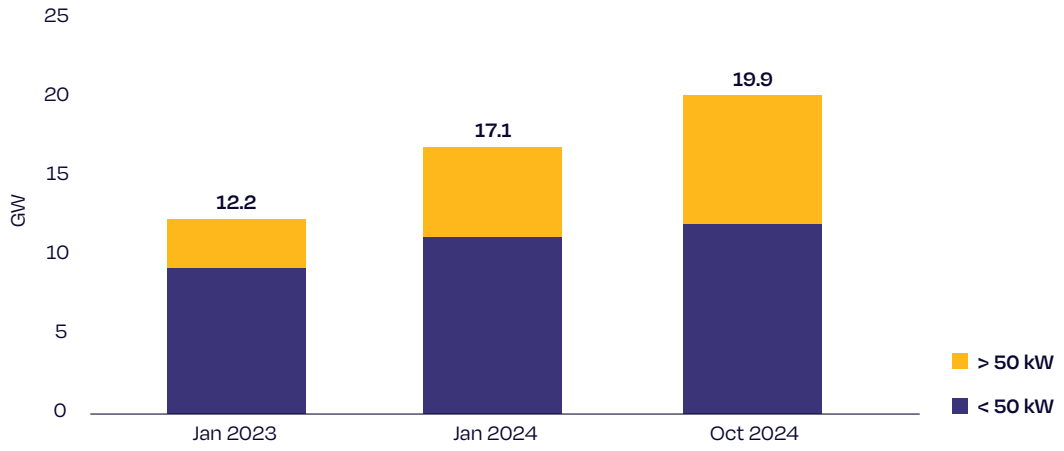
Overview of the solar market

Solar PV is the undisputed leader in Poland among all other renewable energy sources, in terms of both the pace of development and the total installed capacity. PV has emerged as a pivotal component of Poland's renewable energy. At the end of December 2023, over 28.8 GW of renewable energy was installed in Poland, of which 17.1 GW (60%) were solar PV systems. This represents a 40% year-on-year growth from December 2022, when total solar capacity amounted to 12.2 GW. While 2022 remains Poland's record year in terms of increase in annual installations, with 50% more PV installed than in 2021, newly installed capacity in 2023 only matched the amount installed in 2022, with 0.2% difference, indicating a stagnating market.

GW Figure 5.1

Poland GW-scale markets

Cumulative solar PV installed capacity 2023-2024



Source: PV Poland

In October 2024, cumulative solar PV installed capacity was 19.9 GW, and is expected to reach 20.5 GW by the end of the year (GW Fig. 5.1). The success of solar energy in Poland is mostly due to the popularity of residential prosumer installations. The vast majority of Poland's installed PV capacity is concentrated in micro-installations up to 50 kW. According to data from the Energy Market Agency, by the end of September 2024, there were more than 1.5 million such installations, and with cumulative capacity for the segment reaching 12.3 GW. This growth has been driven by government programmes and grants, as well as an increased awareness and concern for environmental issues.

This large growth in the number of micro-installations turned out to be challenging for distribution networks and led to changes in the policy framework. On the 1st of April 2022, the net-metering scheme was replaced by a net-billing scheme, whereby the amount of electricity injected and retrieved from the grid is balanced in an hourly settlement using a metering system. Under the new scheme, prosumers are rewarded for surplus energy fed into the grid at the wholesale pay price, and they pay for the consumed energy just like other electricity consumers do. After this change, the popularity of micro-installations somewhat decreased. The slowdown in the prosumer market is also influenced by the government's "freeze" on energy prices for individual consumers.

According to data from the Polish Institute for Renewable Energy (IOE), the slowdown in this group was compensated by an increase in installed capacity in larger rooftop installations (50 kW – 1 MW) and ground-mounted PV parks above 1 MW.

Moreover, among enterprises and industry, there is clearly a growing interest for investing in one's own source of electricity generation. Self-consumption of electricity, or prosumerism, contributes to decarbonisation, and more generally to sustainable development strategies such as ESG frameworks, and also supports energy independence. Self-consumption is understated and not clearly framed in Polish legal regulations, which leads to a lack of clear measurement of the phenomenon. For this reason, its true scale is not known and it isn't included in the national RES target.

200 MW solar plant, Przykona, Poland

Public solar PV targets

In September 2024, the Ministry of Climate and Environment presented new assumptions of the National Energy and Climate Plan until 2030. In its most ambitious scenario, the share of renewable energy in gross final energy consumption by 2030 increases to 32.6% – specifically, 56.1% of renewable energy in the power industry, 35.4% in heating and cooling, and 17.7% in transport. Installed PV capacity is projected to reach 29.3 GW in 2030, and 46.2 GW in 2040.

Key drivers for the solar market

In the small-scale segment below 50 kW, in addition to the change from the previous net-metering framework to the net-billing scheme, the popular Mój Prąd (My Electricity) scheme is also being revised. The latest – already sixth – edition of this programme provides for the possibility of co-financing the purchase of energy storage devices. Additionally, in the case of new prosumers, the programme includes the obligation to purchase an energy storage device alongside the PV system. The programme has been very popular, to the extent that after just 11 days, the organisation in charge for the scheme, the National Fund for Environmental Protection and Water Management, decided to increase the budget. The financing, totalling 1.25 billion PLN (287 million EUR), is provided by the European Funds for Infrastructure, Climate and Environment (FEnIKS) 2021-2027.

In the case of larger PV installations, the main factors driving the development of PV include the perception of risks related to changes in electricity prices, the trend of decentralisation and diversification of electricity generation focused on renewable energy located as close as possible to the end user, and the electrification of industrial processes.

Key challenges for the solar market

The biggest barrier is still the limited capacity for connecting new generation sources. Where the grid develops, solar PV will quickly replenish power shortages. The grid requires modernisation, not only to effectively carry out the energy transition, but also given its age – most of its components are over 25 years old, and a significant part is over 40 years old.

A new but increasingly common phenomenon is non-market re-dispatching of power, i.e. temporary limitation of generation and introduction of energy from renewable sources to the grid, by the decision of the TSO. Curtailment in Poland primarily covers large-scale and industrial solar, mainly during periods of peak productivity. In 2023, around 40 GWh of solar energy was curtailed, and the scale of the phenomenon has been growing rapidly.

The main cause of this is linked to rising challenges for balancing the power system, especially during periods of low energy demand and high production from RES (especially weekends and holidays). The prospect of mass reduction of RES generation significantly worsens the investment climate for the Polish market. Non-market redistribution discourages new investors and financial institutions from committing funds to new renewable sources and concluding long-term energy sales agreements such as PPAs. Against this background, the Polish power system must become more flexible. Therefore, comprehensive support for the development of energy storage technologies is necessary.

Poland has great potential for the development of Agri-PV. There is great interest in the synergy of agriculture and solar, and the first pilot projects are being developed. Unfortunately, one key barrier to Agri-PV is the lack of an appropriate legal environment. Currently, the decision to build a PV installation entails that land must be de-agriculturalised.

Solar market prospects 2024 -2028

The future of the solar energy sector in Poland looks promising, in light of stable demand in the prosumer market, and committed investments of close to 20 billion PLN (4.6 billion EUR) annually. In the short term, we predict a slowdown in solar energy development. The self-consumption segment is expected to grow, while large-scale development of PV farms will require large investments in power grids and energy storage. Until system flexibility is improved and The large size of the market and current dynamics create a huge opportunity for local producers to develop their products and services, for internal and international markets.

Authors: *Paulina Wojciechowska*, Communication Officer, Polskie Stowarzyszenie Fotowoltaiki (PSF); *Stanislaw M. Pietruszko*, President, Polskie Towarzystwo Fotowoltaiki (PV Poland)

5.6 Netherlands

At the forefront of the energy transition: it hurts, but opportunities await

Overview of PV developments

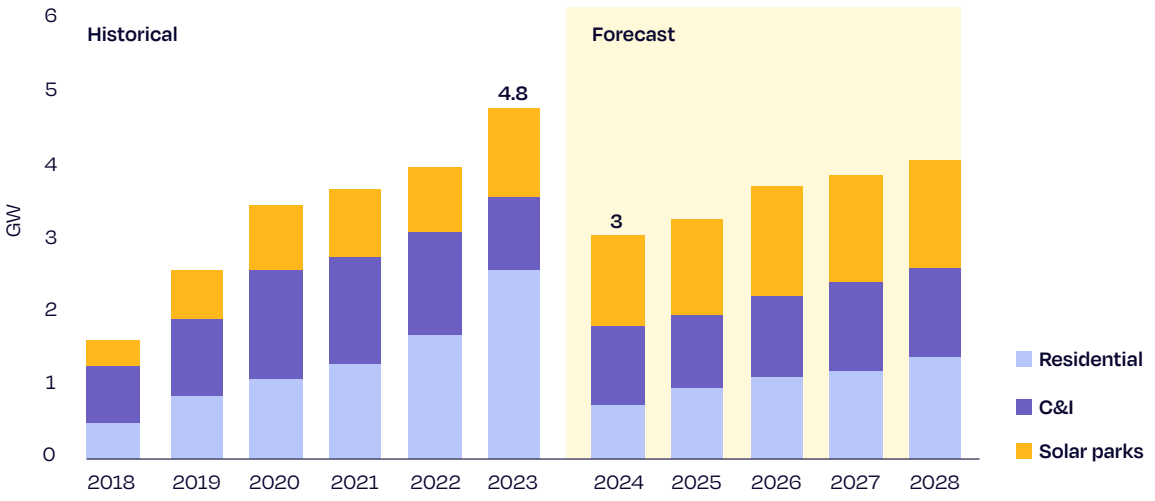
The solar market in the Netherlands has faced significant struggles in the past year. An additional 3 GW is expected to be added in 2024, compared to almost 5 GW in 2023. This decrease in additional capacity is mainly due to a near 70% shrink of the residential market. Despite this challenge and decreasing interest in the residential sector since the second half of 2023, the Dutch solar energy market is expected to stabilise in the coming years to around 4 GW of installations per year (see GW Fig 6.1).

The Netherlands still has a significant pipeline of over 11 GW of large-scale solar PV projects. Counting on this pipeline and the successful completion of several offshore wind projects, the government has been assured that the 2030 National Climate Agreement target of 35 TWh/year renewable electricity production on land will be met in time. The Dutch National Climate Agreement was signed in 2019 and does not yet consider the increased national targets – changed from 55% to 60% – related to the EU ambition of 55% greenhouse gas emissions reduction by 2030, or the impact of the Russian invasion in Ukraine. The new coalition government's stance is to have 'no additional policy nor support until we agree that we won't reach national climate targets.' In October 2024 it was concluded that the odds of reaching national climate targets are less than 5%, so a new policy will need to be announced in Q2 2025. Furthermore, for the first time, grid operators in the Netherlands have recognised the significant growth of the solar sector and estimate that between 42-76 GW of solar capacity will be installed in the Netherlands by 2030. Moreover, the newly finished National Energy plan expects over 50 GW of solar to be installed by 2030. However, strangely the current solar target as indicated in the Dutch National Energy and Climate Plan (NECP) only aims for 25.7 GW by 2030, which is expected to be reached already by the end of 2024.

GW Figure 6.1

Netherlands GW-scale markets

Annual solar PV installed capacity 2018-2023 and scenarios 2024-2028



Source: Holland Solar

Collapse of the residential market

2024 saw enormous policy swings concerning the Dutch net-metering scheme. While discussions about a phase-out have been ongoing since 2017, a new bill introducing this phase-out was passed in Parliament in December 2023, although it didn't make it through the Senate in February 2024. Announcements that the scheme would continue caused a short revival in March, April and May 2024 with about 100,000 residential installations installed in just three months. In May the new coalition government, which had previously voted against the phase-out, announced it would cut the net-metering scheme on 1 January 2027 without a phase-out. This caused havoc in the already volatile market. In November 2024 the Parliament voted the bill through and a Senate majority has been announced as well.

Political discussions around the net-metering scheme blocked any policy improvements towards encouraging self-consumption and interoperability for households that have electrified their energy use with chargers, heat pumps and storage. This resulted in almost 10 GW of residential solar, which is difficult to manage from a power markets perspective. As a result, the number of negative hours on the day-ahead market in the Netherlands has increased to more than 500, consisting mainly of 'solar hours.' This has grave implications for the utility and ground-mounted segments as well, as it decreases capture prices, puts a heavy burden on DSOs in the low-voltage networks, and causes competition for expansion between low and medium-voltage networks.

To make matters worse, the new coalition government also cancelled the hybrid heat pump mandate which was set to take effect in 2026. This mandate would have required that whenever a gas boiler is replaced, at least a hybrid heat pump (a combination of a gas boiler and a heat pump) should be installed. This caused a significant slump in the heat pump market as well. Notably, there is a strong correlation in the Dutch market between residents who buy heat pumps in combination with solar PV. For these reasons, we don't expect a quick recovery of the residential market due to other mandates being actioned.

The Dutch residential solar market must come to terms with receiving less political support and stimuli in the next few years. The challenge will be to ensure that the PV system remains the central component in the home for all new investments in energy demand (heat pumps, EV chargers, batteries, etc.). The interoperability of the smart energy home will be vital to ensure renewed market growth. Moreover, with grid congestion on low-voltage levels increasing, developing the flexibility of assets in the home will be essential to keep energy costs low. Plans for flexible grid tariffs for households and (commercial) plans for better integration into power markets are clear opportunities for the industry to build on. In that regard, the Netherlands is truly at the forefront of the next phase of the energy transition.

Slow down of the C&I market

While the pipeline for the C&I market in the Netherlands has remained relatively stable in recent years, it isn't living up to its potential. There are three key barriers to scaling up the pipeline. The first has been historical constructive norms which make many large roofs unable to bear the weight of PV systems. In the SDE++-subsidy scheme, a new category has been introduced to subsidise 'weak rooftop constructions'. This will likely improve the business case for installing PV on weak rooftops across the country. The second barrier is grid congestion. In the Netherlands, particularly in the medium-voltage levels, grids have been overburdened, which especially affects the C&I market. The third is capture prices for public market traded electricity, which have been decreasing significantly. Concerning the second and third challenges, there are more and more opportunities within the industry for combining PV with charging mobility solutions, both for medium and heavy duty.

Additionally, with preparations being made to implement the Energy Performance of Buildings Directive (EPBD) and energy sharing also being legally developed in the national context, there are reasons to be optimistic about the growth in this segment. Crucially, this would require both an increase in the uptake of electric mobility and grid congestion for feed-in to be administered in a more flexible rather than rigorous approach.

Ground-mounted solar parks require 'a new look and feel'

The Dutch ground-mounted solar segment has been the subject of political debate for quite some time now. Concerns about the size of installations compared to the scarcity of land, biodiversity concerns and public acceptance of residents near new projects have proven the most pressing.

In terms of public acceptance, the industry has seen increasingly positive reports, making it unlikely that any policy changes by the central government will be made in this regard. With respect to biodiversity concerns, the Dutch industry's Certification scheme will be operational by 2025. Additionally, the Dutch government has opened the SDE++ 2024 round for 'biodiverse solar parks', making their requirements mandatory from 2025 onwards. Nevertheless, due to national government concerns about spatial planning, new spatial planning rules have been implemented in the past year. The national government's limiting summary of the kind of solar parks which can be developed has been copied and or modified at the provincial level. This has caused confusion about which types of solar parks are allowed in a given area. Generally, new solar parks that do not have a multifunctional purpose (Agri-PV, combined with flood protection water storage, or near electricity infrastructure with sufficient capacity) are increasingly difficult to get a permit for.

700 kW Symbizon solar PV plant, Flevoland, Netherlands

Due to net congestion, we see an increased trend for locally developed solar parks which feed directly into local grids in order to avoid waiting times for grid expansion. More and more communities – businesses and municipalities working to increase the number of available houses – are calling upon provincial governments to allow solar parks to be built near their new housing developments. Furthermore, the central government is working with the solar industry to develop Agri-PV policies. We expect this type of installation to become increasingly prevalent in the Dutch market. Furthermore, the central government is increasing the number of land tenders for developing RES. The total potential is still unclear but will pertain to GW potential across the country. The majority of projects will be built near roads, rail and waterworks infrastructure.

Concerning the issue of grid congestion for feed-in, we see that the implementation of congestion management services and the mandate for all installations above 1 MW to participate in the congestion management programme have reaped results. Slowly but steadily, more space on the grid has been created, allowing for more installations to come online in the coming years. Moreover, new sets of standardised contracts are being introduced to promote flexible grid connections, with the benefit of shorter waiting times, with the hope that they become more widely used.

The battery storage market in the Netherlands, which so far has been somewhat sluggish, is gaining momentum due to low capture prices, caused by a large share of residential systems not responding well to market developments. This segment clearly represents an opportunity for the solar PV market, and new assets will increase the value of solar electricity generation. Moreover, as electricity prices are increasingly determined by natural gas in off-peak hours, the business case for shifting consumption of solar electricity to other hours of the day becomes more interesting. To stimulate this, a new subsidy scheme for collocating batteries with solar PV systems (ground-mounted and rooftop) worth 300 million EUR has also been announced.

Outlook

All in all, the Dutch solar PV industry is at a crucial stage. Can we truly solve the puzzle of the energy transition and offer industries and society at large sufficiently attractive propositions for decentralised production of solar energy? The most important step is to urgently create effective policies on the electrification of industry, mobility, and heating, which should go hand-in-hand with creating a level playing field for flexible green electricity production. The game is on!

Authors: *Wijnand van Hooff*, CEO; *Nold Jaeger*, Head of Policy and Public Affairs, Holland Solar

The first PV company to have a "Wafer-Cell-Module" fully certified "Zero-Carbon-Factory".

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5.7 Greece

Yet another record-breaking year

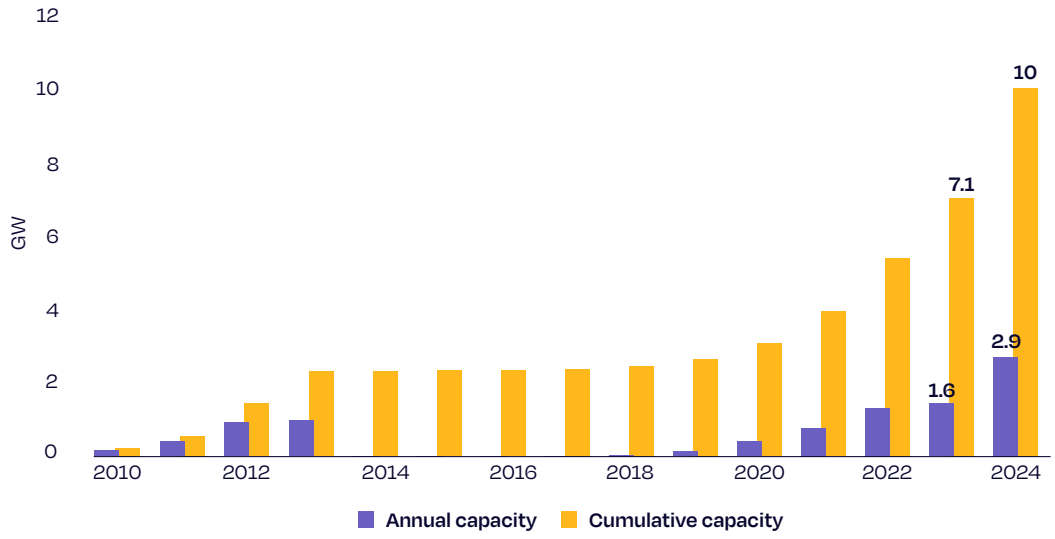
Overview of PV developments

The Greek PV market seems unstoppable, breaking one record after the other. After having achieved two record years in 2022 and 2023, the annual solar market it is expected to almost double again in 2024, reaching 2.9 GW of annual installations – and it seems that this is not the end of the road yet. Thanks to the record installations, Greece is expected to reach an operating solar fleet of 10 GW by the end of 2024, up 40% from the 7.1 GW in 2023 (see GW Fig. 7.1).

GW Figure 7.1

Greece GW-scale markets

Annual and cumulative solar PV installed capacity 2010-2024



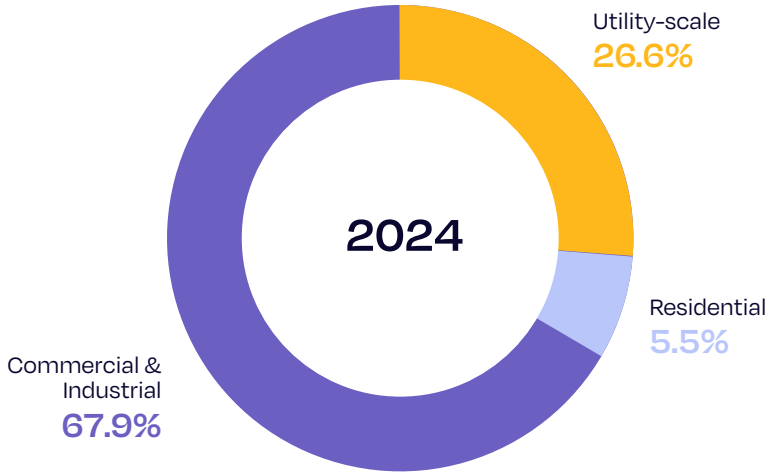
Source: HELAPCO

As can be observed in GW Figure 7.2, the market is still dominated by medium-size C&I projects between 10 kW and 1,000 kW, which provide 67.9% of total installed capacity. However, the utility-scale (26.5%) and the residential self-consumption (5.5%) segment are experiencing noteworthy growth as well. The self-consumption segment as a whole almost doubled compared to 2023 reaching 400 MW in 2024.

GW Figure 7.2

Greece GW-scale markets

Cumulative solar PV segmentation, 2024



Source: HELAPCO

Solar PV targets and market outlook

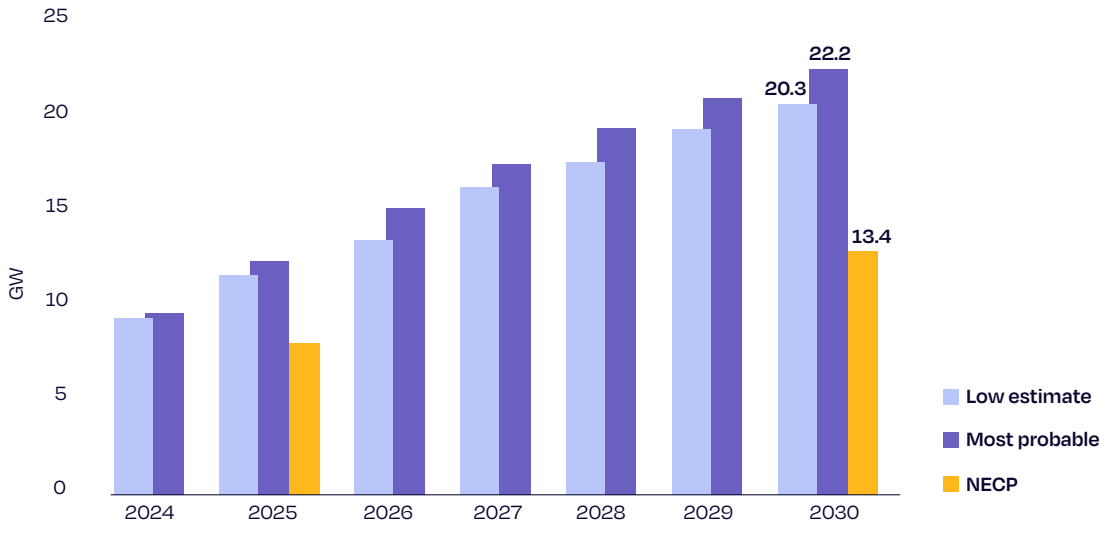
The solar target outlined in the Greek NECP, updated in 2023, foresees 13.5 GW of solar capacity deployed by 2030. This, however, will already be reached by 2026, according to HELAPCO's projections (GW Fig. 7.3). Total solar capacity is expected to reach 22.2 GW by the end of the decade – which is 66% more than the national target.

Similar considerations can be made for the emerging storage market. While the NECP foresees 4.33 GW of battery storage by 2030 – and 1.75 GW of pumped storage capacity – HELAPCO estimates that some 7-8 GW of batteries will be needed by that time.

GW Figure 7.3

Greece GW-scale markets

Cumulative solar PV capacity scenarios 2024-2030



Source: HELAPCO

Challenges

The major bottleneck for solar deployment in the country remains the availability of grid capacity. Most of the medium-voltage grids are now congested, and soon, the same is likely to happen with the high and ultra-high-voltage grids. The government presented a priority list for grid connection in August 2022 and then again in 2023 and 2024, raising numerous complaints from interested investors. To address these complaints, a roadmap for grid enforcement and development for the coming years was made. However, the appetite of investors transcends this plan. Grid constraints could lead to a decrease in utility-scale developments unless corrective action is swiftly taken.

A second issue raising concerns among investors is the growing amount of curtailment. Some 1 TWh of electricity generation has been curtailed in 2024, the majority of which was related to PV. Contrary to other EU countries, Greece has not experienced significant negative prices, as only 11 hours of negative prices have been recorded so far in 2024.

With regard to self-consumption, 2024 saw the end of the net-metering scheme, which was substituted by a net-billing support scheme. The transition might somewhat affect the residential market, which is now inclined to maximise self-consumption.

In the large rooftop and small utility-scale segments, a feed-in premium scheme for systems between 500 kW and 1 MW was discontinued in August 2024. While a large number of systems that met the August deadline are expected to be grid-connected only in the coming months, a significant decline in these segments can be expected as of 2026.

Author: *Stelios Psomas*, Policy Advisor, HELAPCO

5.8 Austria

23% annual decrease in installations expected, compared to the record-breaking 2023

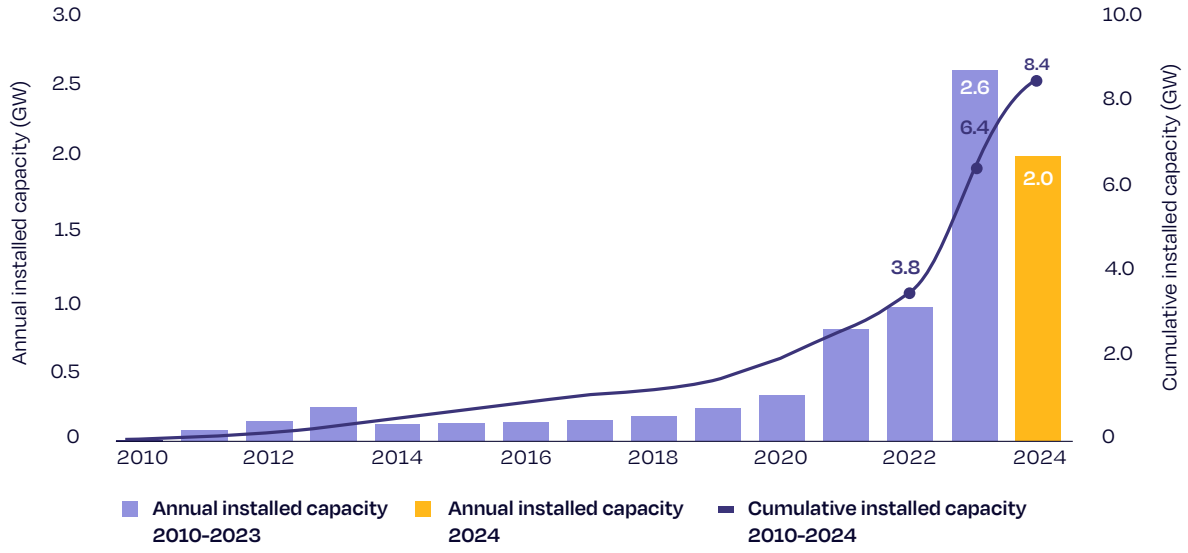
Overview of solar PV developments

2023 was an extraordinary year for solar in Austria, with a record-breaking 2.6 GW of newly installed PV capacity. An important record, but one that is unfortunately difficult to repeat. Although official data won't be published until mid-2025, preliminary forecasts already confirm that there will be no new record in 2024. Austria is expected to add around 2 GW of new PV capacity this year, approximately 23% less compared to the previous year. A total fleet of around 8.4 GW of PV systems is expected to be in operation by the end of 2024 (see GW Fig. 8.1).

GW Figure 8.1

Austria GW-scale markets

Annual and cumulative solar PV installed capacity 2010-2024



Source: PV Austria

Unfortunately, no clear statement can be made about the distribution of utility-scale, small PV systems or rooftop solar developments in Austria. Grid operators do not publish data regarding proportions of centralised or decentralised generation or which categories – rooftop, ground-mounted or Agri-PV – were installed. However, we do know that 89% of all PV systems installed in 2023 were decentralised systems. It is therefore assumed that in 2024, the majority of newly installed PV systems will also be rooftop systems, with utility-scale and Agri-PV installations covering a minor share.

National PV Targets

Contributing to achieving the European Union's 2030 renewable energy target, Austria has defined binding national goals for its energy transition through the Renewable Energy Expansion Act (EAG) in 2021. Primarily, the EAG includes Austria's plan to cover 100% of its total electricity consumption with renewables by 2030 and sets a direction to become climate-neutral by 2040. To achieve the 2030 target, the EAG specifically mentions that renewable electricity generation must be increased by 27 TWh by 2030, compared to 2020 levels. Of this renewable generation target, 11 out of 27 TWh must be generated by PV. According to the Austrian Grid Infrastructure Plan (ÖNIP) – which came into force in the first half of 2024 – the EAG expansion target for 2030 of 11 TWh of electricity from PV must already be increased to 21 TWh. Otherwise, Austria's plan to cover 100% of its total electricity consumption with renewables by 2030 will not be achievable.

Drivers for solar growth

A key driver in 2024 was the reduction of VAT for private individuals for PV systems up to 35 kW from 20% to 0%, which came into force at the beginning of the year. This allowed customers to save directly on their purchase without having to submit a separate subsidy application. Despite this tax incentive, the still wide range of PV subsidies at the federal and state levels continued to support the expansion of PV in Austria. Due to the sharp drop in feed-in tariffs, there was a significant movement towards the market premium for PV systems (CfD scheme) this year. Unused quotas from the previous year were rolled over, creating a record market premium volume of 1,150 MW. And finally, another significant factor was the backlog of PV projects from 2023, most of which were completed in 2024.

Vienna City Hall, Austria

Challenges for the market

The lack of grid capacity is a major obstacle. On the one hand, grid expansion is lagging behind the expansion of renewables, while on the other hand, important laws – such as the Electricity Industry Act (ElWG) and the Renewable Expansion Acceleration Act (EABG) – were not passed in 2024 to establish the necessary framework for a modern and more flexible electricity grid infrastructure in Austria. Without prompt and decisive action at a political level, Austria risks missing its climate targets.

The challenging economic situation resulting from the Ukraine-Russia conflict and the ongoing energy crisis has also impacted Austria's PV industry this year. For several months, Austria experienced one of the highest inflation rates in the EU. This inflationary pressure has particularly affected the commercial sector, where demand for PV systems has seen a noticeable decline, leading to several insolvencies within the industry. The manufacturing sector has been hit particularly hard, struggling to compete with low-cost imports from Asia.

Another domestic problem is the designation of areas for ground-mounted PV systems. Since Austria follows a federal structure, the competence for acceleration areas for PV systems lies with the individual federal states. So far, only four out of nine federal states have provided acceleration areas. An analysis of these areas revealed a major limitation: many of these zones lack adequate grid capacity.

Outlook

The future of the Austrian PV sector and its further expansion will heavily depend on the new government, which has not been formed at the time of writing. Will it pursue renewable energy development with the same commitment as the former "green" Climate and Energy Minister? How quickly will the essential framework laws (ElWG, EABG) be passed? What strategies will be implemented to revitalise the commercial sector? And what support will be provided to the struggling industry? The PV industry knows what needs to be done. To achieve the national targets – 100% electricity from renewable energies by 2030 and climate neutrality by 2040 – Austria must install approximately 2.1 GW of new PV capacity every year, according to ÖNIP.

Author: *Lisa Grün*, Bundesverband Photovoltaic Austria (Federal Association for Photovoltaics in Austria)

5.9 Hungary

Strong 2024 solar market, with over 1.5 new capacity installed

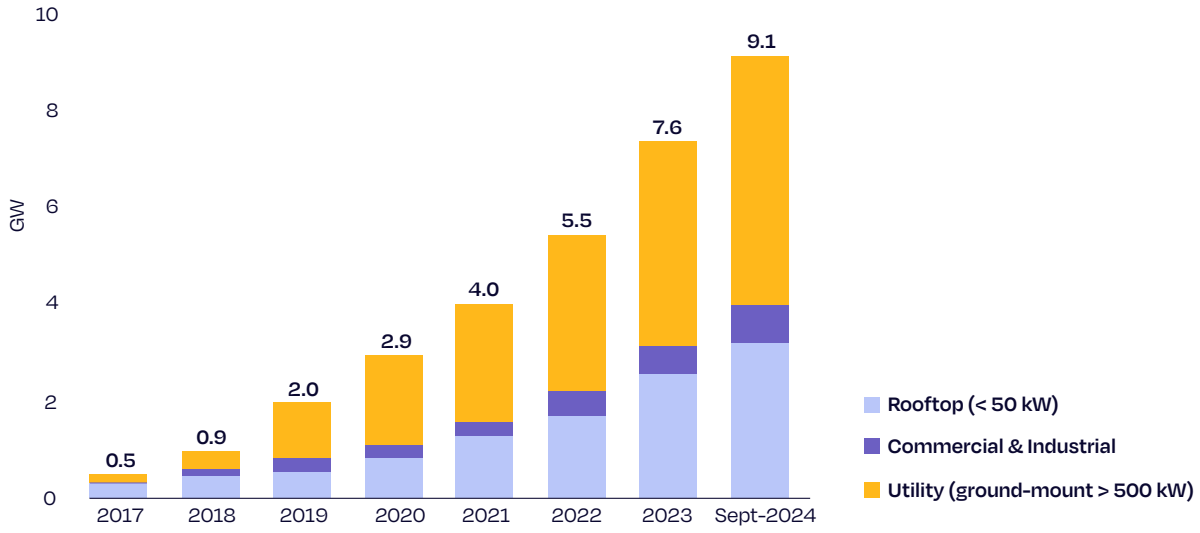
Overview of Hungary's PV market

2024 has been a strong year for solar PV in Hungary, with annual installed capacity reaching well beyond the GW scale for the second time in the country's solar PV history. As of September 2024, almost 1.5 GW of capacity had already been installed, bringing the country's total PV operating capacity to 9 GW (see Fig. 9.1). Despite a solid performance this year, it appears unlikely that the record level of capacity added in 2023, when 2.1 GW of PV was installed, will be surpassed.[8]

GW Figure 9.1

Hungary GW-scale markets

Cumulative solar PV installed capacity 2017-2024



Source: MAVIR

Rooftop solar market

One recent important change for the rooftop solar market (below 50 kW) was the lifting of the "feed-in ban" at the end of 2023 across most of the country. Although short-lived (as it was introduced in 2022), this ban negatively impacted the public perception of the sector. At the same time, a new "gross metering" (i.e. net billing) scheme was introduced at the end of 2023, and is seen as quite unfavourable for consumers compared to the previous net-metering scheme. This, along with stabilising energy prices, has resulted in a significant slowdown in the residential solar market in the course of 2024.

8 Since official statistics are provided in AC values, data has been converted to DC values using DC/AC ratios of 1.2 for the residential segment, 1.25 for the C&I segment and 1.3 for the utility-scale segment.

Without substantial investment support schemes, it is now nearly impossible for new small rooftop systems to be installed at scale. One residential support programme for solar PV and storage systems closed after only 3 months. Though this scheme will lead to the installation of over 20,000 new systems, progress has been slow, as installers must pre-finance installations, with the government slowly disbursing support directly to them. These delays hinder the expansion of residential rooftop solar in the country.

In contrast to the small-scale distributed market, the C&I sector is currently the only segment showing growth. Although the number of new systems is limited, with 375 systems totalling 311 MW of installed capacity in 2024, this segment continues to develop. Nevertheless, several regulatory hurdles are slowing down progress. For example, grid connection rules now require even relatively small systems (as small as 200 kW) to participate in the automatic frequency restoration reserves (aFRR) capacity market, which is controlled by the local TSO. These requirements add complexity and slow down the pace of new installations.

Utility-scale solar market

Utility-scale solar installations still represent a significant portion of Hungary's solar capacity. Most new installations in 2024 were developed under the old feed-in tariff scheme, known as KÁT. While some projects will continue under the KÁT scheme in 2025, the sector is expected to slow down as the majority of these projects are completed.

1 MW 1 axis tracker installed PV plant under construction in Komárom-Esztergom County, Hungary

Premium market schemes like METÁR, as well as merchant and PPA systems, still remain a minority in Hungary. Financing challenges for merchant and free-market solar projects further dampen the growth of utility-scale installations. While PPAs are gradually entering the market, they are not yet widespread enough to drive significant market growth. Moreover, the cancellation of a new grid connection tender—due to overwhelming demand—has delayed the connection of new projects. Finally, with the grid capacity pipeline still containing permits for 3-4 GW, it is unlikely that new connections will be available before 2030.

In the field of large-scale storage, a recent support scheme tender was closed successfully, resulting in plans for 440 MW / 900 MWh of energy storage to be built by 2026. This storage capacity will play a critical role in balancing the grid as more renewable energy, including solar, is integrated into the electricity mix.

Outlook for 2024-2028

2024 marked another strong year for the Hungarian solar market, albeit affected by a notable slowdown, particularly in the rooftop and utility-scale segments. Regulatory challenges, financing issues, and a gradual shift away from the highly successful KÁT scheme are some of the key factors which will shape growth trends in the next few years. While the C&I segment will remain strong, with expected annual installations reaching 300-400 MW over the 2024-2028 horizon, overall market growth will likely be tempered compared to 2023. As grid connection capacity becomes increasingly scarce and investment conditions may not improve, the market will need innovative solutions, particularly in the realm of energy storage, to maintain its forward momentum.

Author: *Ádám Szolnoki*, President, MANAP (Hungarian Photovoltaic Industry Association)

5.10 Portugal

Total solar capacity nearly quintupled, from 1.1 GW in 2020 to 5.0 GW today

Overview of PV developments

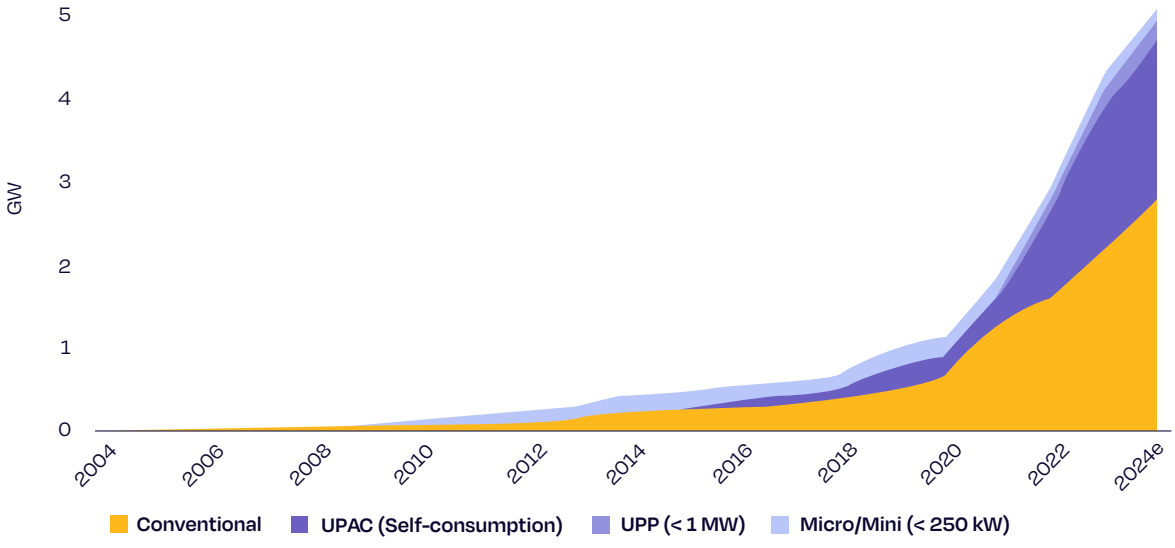
Portugal has one of the highest solar energy potentials in Europe, with an annual average of 1,600 to 2,200 kWh/m² of global horizontal irradiation (GHI). Additionally, Portugal has developed an ambitious strategic vision for solar PV, as set out in the National Energy and Climate Plan (NECP) for 2030, making the country one of the most promising markets for solar PV development. This reality places the spotlight on market evolution and calls for a strategic focus on the primary barriers that still persist.

Since 2020, solar installed capacity has nearly quintupled, from 1.1 GW W to 5.0 GW (GW Fig. 10.1). Of these, 2.7 GW are utility-scale, 1.9 GW are for self-consumption and 377 MW are small-scale grid-connected systems (under 1 MW, without self-consumption). From January to September 2024, Portugal has already installed 1 GW of new PV capacity, after a record 1.2 GW in 2023 connected to the grid. In 2023, solar PV generation accounted for 8.2% of all electricity generated in mainland Portugal. In 2024, as of November, this figure stands at 11.2% and is anticipated to increase substantially in the coming years.

GW Figure 10.1

Portugal GW-scale markets

Cumulative solar PV installed capacity 2004-2024



Source: APREN

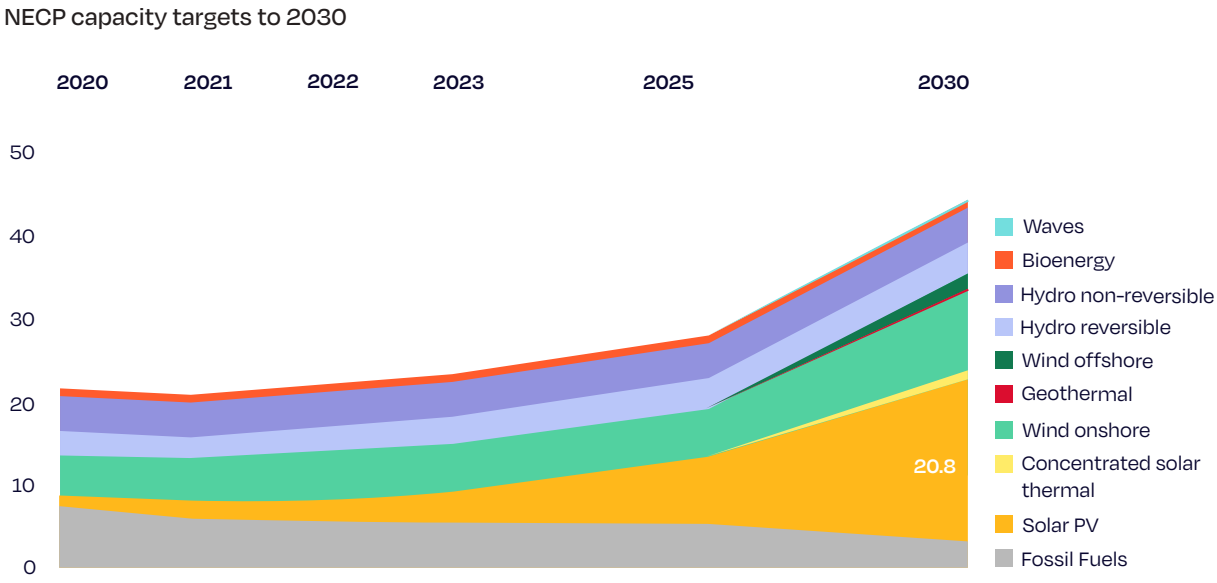
This growth reflects the Portuguese government's ambition for the national energy transition and the actions it has undertaken thus far. The restructuring of sector legislation in 2022 sought to re-establish and organise the functioning of the national electricity system, bringing various existing legislative pieces together into an updated and clarified framework. The simplification of certain licensing processes in recent years has accelerated these complex procedures, although there are still areas for improvement and reorganisation.

In terms of decentralised capacity, there has been a rise in energy communities due to greater awareness of solar PV's advantages , as well as incentives for installation and the reduced cost of the technology. These energy communities often include producers with relatively short consumption peaks and lower average consumption (such as football stadiums, municipal buildings, etc.), and they frequently engage local communities in the projects, thereby increasing public participation in the energy transition and improving energy literacy.

Despite the sector's development to date, there is still much work to be done in order to achieve the ambitious targets set forth. In July 2024, the Portuguese government raised targets for renewable capacity expansion by 2030, with solar PV set to see the greatest growth with 20.8 GW installed by 2030 (GW Fig. 10.2). Of these, 15.1 GW will be centralised, and 5.7 GW decentralised. A portion of this capacity will supply electricity to 3 GW of electrolysers for green hydrogen production (together with onshore and offshore wind capacity).

GW Figure 10.2

Portugal GW-scale markets



Source: APREN

In the NECP 2030, the Portuguese government also highlights the need to incentivise long-term contracts — PPAs and CfDs — to supply electricity from PV plants. This aims to protect consumers and producers from fluctuations in electricity prices and to increase the resilience of the electricity system. In connection with this measure, the development of storage systems is also planned, with batteries and green hydrogen providing the flexibility needed to meet consumption demand outside peak solar production hours. The first storage auction has already been announced, with 500 MW of batteries, for which the government will contribute approximately 100 million EUR to support the projects which must be developed by the end of 2025.

However, meeting these targets will depend on overcoming both current and anticipated obstacles. Nowadays, Portugal faces challenges in expanding the electricity grid's reception capacity, which limits the development of large-scale PV projects that are less likely to serve local consumption. Additionally, the year 2024 saw a record number of hours with negative prices on the Iberian spot electricity market (MIBEL). Those result from the cannibalisation of existing supply from the already high share of renewables on the Iberian market, which lacks adequate development in auxiliary and flexibility services. This effect is expected to become more frequent as installed capacities increase in both countries. To prevent this:

1. Investment in storage systems is needed,

2. The necessary conditions for long-term contracts must be created.

The future of solar PV in Portugal has great potential for success and is sure to be bright, with government actions and strong sectoral interest pointing towards positive progress towards the ambitious targets established.

Authors: *Susana Serôdio* and *Ricardo Ferreira*, Policy and Market Intelligence, Associação Portuguesa de Energias Renováveis (APREN)

4.5 MW solar project, Faro, Portugal

5.11 Romania

Total installed capacity surges to 5 GW in 2024

Overview of PV developments

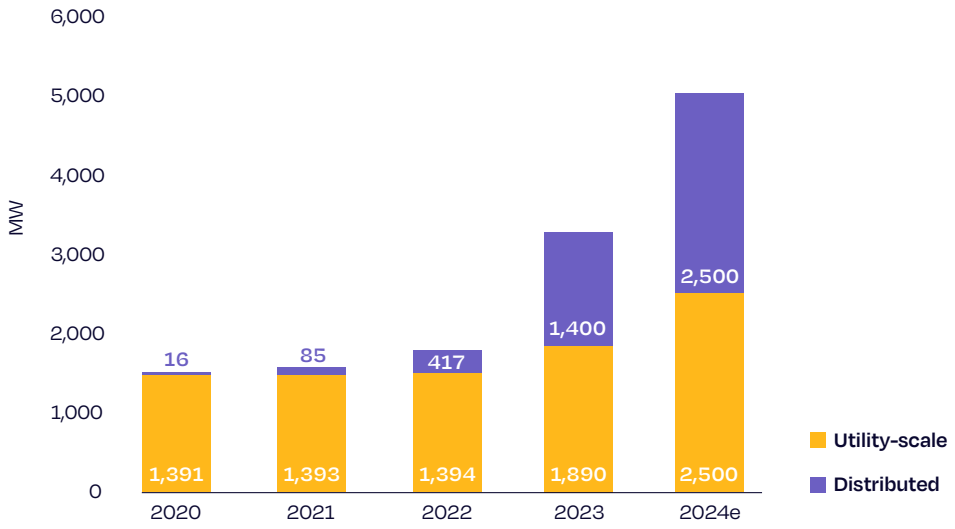
For the second consecutive year, Romania registered GW-scale growth in its PV sector, taking the country's total installed capacity from 3 GW in 2023 to close to 5 GW expected in 2024. The number of new PV installations, reflecting a 12% increase from last year, has marked a new record, reinforcing solar PV's position as the fastest-growing power source in the country.

With the expected addition of 613 MW from utility-scale projects installed in 2024, the centralised PV capacity will reach close to 2.5 GW, accounting for 36% of the total solar capacity installed this year (see GW Fig. 11.1). While utility-scale projects are expected to increase by 23% compared to 2023, the main growth driver remains the distributed generation segment. By the end of 2024, the number of prosumer households, firms, and institutions is poised to reach 200,000, totalling over 2.5 GW, with the residential sector accounting for 64% of annual installations.

GW Figure 11.1

Romania GW-scale markets

Cumulative solar PV installed capacity 2020-2024



Source: RPIA

National targets for solar PV

While Romania has the necessary preconditions for the large-scale development and deployment of renewable energy sources (RES), including adequate irradiation and wind speed levels, proper climate factors, land availability, and relatively streamlined permitting processes, the country's assumed targets fall below the mark. The updated National Energy and Climate Plan (NECP) significantly raises the share of RES, from 30.7% to 38.3%, failing, however, to align with the European binding objective of 42.5%. For solar, this translates into a target of 9.9 GW by 2030, out of which 6.4 GW in utility-scale projects, an addition of 4 GW to the existing capacity, and only 3.5 GW in rooftop PV, a goal that will be surpassed in the next one to two years. While the objectives for large-scale solar are on par with the expected development of the sector, in order to align with the EU ambition level, the target for distributed solar should be increased to 5 GW.[9]

Drivers for solar growth

Over the past three years, the Romanian PV sector has experienced several legislative changes which have promoted the development of new solar capacities. Notably, the permitting time for projects smaller than 50 hectares has been reduced to a period of 6 to 12 months, resulting from the elimination of the Urbanistic Zonal Planning (PUZ) requirement. Additionally, distributed solar systems with capacities of up to 400 kW now have a streamlined approval process that takes one month. Other factors that drove this significant solar growth include the unprecedented levels of funding for large-scale projects through the National Recovery and Resilience Facility and Modernisation Fund, which totals close to 1 billion EUR, and for rooftop PV through the Environment Fund (*Fondul pentru Mediu*), which in 2024 has a budget of 400 million EUR, coupled with the possibility for prosumers with an installed capacity of up to 400 kW to sell the excess electricity directly to their electricity supplier. In parallel, the new investments in solar led to an increase in clean energy employment, as every million EUR invested creates, on average, 6.1 jobs. Therefore, in the medium term, the PV sector alone is expected to generate at least 75,000 full-time jobs, placing Romania among the top seven in this segment.

Aside from the comparatively streamlined permitting process and available funding, the Romanian market is taking significant strides toward reducing volatility through the recently launched CfD mechanism, which will support the addition of 2.5 GW of new solar capacity by 2030.

91 MW, Părău PV park, Solar Open Day 2024, Romania

9 Deloitte & E3M (2023): Renewable Energy in Romania: Roadmap to 2030

Challenges

While the overall framework for the development of RES projects is constantly improving, the industry still faces a series of legislative and structural challenges. A primary issue stems from the fact that guarantees of origin (GOs) for the moment cannot be transferred internationally, as Romania is not a member of the Association of the Issuing Bodies (AIB). Therefore, the number of offtakers is limited, as the development of the PPA market is limited in terms of development to local buyers.

Furthermore, grid connection remains the main bottleneck due to the long queues and the postponement of certain necessary reinforcement and expansion works. To address part of the problem, in August of 2024, the National Regulatory Authority (ANRE) introduced, through Order 53/2024, the requirement of a 5% guarantee of the connection tariff for the issuance of every new grid connection permit above 1 MW, as a means to ensure that the projects will be finalised, coupled with of daily penalties of 0.01% on grid operators for delays in completing the necessary works. Furthermore, starting with January 2026, the "first come, first served" rule will no longer apply for projects above 5 MW, being replaced by a capacity tender. Given the complexity of this new auction-based system, including the implementing procedure to be issued by TSO, as well as the alignment of the system's timeline with the overall project development process, the full implications of this change cannot be yet assessed.

Outlook for 2025-2028

The Romanian PV sector is gradually moving toward maturity, underpinned by a more stable legislative framework that strives to reduce uncertainties and volatility. While there is much room for improvement, especially in terms of regulatory harmonisation, the stable growth registered in the past two years points toward the mainstreaming of solar, which drives sustained development. In the upcoming years, Romania is expected to not only reach, but surpass its national targets. However, for this to happen, it is necessary to ensure that the new auction-based rules for grid connection are properly designed and implemented.

Author: *Irene Mihai*, Policy Officer, Romanian Photovoltaic Industry Association (RPIA)

5.12 Belgium

GW scale reached in 2024 despite a 33% market decline

Overview of PV developments

In 2024, the Belgian solar market experienced a 33% decline, driven entirely by a contraction in the residential segment. Despite this, Belgium has now established a mature and stable market with annual installations exceeding 1 GW. Due to energy policy being a regional responsibility, each region – Brussels, Flanders, and Wallonia – operates under distinct support schemes and legal frameworks. This article highlights key market data and developments in each region, along with some overarching national trends.

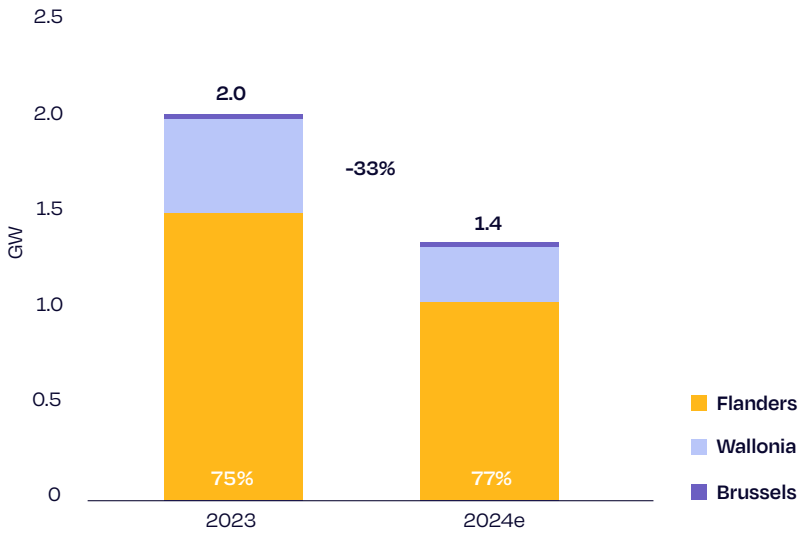
The latest figures indicate that around 1.4 GW of new capacity can be expected for 2024, a significant drop from the record-breaking 2023, when 2 GW was installed. However, the performance of 2024 should not be compared to the exceptional circumstances of 2023, where the phaseout of government support created a rush in installations. Instead, it is more appropriate to compare 2024 to 2022, a year in which 1.2 GW was installed. This represents a 12% increase, demonstrating that the maturing Belgian PV market is increasingly driven by factors beyond subsidies.

The residential segment accounted for only 33% of all installed capacity in 2024, a sharp decrease from 57% in 2023. In contrast, the C&I segment dominated with 63% of installations, while just 3% came from utility-scale systems. Regionally, Flanders contributed nearly 80% of all installations (GW Fig. 12.1). This division partly reflects population distribution: approximately 58% of the population resides in Flanders, 31% in Wallonia, and 11% in Brussels.

GW Figure 12.1

Belgium GW-scale markets

Annual solar PV installed capacity 2023-2024e



Source: VEKA, Energie Commune, SolarPower Europe

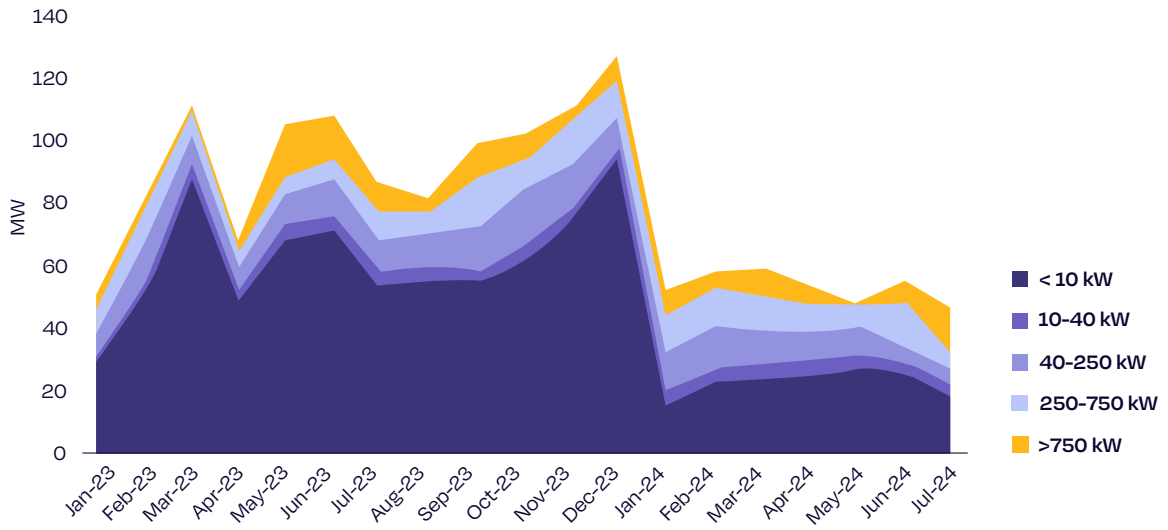
Solar PV developments in Flanders

The Flemish solar market in 2024 is facing notable adjustments, reflecting both challenges and opportunities. Residential and small commercial-sized rooftop installations are projected to decline by 30–50% compared to the high levels of 2023, though they will still surpass those seen in 2022. One traceable cause of this sudden drop is the Flemish government's gradual phaseout of subsidies for solar PV installations. In 2020, net metering support stopped, benefitting those who installed before the deadline, until 2025 at the latest. This naturally created a rush in the market, followed by a sudden drop before rising again due to the energy price hikes in 2022. On the 1st of January 2024, the government ended a subsidy for residential installations of up to 750 EUR per installation (after already halving it from 1,500 EUR in 2023). Regardless of the graduality and early communication surrounding the phaseout, this once again resulted in a subsidy-driven rush with a sudden drop in 2024 (GW Fig. 12.2). The drop in residential installations is partially compensated by commercial and industrial capacity. Next to electrification, one of the biggest drivers in this segment is the solar installation mandate for large electricity users by mid-2025. This mandated capacity per company is planned to grow stricter in 2030 and 2035, giving larger companies a clear push to invest in solar PV today. Nonetheless, the sector is experiencing delays, possibly due to a change in government and some speculation on the strictness of the mandate. Today, the government has officially confirmed the deadline will remain in place. As some companies might not install the capacities before the deadline, the stance on potential financial consequences is still under debate. With strong fundamental drivers along the mandate, the C&I market is set for growth, particularly in 2025.

GW Figure 12.2

Belgium GW-scale markets

Monthly solar PV installed capacity in Flanders, January 2023-July 2024



Source: VEKA, Energie Commune, SolarPower Europe
Note: Capacity is expressed in AC terms.

The Flemish market is largely subsidy-free but has many drivers that could sustain growth at a healthy pace. As mentioned, one of the most significant is the mandatory solar obligations for businesses consuming over 1 GWh of electricity annually, set to take effect in 2025. Additionally, all 430,000 households that still have net metering will lose this after the mandatory installation of a digital meter in 2025. Therefore, there will be an incentive for energy management and hybrid systems with additional solar capacity to increase self-consumption, potentially creating a new wave of residential installations in 2025/2026. The incentive is high for owners who invested in heat pumps or electric vehicles from the early 2020s and would have lost net metering if they added PV modules in the past years.

Policy and technological innovations are also significant growth drivers. The current coalition agreement includes amongst others: measures to expand energy-sharing for apartment buildings and encourage grid flexibility through technologies such as vehicle-to-grid (V2G). These policies, coupled with the long-term vision of a shift in taxation from electricity to gas, make solar a more attractive investment across all market segments. Moreover, plug-in solar systems will be legalised in Belgium as of mid-2025. While these products have the potential to be a stepping-stone towards deeper market penetration, they do not come without challenges. If technical limits are not considered, excessive feed-in could be hazardous. Additionally, one could argue that plug-in solar systems might cannibalise part of the residential rooftop market.

Next to today's challenges for the residential market, grid congestion stands out as a critical issue. As in many EU markets, solar curtailment is becoming more prominent. Additionally, transmission grid connections are significantly delayed due to a lack of capacity and manpower in permitting authorities. The slow pace of grid upgrades and a lack of widespread storage solutions exacerbated these issues in 2024. Furthermore, policy uncertainty creates unnecessary delays. Finally, many residential installers are facing empty project pipelines as the market shrinks. Anecdotal reports indicate this is especially challenging as many are unable to shift to the growing C&I market, due to the complexities of medium-voltage installations. If this workforce is trained and oriented towards larger installations and flexibility technologies such as storage, this could accelerate the Belgian energy transition.

PV installation in Ciney, Belgium

Solar PV developments in Wallonia and Brussels

Though the slowdown in Flanders is strong, it is still minor compared to the downturn in the Wallonian solar market. The end of net metering in 2023 resulted in a rush in rooftop installations in the second half of the year. From 2024 onwards, the residential segment has been subsidy-free for new installations, leading to an impressive drop in installations in this segment this year—by 80-90%, according to installers. Official numbers are yet to be published.

For the C&I segment, a significant drop has been recorded, with installations halving compared to last year. This is largely due to the considerable decrease in electricity prices during solar production hours, reducing the financial incentive for new projects.

Although the region adopted ambitious 2030 targets aiming for a PV production of 5,100 GWh/year by 2030, Wallonia has made no progress compared to last year. The region has yet to develop a clear strategy to achieve this target and still needs to adopt adequate measures. The sector has called for specific rules to support PV integration in buildings, PV development for carports and open fields, as well as obligations for large consumers, similar to those in Flanders.

Developers also face challenges with grid access and land availability. Utility-scale projects remain scarce in Wallonia, despite the immense potential for large-scale systems. EDORA continues to urge the government to establish a clear framework to enable the deployment of this much-needed segment to reach regional targets.

In Brussels, the net-metering scheme ended in 2020 and was replaced by feed-in at market prices. PV installations of any size can still get additional support via 'green certificates,' which are benchmarked to the feed-in prices. The number of certificates and their value depend on the size of the system and the electricity produced. The certificates are priced according to a targeted payback time of 7 years for a PV installation, though this is not guaranteed. Nonetheless, since these certificates can be earned for 10 years, the business case is strong. Still, all prosumers have a digital meter and pay grid fees based on actual consumption, creating an incentive for self-consumption. To further smoothen the integration of solar PV, energy-sharing installations, such as those on apartment blocks, can be exempt from paying grid fees.

Outlook

The Belgian solar market is shaped by a transition, moving away from government-funded growth. While the subsidy-driven rush of previous years has faded, long-term drivers such as mandatory solar obligations for businesses, electrification, and innovative energy-sharing solutions are expected to sustain steady growth. Regional differences will continue to play a key role: Flanders, with its focus on C&I development, is set to remain the primary contributor, while Wallonia faces the challenge of aligning its ambitious targets with actionable strategies. Overcoming barriers such as grid congestion, delayed connections, and policy uncertainty will be critical to unlocking the full potential of the market. Despite these hurdles, Belgium's solar sector remains resilient, with its established 1 GW+ annual market signalling a stable foundation for further growth as the country continues its transition to a more electrified and sustainable energy system.

Authors: *Jonathan Gorremans*, SolarPower Europe; *Walter Brosius*, Policy Expert, PV-Vlaanderen; *Marion Bouchat*, Policy Expert, EDORA

5.13 Ireland

A new member of the GW market group

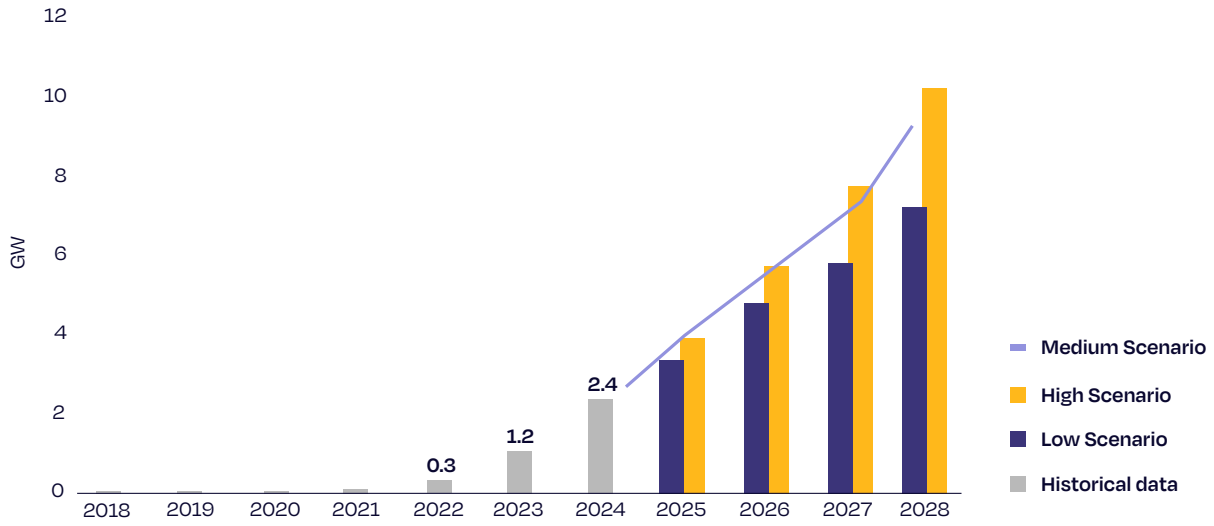
Overview of PV developments

In recent years, Ireland's solar PV market has seen remarkable progress, reflecting a substantial leap forward in solar PV deployment. Only one year after it crossed 1 GW of total installed PV capacity in 2023, Ireland is going to reach the GW scale of annual installations in 2024: according to SolarPower Europe, by the end of the year, it's estimated that Ireland will have installed an additional 1.2 GW of capacity.[10] The current challenge for the country is less about fostering interest and growing the market for solar PV, but rather about creating the right conditions to scale it up in order to reach its ambitious renewable energy goals.

GW Figure 13.1

Ireland GW-scale markets

Cumulative solar PV market scenarios 2024-2028



Source: SolarPower Europe

10 Capacities in this article are expressed in DC values, using DC/AC conversion ratios of 1.25 for the residential and C&I sector, and 1.8 for the utility-scale segment.

National Targets for Solar PV

Ireland's National Energy and Climate Plan, updated in 2024, has set a target of reaching 8 GW_{AC} of solar PV capacity by 2030. Translated to DC values, this NECP target is equivalent to reaching 13 GW_{DC} of cumulative solar PV capacity by 2030. This goal is part of a broader objective to generate 80% of electricity from renewable sources by the end of the decade. Solar is expected to play a key role in achieving this, alongside wind, storage and other renewables.

Drivers for Solar Growth

The acceleration of solar PV deployment in Ireland can be attributed to several key dynamics. In the large-scale segment, the Renewable Electricity Support Scheme (RESS) provides guaranteed revenue for developers through auctions, encouraging investment in utility-scale solar projects. The first four RESS auctions have allocated a combined capacity of 3.7 GW_{AC}, which are expected to be commissioned between 2026 and 2029. The government has announced a total of at least 5 auctions to achieve its 2030 target. Alongside this strong auction pipeline, corporate PPAs are another popular choice for utility-scale project developers.

In the residential and small commercial segment, microgeneration grants, i.e. government incentives for smaller solar installations aimed at homeowners and small businesses, have also made rooftop solar more attractive. Although the amount of the grant is decreasing at a rate of 300 EUR/year, and despite the end of the energy crisis, the slow-down in this segment in 2024 has not been dramatic. Moreover, the declining costs of solar technology have made PV more affordable, helping solar gain further traction in all segments. Finally, a favourable political climate for renewable energy deployment is also a positive driver for the industry.

200 MW Ballymacarney Solar Project, County Meath, Ireland

Utility-scale vs. rooftop developments

The solar market in Ireland is still led by utility-scale projects, which make up the bulk of the country's capacity, driven mostly through corporate PPAs and auctions. However, there is notable growth in the rooftop segment, both residential and C&I, driven by a growing interest in self-consumption and energy independence. Distributed solar is gaining a foothold, as small-scale installations contribute to local energy needs and reduce strain on the central grid.

Challenges and outlook 2025-2028

Grid capacity and infrastructure are key challenges, with the current grid needing significant upgrades to handle increased solar capacity. Weak grid infrastructure, especially in rural areas, complicates the integration of new solar projects. High costs for grid connections and lengthy planning approvals remain major hurdles for developers, affecting the economic viability of many projects.

From 2025 onwards, Ireland is expected to maintain the GW level, thanks its large auction pipeline, dynamic PPA market and stable microgeneration market, with further potential in the C&I segment to be tapped with adequate policy improvement. Investments in grid infrastructure and storage solutions will be essential for handling the fast increase of solar penetration in the electricity mix.

Author: *Conall Bolger*, Chief Executive Officer, Irish Solar Energy Association (ISEA)

5.14 Bulgaria

Bulgaria adds another GW of new solar capacity in 2024

Overview of solar PV developments

Bulgaria's grid-connected solar PV capacity will most likely pass the 4 GW mark in 2024. After adding close to 1.5 GW in 2023, the solar industry looks set to keep the momentum with another gigawatt of new installations in 2024, according to estimates of the Association for production, storage and trading of electricity (APSTE).

The utility-scale segment continues to dominate, accounting for over 80% of all newly installed solar power plants in the country, which helped the industry quickly become a major source of clean electricity in the country. Solar now regularly makes up a substantial portion of Bulgaria's electricity mix during daytime with 40% or more of total generation at noon hours.

113 MW Tsenovo solar plant, inaugurated in October 2024, Bulgaria

Drivers of growth

Naturally high solar irradiation levels in Bulgaria, with 2,000 to 2,600 hours of sunshine per year in different regions, combined with attractive price levels for solar electricity, make investments in solar power generation attractive. Solar is currently the cheapest power source available on the market and energy-intensive businesses are beginning to take notice. The recently inaugurated Tsenovo solar power plant offers an excellent example, with three power purchase agreements secured.

The 113 MW Tsenovo solar plant is expected to generate 177 GWh of clean electricity annually, supplied under long-term power purchase agreements to Bulgarian KCM AD – a leading producer of lead and zinc in Southeastern Europe, telecom group Orange Romania, and Dreher Breweries, part of Asahi Europe & International (AEI).

Another major solar power plant investment, a 225 MW PV project developed on the site of a decommissioned airfield in Silistra, closed financing after Ardagh Glass Packaging-Europe (AGP-Europe) agreed to buy 110 GWh (or one-third of the expected annual generation) via a virtual PPA.

It is worth noting that sustainability and early stakeholder engagement will be key to securing social support for further investments in large-scale solar, and the Tsenovo solar plant offers a case to study in that respect, quite literally. To support the area's biodiversity and promote nature conservation, the solar power plant site will host an innovative biomonitoring project in partnership with local environmental research firm Pollenity. Several beehives are installed on-site and the bee pollen will be analysed to assess baseline biodiversity in the area, helping the solar farm owner define future environmental policies with greater precision and efficiency.

Challenges

Grid congestion management and improved regulatory and market incentives for flexibility are needed to secure the continued sustainable development of the solar sector in Bulgaria. Tripling installed solar capacity in less than two years with no corresponding growth in demand has brought the typical "solar duck" curve to power market prices in Bulgaria and the region as a whole, although wholesale power prices remain elevated compared to the EU average. Concerns over scarce grid-connection capacity and low capture prices for solar generation profiles have already tightened requirements from financing institutions and now drive investments in co-located or stand-alone energy storage systems.

Outlook 2025-2029

Under its National Recovery and Resilience Plan (NRRP), Bulgaria launched its first renewable energy auction in the first half of 2024. The auction will allocate CAPEX support for 1.4 GW of renewable energy projects co-located with at least 350 MW / 700 MWh of storage. The list of successful applicants is expected to be confirmed by the end of the year and projects will start operation by March 2026.

Another tender for CAPEX support to 3 GWh of stand-alone storage facilities is accepting bids by the end of November, with an even tighter commissioning deadline by March 2026. When up and running, this storage capacity is expected to help tame volatility and cut spreads between noon and evening hours, thus helping the business case for adding more solar and wind power to the grid.

While currently almost untapped, the rooftop residential and energy communities markets might also see improved economics if the power market liberalisation reform is completed in 2025.

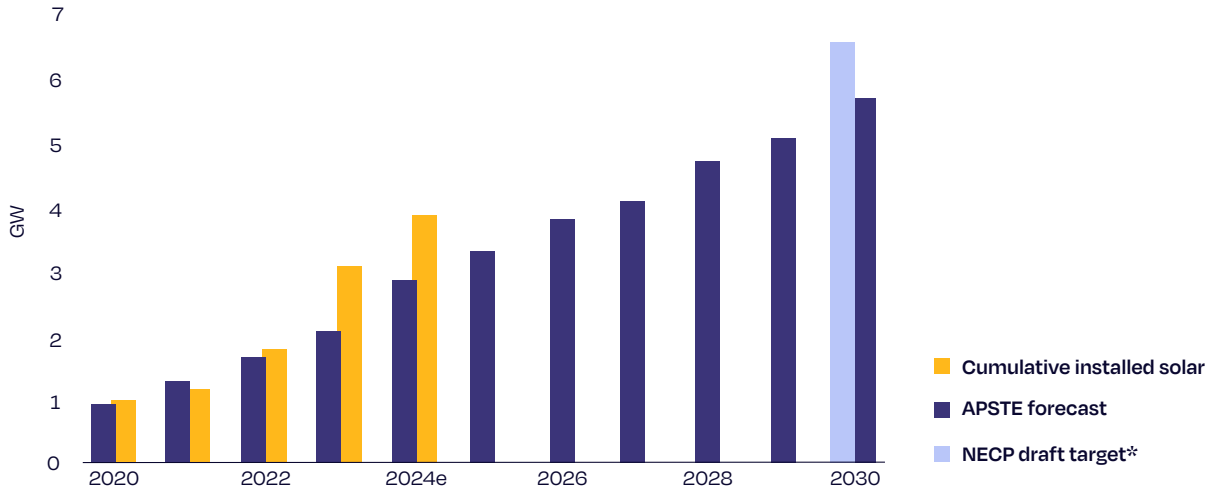
As can be seen in Figure GW 14.1, APSTE believes the solar sector will continue to grow by between 450 to 750 MW of new capacity per year over the next three to four years.

Author: *Mariyana Yaneva*, Policy and Communications Director, Association for Production, Storage and Trading of Electricity (APSTE)

GW Figure 14.1

Bulgaria GW-scale markets

Cumulative solar PV capacity forecast 2020-2030



Source: APSTE, SEDA
*Updated draft NECP target of 6.6 GWDC by 2030, not yet officially endorsed, converted from AC.
Meeting this target will largely depend on the faster market entry of energy storage and flexibility market incentives.

5.15 Czech Republic

B2B takes over the baton from residential as PV market driver, but the threat of retroactive measures still hampers real growth

Aiming for 1 GW again

In 2023, Czechia returned to the GW-markets stage after a 12-year absence. One of the original large-scale PV markets in 2009 and 2010, Czechia saw retroactive changes and anti-PV campaigns that all but killed off solar growth in the years after 2011. The country stumbled into the 2021-2023 energy crisis almost entirely unprepared for the astronomic growth in solar installations that we have seen over the past few years. While in 2020 a total of 6,300 solar PV projects (almost all of them residential) was connected, this number rose to almost 83,000 connected projects last year. In terms of installed capacity, Czechia grew from a market with an added capacity of 51 MW in 2020, to a total of 970 MW in 2023. Again, the main market driver was residential systems, incentivised through an investment subsidy scheme.

In 2024, Czechia is once again aiming for around 1 GW of newly added PV. Half-year figures presented by the Czech Solar Association in July 2024 showed almost exactly the same growth in MW as for the comparison period of 2023. However, the actual number of new PV plants connected dropped to half compared to the previous year. This trend, confirmed by installer companies, shows a rapid decline in interest for residential PV and increased demand for B2B projects. Czechia is now building fewer, but larger solar power plants. The average size of connected projects almost doubled, from 11.7 kW in 2023 to 20.3 kW in H1 2024.

Residential segment: insecurity and power prices cut demand

After a record year in terms of residential installations as well as companies active on the market, the B2C segment suffered an unexpected shock at the beginning of 2024. At the end of 2023, in an effort to reflect falling panel prices, the "State fund for the Environment" (the institution governing renewable subsidies) were looking to adjust the subsidy scheme by lowering the maximum possible subsidy available. Key information from one working meeting in late 2023 was leaked, and in January 2024 information began to spread about subsidies being cut. This was used by some installers' marketing teams, before it was shut down by the Czech Solar Association and respective companies were warned. However, by this time the damage was done, and panic began to spread around the sector and among potential customers who – in order to secure higher subsidies – hastily registered applications in January and February. With thousands of applications for residential projects submitted in these two months, followed by an announcement of subsidy cuts (from around 8,000 EUR to 6,500 EUR), demand for new residential projects fell to near-zero in March and April 2024. This coincided with a significant drop in electricity prices, dealing a further blow to demand for residential projects, which has not picked up to date. With the fading out of the energy price crisis – the main driver of residential growth since 2021, it now appears that the B2C market has reached a point of saturation where massive growth cannot be sustained.

Another blow to the sector was the introduction by the State fund for the Environment of a maximum percentage of energy that can be fed into the grid for subsidies projects of 35%. This was added to ease the strain on the power grid. In 2022 and 2023, almost all residential self-consumption projects were oversized (averaging 10.3 kW in 2023), as consumers hoped to secure another revenue stream by selling the excess energy produced. However, falling energy prices in 2024 resulted in tens of thousands of households now having oversized PV installed on their rooftops and shattered hopes of quick returns. This too has caused potential customers to reconsider and put investments on hold.

C&I segment: taking the lead, but dependent on subsidies

In 2023 companies started to apply for investment subsidies from the Recovery and Resilience Fund, for projects that are mostly being built and connected this year. In total, applications for close to 1 GW of additional PV were submitted to the subsidy scheme by the end of 2023. At the same time, a similar scheme was introduced for companies financed through the Modernisation fund (available in Czechia and other countries with a coal-heavy energy mix). Here too, a maximum of 35% grid injection was introduced, together with a new stipulation that new projects can only apply for subsidies with a valid building permit. However, delays in 2024 for building permits, combined with a botched digitalisation of the permitting process, caused problems with subsidy applications.

Most commercial projects connected in 2024 will fall under the Recovery and Resilience fund with some projects from the Modernisation fund already built. The average size of commercial projects in the first half of 2024 was 118 kW.

800 kW C&I solar plant, Valašské Meziříčí, Czech Republic

As with the residential sector, falling energy prices are also a hurdle for installers negotiating with potential C&I customers. The focus for 2025 and beyond will therefore be on efficient subsidy programmes. The Modernisation fund may have to be adapted to reflect delays and building permits. In August 2024, a new subsidy programme for commercial projects between 10-50 kW was launched by the Ministry of Industry and Trade in cooperation with the Czech National development bank (NRB), which incorporates an interest-free loan. This long-anticipated programme, however, became quickly stuck as the administration was taken over by the NRB, which was inundated with applications it is now struggling to work through.

Utility-scale segment: permanent insecurity delays much-needed growth

While thousands of applications for rooftop power plants and a GW-scale market seem like positive news, they will not be enough for Czechia to reach its decarbonisation targets. Czechia is among the EU's most industrialised economies per capita, with automotive, chemical and steel sectors unable to cover their energy demand with rooftop PV installations alone. Whether or not this industry will remain competitive depends on whether Czechia can build enough utility-scale power plants in the coming years. So far, however, the outlook seems uncertain. There are several GWs of projects in the pipeline, but few are actually being built, for two reasons.

Firstly, low energy prices have damaged investors' business cases. Projects at the ready-to-build stage are being shelved, since Czechia does not offer investors a CfD or similar scheme. Companies therefore have to rely on merchant or commercial PPAs, which are very rare in Czechia. This year, Austrian IPP Enery announced a future 30 MW PPA with a Czech automotive company, the first solar PPA in the country.

Secondly, the Czech solar market is experiencing annual political threats to retroactively cut feed-in-tariffs granted to 2 GW of existing solar PV projects built between 2009-2010, which are guaranteed by law to run until 2029-2030. Given that most investors in new utility-scale PV also operate old PV plants and are still paying off bank loans, any threats to their asset base causes new projects to be put on hold. At the time of writing, the Czech government is again threatening to cut these tariffs. Installation data reflects this insecurity: only 25 projects above 1 MW were connected in H1 2024, mostly from large rooftop PV.

Challenges ahead: market consolidation, grids, permitting and utility-scale growth

The year 2024 has shaken up the Czech solar market. Installers, which for 2 years relied on a residential segment abundant with clients, are now shifting to the commercial sector. While shrewd companies realised this sooner, the rest of the sector is still catching up. From hundreds of companies currently active in the country, we expect the market to consolidate: companies are merging, being bought by larger players, or withdrawing altogether, while others are facing bankruptcy. This can be an expected result once a market stops being overheated.

As with most countries, another key question concerns grid capacity and whether it can handle the growing amount of rooftop projects. In 2024, Czech DSOs offered a more flexible approach for rooftop PV, allowing installation without permitted surpluses to be installed, allowing PV to be built in areas where new grid connections had previously been blocked. The introduction of non-guaranteed grid connections in mid-2024 might also be an impulse for the sector.

In terms of permitting, key law changes were pushed through by the Czech Solar Association. The sector now waits for the publication of secondary legislation and ministerial guidelines for local offices. If correctly applied, these law changes could significantly cut permitting times.

The key driver in 2025 will be a new law currently being passed, which, after years of lobbying by the association AKU-BAT and the Solar Association, will finally introduce flexibility and storage into Czech law. This should help ease grid congestion as well as negative energy prices.

Therefore, crucial steps for driving solar PV further are:

- Embracing solar as more than a quick means to fix current high energy prices, and rather as an insurance policy against further price hikes;
- Improving the grid and allowing more projects to be connected;
- Adjusting subsidies to increase solar demand;
- Issuing guidelines that speed up permitting;
- Finally putting the past behind and stop threatening the sector with retroactive cuts.

Outlook: everything is possible

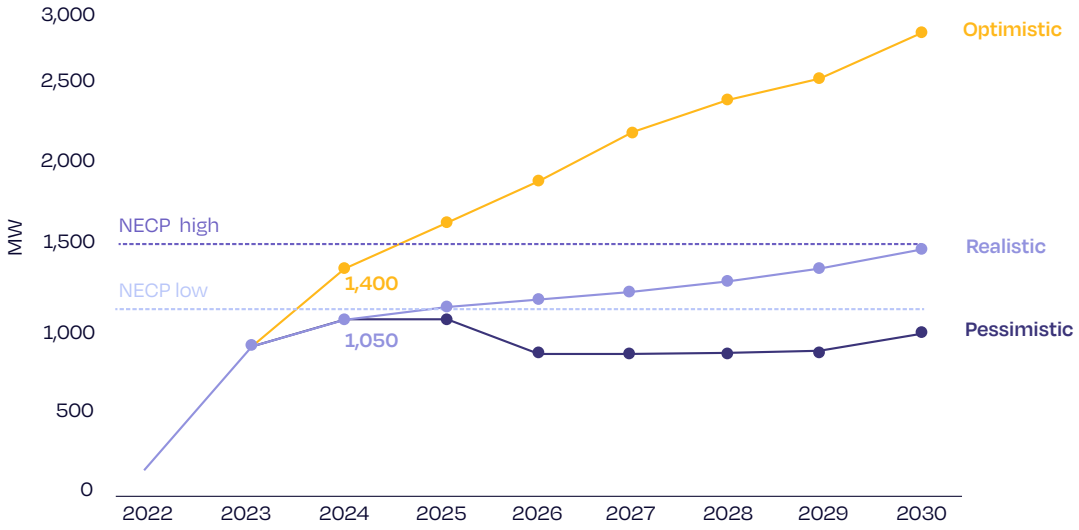
With the future of utility-scale projects hanging in the balance, it is difficult to issue reliable forecasts in terms of annual growth (GW Fig. 15.1):

- In a pessimistic scenario with mostly rooftop installations and little utility-scale, we expect annual growth between 0.9 - 1 GW;
- In a realistic growth scenario, where utility-scale picks up steadily, annual growth could reach between 1 - 1.5 GW;
- In an optimistic growth scenario where barriers to deployment are removed, we could see annual growth between 1.4 - 2.8 GW.

GW Figure 15.1

Czech Republic GW-scale markets

Annual solar PV market scenarios 2024-2030



Source: Solární Asociace

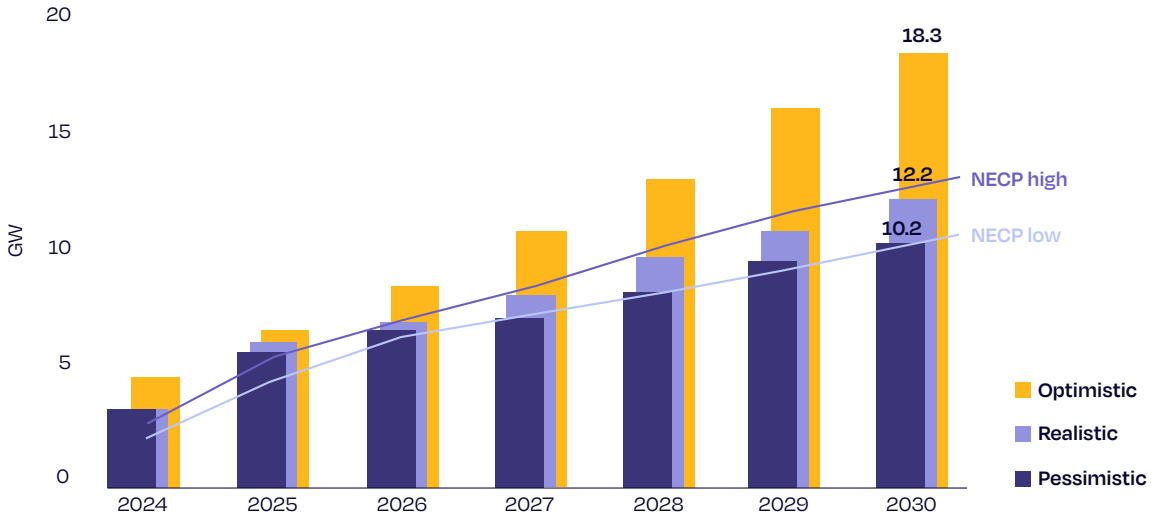
In terms of total installed capacity, the pessimistic scenario leads to about 10 GW of solar by 2030, while the realistic scenario surpasses 12 GW and the high scenario reaches as much as 18 GW by the end of the decade (GW Fig. 15.2). All these scenarios are significantly above the current 8 GW solar target from the Czech draft NECP. In the 2024 NECP update, the Czech government is planning to submit various scenarios of decarbonisation (high/low) rather than a specific number target.

Author: *Jan Krčmář*, Executive Director, Solární Asociace

GW Figure 15.2

Czech Republic GW-scale markets

Cumulative solar PV market scenarios 2024-2030



Source: Solární Asociace

5.16 Sweden

After unprecedented growth last year, projection for 2024 is just above 1 GW

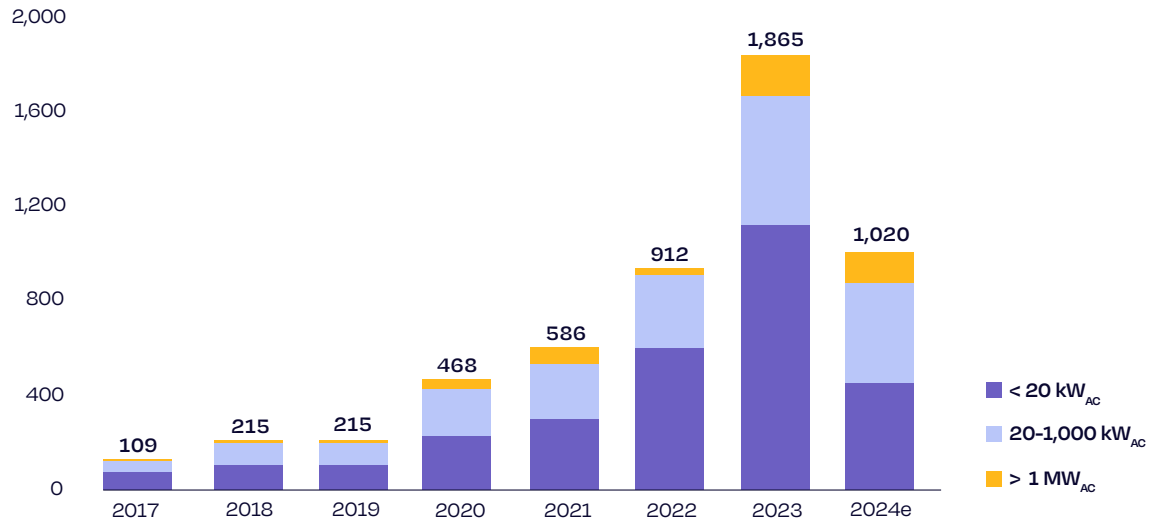
Overview of solar PV developments

The steady growth of the Swedish solar market up until the end of 2021 was suddenly disrupted in 2022 and 2023 by unprecedented growth. Annual installed capacity grew 56% in 2022 to about 910 MW and another 104% in 2023 to 1,900 MW. However, new system sales had already peaked in the autumn of 2022, while installation rates kept growing until June 2023, resulting in a fast decrease in installed capacity during the second half of 2023. At the start of 2024, this decline levelled out and installation rates per month have been relatively even throughout the first three quarters of the year, with a total of about 780 MW of newly installed capacity. The projection for the entire year 2024 is just above 1 GW (see GW Fig. 16.1).

GW Figure 16.1

Sweden GW-scale markets

Annual solar PV installed capacity 2017-2024



Source: Svensk Solenergi

The residential segment now stands for 60% of the cumulative installed capacity and has been driving solar deployment in Sweden in recent years. The above-described trend, however, has been significant in this segment. The expectation for 2024 is around 470 MW of new residential solar capacity, which is 60% less than in 2023 but still 76% higher than in 2021. The C&I segment has around one-third of the cumulative installed capacity and over 400 MW are expected to be added in 2024, which is 23% less than in 2023, yet 74% more than in 2021. Lastly, the utility-scale segment remains at a low level, only about 7% of the cumulative installed capacity. However, a large number of projects are being developed, the effects of which will be seen in the coming years. For 2024, the expectation is for more than 100 MW to be installed, around the same level as in 2023.

Public target and demand

Swedish electricity production has been close to fossil-free for many years and there are no specific goals for renewables in Sweden. However, in 2024 the nuclear-friendly right-wing government set a planning goal for doubled electricity production until 2045 to meet the expected rise of demand in industry and transport.

In August 2024, a government inquiry on financing new nuclear power suggested a fixed price CfD of about 70 EUR/MWh and a public loan of 75% of the investment costs. It isn't clear whether this will be enough to realise new reactors in Sweden. Regardless, electricity consumption is expected to start rising in a few years and might already be 50% higher by 2030. This rise in demand will increase electricity prices and there is a need for more power production that can be expanded at a rapid pace. In 2024, solar power only counts for less than 2.5% of the electricity production, hence there is potential for a large expansion.

Opportunities for utility-scale PV

For large-scale projects, the main driver for growth is the above-mentioned expected rise in electricity demand. There is good availability of land for ground-mounted PV since Sweden has a low population density and is the fifth largest country in Europe. Swedes are also more positively inclined towards solar power compared to other energy sources. About 80% of Swedes want more investments in solar than today.

Yet, so far, there are no solar PV systems in Sweden larger than 22 MW. However, plants close to 100 MW are now under construction. The legal obstacles for utility-scale solar are now starting to clear. In April, the highest court for land and environment passed a ruling which put extensive requirements on the investigation of alternative locations for projects that are planned on farmlands. In October, the same court passed a ruling with the implications that regular ground-mounted racks do not require building permits from the municipality, contrary to what was previously requested by some municipalities.

The permit process at local administrative boards is somewhat improving and about 70% of utility-scale projects receive permission. At the same time, grid congestion and lack of information from the DSOs about available capacity are the biggest obstacles for project developers.

Growth for BESS pushing for solar

In 2023 and 2024 there has been tremendous growth in BESS deployments in all segments, mainly driven by the possibility to provide ancillary services for the TSO. BESS investments also clearly drive investments in PV, not least in the residential sector. In this segment, a tax deduction for home storage investments is granted only if the device is connected to personal electricity production. Statistics from the tax authority even show that in 2024 more households are getting the tax deduction for storage than for solar. This development took place despite the tax authority claiming during the first half of 2024 that no tax deduction could be approved if storage was used for anything other than self-consumption. This problematic interpretation, which harmed the installer sector, was then rejected by a legal entity in July, leading to a strong growth in home storage sales.

Removal of support schemes

There are two support schemes for solar energy in Sweden, mainly directed to the residential sector. However, the government recently announced the reduction of one and the removal of the other. The feed-in bonus of 60 öre/kWh (5.5 EUR cents/kWh), for small prosumers with grid connections of maximum 100 A, is planned to be terminated abruptly on 1 January 2026. This is expected to further increase investments in storage and reduce the system size of PV installations in this segment, which has been larger than in many other European countries.

The other support scheme is a tax deduction for investment costs in green technologies (solar, storage and EV chargers) for private homeowners. The government has now proposed to reduce the tax deduction for solar from 20% to 15% from 1 July 2025. For energy storage and EV chargers, the tax deduction is 50% of the installation work and materials costs.

Opportunities

For the C&I segment, the largest obstacle to expansion is a rule that indirectly limits many rooftop PV systems to 499 kW. According to this rule, property owners must pay energy taxes on self-consumption for installations over 500 kW. This rule inhibits the expansion of large rooftop PV installations. The government has still not indicated whether it will review this rule, but it's expected that removing this rule might be a way to fulfil the solar mandate in the EPBD.

There is currently no regulatory framework for energy communities and energy sharing in Sweden. However, this is now being investigated by authorities and so there are expectations of upcoming incentives for energy sharing.

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Active Pressure Release Technology

[1] Throughput per kWh promised in the corresponding warranty letter.
[2] The 15-year warranty is valid only when the LUNA S1 is connected to the SmartPVMS. For details, see the warranty letter.
[3] Based on typical configurations: single/three-phase up to 10kW PV+ESS solutions, measured 1 m away under typical operating conditions. Noise levels within quiet bedrooms should not exceed 30 dB.
[4] LUNA S1 is not intended for use in water. Please keep it away from water sources during daily use.
[5] Severe impact affects the stability of the ESS. Avoid impact whenever possible.

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Leading the Energy Transition

SolarPower Europe, the premier association for the European solar PV sector, unites 320+ organisations. Collaborating with members, we shape regulations and business landscapes for solar's growth.

Our dedicated policy experts lead focused workstreams, addressing key issues and influencing legislation. Based in Brussels, we build strong relationships, ensuring solar's pivotal role in the European energy transition.

As co-founders of the RE-Source Platform, Renewable Hydrogen Coalition, and the European Solar Initiative, we actively engage in EU and international projects, fostering partnerships with 40+ organizations globally.

SolarPower Europe's top analysts provide market intelligence through reports like the Global Market Outlook for Solar Power and EU Solar Jobs Report. Our events, including the SolarPower Summit and RE-Source, bring policymakers and stakeholders together for networking and business opportunities.

Quick Facts

SolarPower Europe was established in April 1985 – we will celebrate our 40th anniversary in 2025!

SolarPower Europe represents over 40 national solar energy associations across Europe

Almost 90% of our members are European headquartered companies

SolarPower Europe won 'European Association of the Year' at the International & European Association Success Awards 2024

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