EU Market Outlook

For Solar Power

2023 - 2027

SolarPower Europe

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Foreword

Welcome to the EU Market Outlook 2023 – 2027,

If the energy crisis was the wake-up call to accelerate the renewable energy-based transition and foster EU energy security, the solar sector has heard it loud and clear. In 2023, we not only installed more new power generation capacity than all other technologies in the EU combined; solar has shown outstanding performance – the third year in a row – at annual growth rates of at least 40%. Grid connecting around 56 GW of solar in 2023, the sector has delivered what the International Energy Agency (IEA) was asking for a year ago to avoid any energy supply short falls this winter.

As the European solar sector's association, we would like to take a moment to thank the more than 800,000 people working in the solar industry today across the value chain in the EU. Without the hard work of these companies, going the extra mile to respond quickly to market needs in challenging circumstances, and despite a huge skilled worker gap, the spectacular solar growth story would have not been possible.

We also must acknowledge policymakers in Brussels and Member States that are starting to embrace solar's immense potential – and what's needed to tap it rapidly. The solar ambition outlined by the European Commission in its solar strategy, and the REPowerEU plan to get off Russian gas, are inspiring Member States to increase solar ambition in their updated National Energy and Climate Plans.

This should be a true moment to celebrate. Unfortunately, today's outstanding solar success story could be over soon. Despite impressive achievements until now, solar is reaching a critical juncture at which the further growth path for the lowest cost, most versatile, and most simply deployable power technology will be decided on. It needs to be crystal clear that the extremely fast growth period of the last three years was exceptional, triggered by extreme energy price spikes and the fear of energy supply outages. In the meantime, energy prices have come down close to pre-energy crisis levels, taking away the urgency to install solar; a market situation that is aggravated by an inflationary environment with high interest rates.

We must caution that a large proportion of the 2023 growth stems from 2022 orders that could not be built earlier due to the lack of solar contractors at the time. Installation activities in the final months of 2023 were much quieter. After increasing our market projections for years, this edition it's very different: for 2024, our market growth forecast decreases to 11%.

We need decision-makers in Brussels and EU capitals to step up now, and enable the solar sector to realise its growth potential and contribution to the EU's climate, security and prosperity agenda. The sector is ready to keep delivering for the energy transition – with the right political support.

That starts with several Member States who have to raise their solar ambition of the updated **National Solar Energy Climate Plans**, which altogether are falling short around 20% of meeting the EU 2030 solar targets. In addition, further strong headwinds that need to be addressed quickly are limitations of the traditional **energy system** and **market design** to cope with the integration of massive volumes of new solar power capacities looking for grid-connection. While grid investments have to be brought to new levels, insufficient framework conditions for **flexibility and storage** require urgent attention too. We also see solar developers still suffering from local permitting issues despite all the recent legislative efforts. And the much needed renaissance of the **European solar manufacturing** industry, aimed at providing sustainable supply chain resilience for the local market, is not coming off the ground due to insufficient financing tools, notably for operational costs.

In the policy recommendation outlined in this report we have come up with a set of detailed solutions to overcome all these obstacles for Europe's solar sector to play an even larger role in the energy transition to a resilient net zero energy system-based renewables. As we offer an outline on the actions that policymakers should undertake, the solar sector is also clear on the political actions to be avoided. Considering trade defence measures on solar entering Europe is irresponsible and will not fulfil the need for a robust industrial policy. We are working hard to set European solar manufacturers on a path for solar growth and this must go hand-in-hand with the speedy deployment of solar. Working together, we can bring all segments of the solar sector to new heights.

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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.

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Executive summary

2023 marks another record year for solar PV in the EU, with 55.9 GW installed across the 27 Member States, showing a 40% growth from 2022 and a doubling of the market in just two years. This is the third year in a row that the EU market breaks its previous record, as well as the third year in a row with annual growth rates of at least 40%. This sustained growth can be seen as a continuation of the market dynamics taking place in 2022, when Member States acknowledged solar power as an environmentally friendly, cost-effective, and unparalleled rapid solution to diminish their reliance on Russian fossil fuels. The first months of 2023 were still under the full effects of the energy crisis, with elevated electricity price acting as a shock for citizens, businesses and policymakers.

Germany is now back as the largest solar market, installing 14.1 GW and surpassing Italy's 12-year-old record of 9.3 GW in 2012. Spain follows with 8.2 GW, while Italy entered the top 3 for the first time in a long while, installing 4.8 GW through the year. Poland (4.6 GW) and the Netherlands (4.1 GW) close out the top 5, with France dropping out due to Italy's ascent. In 2023, 20 Member States achieved their best solar year, and 25 installed more solar than the previous year. Market diversification is also growing stronger, with 14 countries exceeding 1 GW of annual installations in 2023, up from 10 in 2022.

The total EU solar PV fleet now amounts to 263 GW, up 27% from the 207 GW in 2022. Germany continues to be the largest contributor with 82 GW, trailed by Spain at 36 GW and Italy with 29.5 GW. While Germany leads both the EU annual market and total capacity ranking, the Netherlands retains its top spot in installed PV capacity per capita, reaching 1,280 W/capita in 2023 and improving by over 250 W/capita in a single year. Germany is nearing the 1 kW threshold, at 985 W/capita.

Looking ahead over the next 4 years, our prospects continue to show double-digit growth every year, but at somewhat lower levels than anticipated last year and considerably below the 40% annual increase experienced in recent years, due to changing market conditions. Over the course of 2023, prices have dropped significantly to record lows, driven by an increase in global production. While this is positive news for installations, the current conditions make for an extremely difficult business case for local manufacturers, and have triggered trade discussions that could potentially impede solar deployment.

As per our Medium Scenario, solar will continue its upward trajectory in 2024, reaching 62 GW with an 11% annual increase. This moderate growth rate is impacted by a decrease in residential demand, which had surged in the preceding 2 years due to the energy crisis. Simultaneously, legislative improvements are expected to take 1 or 2 years or more before impacts on large-scale utility plant developments might become apparent. Our research shows rooftop solar to dominate the market, though gradually declining over the coming 4 years; the energy crisis has created awareness among homeowners and businesses for solar as an effective solution to control their energy bills.

Looking ahead to 2025, we project a 19% growth rate, resulting in 73.8 GW of installations for the year, followed by 84.2 GW in 2026 and 93.1 GW in 2027. Under our High Scenario, the market has the potential to surpass 100 GW as early as 2026. But much more relevant seems our Low Scenario this time, which is characterised by the recently emerged threat of trade defence measures and additional challenges, and hardly sees any growth compared to today's levels with 58.7 GW by 2027. This is below the average of around 70 GW that solar is expected to deploy every year from now to 2030 to reach the REPower EU and solar strategy goals.

Our solar National Energy and Climate Plans (NECP) analysis has been updated, based on the new draft NECP published by EU Member States through the course of 2023. As of the editorial deadline of this report, 22 Member States have submitted a new draft NECP, while 5 updated plans are still missing. The increase in national solar ambition has lifted the aggregate NECP target by 76% to 591 GW by 2030 – a strong upswing that is, however, still significantly below the 750 GW REPowerEU target. By contrast, we anticipate 902 GW of solar capacity deployed in our Medium Scenario projection to 2030.

This report also provides further insights on grids and permitting challenges across EU Member States, the current state of European solar manufacturing, and detailed analyses of the 14 markets that reached the GW-scale in 2023, with the contribution of national solar and renewable associations.

Policy recommendations

Solar PV keeps booming across Europe. We are announcing the third consecutive record of new PV installations, and uninterrupted double-digit growth since 2016. The unsung heroes of these results are the thousands of companies building solar PV across Europe, and the hundreds of thousands of workers giving their best every day. They are nothing short of pioneers, delivering the energy transition on the ground, exploring new approaches and business models every day, to the benefit of Europe's energy security, climate goals and economic prosperity.

Taking any of this for granted would be a grave mistake. We see several trends coming together that require urgent attention. First, the market conditions for solar have been exceptional in the last few years, but these conditions are now changing, in particular due to the normalisation of energy prices and the current inflationary environment. Second, solar PV is hitting real system boundaries, limiting further growth and integration; and thirdly, we are still confronted with heavy permitting delays despite years of legislative action on that front.

The responsibility is back in the hands of EU leaders and local decision-makers to maintain the pace of solar PV deployment and keep it on track to reach the REPowerEU and solar strategy goals for 2030. Looking at the new NECPs, Member States are clearly counting on solar PV to deliver. Solar ambition has increased from 335 GW in the 2019 NECPs to 591 GW in the 2023 NECPs. This is welcome news and a tribute to our industry's reputation and potential. It is, however, not enough to reach the 750 GW (600 GW_{AC}) target, which necessitates higher ambition from several Member States. Moreover, it is very important that these pledges are accompanied with concrete policy and investment plans – plans we are currently not seeing in sufficient volume or quality. The coming year will be crucial to land the last Fit For 55 policy files and engage in fast-track implementation. It also provides a window of opportunity to look ahead and develop an action programme for the next step in the energy transition (see our Manifesto at pg. 11).

While we celebrate another record year, we should also not lose the perspective that solar PV is just doing the minimum of what is needed to keep the door open to a 1.5 °C climate safe world and a Net-Zero Europe well before 2050. **As EU leaders ask the solar sector to break records every year at breakneck speed, they shall also pay attention to our needs.**

1. **Maintain an investment-friendly environment for solar PV, especially now that market conditions are changing.**

   Thanks to the incredible technology and production breakthroughs, solar PV has reached record-low LCOE (levelised cost of electricity) in recent years, making it the cheapest and fastest-growing energy source in the world. We must, however, not lose sight of the factors affecting the economics of solar PV.

   First, **inflation**, reinforced by the EU monetary policy choices, is impacting the cost of capital for solar developers. Solar PV is a capital-intensive investment – more than 75% of the price of a solar electron is capital costs, determined at the investment stage, and directly impacted by rising cost of materials. And half of that capital cost is cost of money – itself impacted by recent decisions of the European Central Bank (ECB) to increase its interest rates to more than 4%. Although this does not affect the competitiveness of solar PV in the long term, it is impacting and delaying solar project financing right now. **Solutions exist at the ECB level to lower the cost of capital for green investments, or simply at the national level by indexing auction design and results to inflation.**

   Secondly, while the sector is achieving record-low LCOE, the question shifts to the market value of solar electricity, i.e. the ability to produce electricity in ways that have value for the energy system. This summer, we have seen an unprecedented number of 'negative' hours, resulting in revenue uncertainty for developers, with Contracts for Difference (CfDs) stopping in such times of negative prices. **It is a sign that the energy system needs to adapt – by better linking electricity demand to generation, and by making generation more flexible and storable to respond to demand.** In the meantime, however, the economic framework should not give the wrong signals to investors in the transition period. CfDs should ensure revenue stability to developers even as negative price signals increase.

2. **Bring grids and flexibility investments to the next level, especially at the distribution level.**

According to the 2023 IEA Electricity Grids report, more than 50 million km of electricity grids need to be built and around 30 million km reinforced between today and 2040, especially at the distribution level. That is more than double the annual rate in the last decades. Building grids takes several years, often more than ten years for high-voltage grid infrastructure – in part due to long and inefficient permitting processes.

Grid operators must also look beyond adding new lines and take steps to modernise and digitalise its operations. Grid-connection procedures, in some cases, still require filling out paper forms, resulting in cumbersome and non-transparent application processes, which can take up to eight years (see Box 3 at p. 28). Grid operators also need to speed up the rollout of smart grid technologies and Big Data analytics infrastructure.

EU storage and flexibility capacity is not growing fast enough. The European Commission Joint Research Center calculated that flexibility solutions need to grow by a factor of two before the end of the decade. SolarPower Europe has estimated that 200 GW of battery storage capacity needs to be installed by 2030, but current projections estimate less than 130 GW by that time.

We need to deal with all of the above challenges urgently. That requires an **EU action plan on grids and flexibility**, primarily focused on accelerating implementation, and drives forward new concepts with respect to **(1) reinforcing the governance of the EU grids policy:** the EU energy infrastructure policy primarily tackles cross-border energy projects. We need new governance tools, based on national indicators on the grid situation, to better monitor decentralised infrastructure, and support swift implementation and **(2) investing smartly into the grid through efficient, participatory, and anticipatory planning:** connecting more renewables will also need more grid investments. Where grid reinforcement is necessary, permitting of grid infrastructure can be a bottleneck. Actions to ensure a consultative and efficient grid deployment are needed.

3. **Grow the pool of certified installers and skilled workforce.**

The solar sector employed around 648,000 people in the EU in 2022. In order to reach the EU's 2030 solar deployment targets, this number must reach 1 million by 2025, and 1.2 million by 2027. **Skilled workers are in high demand in every corner of the continent, particularly for installation works – the wait times last up to a year in certain regions.** Some worries have emerged as to the qualifications of workers involved with installations, and the movement of workers to and within Europe is still too burdensome. We suggest that policy and industry tackle those challenges head on, together.

First, we must rehabilitate technical education and jobs. Working along with governments, we must amend our education systems and launch communication campaigns for a better consideration of technical schools. Those must also be staffed with more skilled teachers, and better bridges can be built from various education streams into vocational education and training (VET).

Second, we stand ready to work with the European Commission and any other interested stakeholder in the solar and educational sectors to **develop standardised training material for solar workers, especially for installers.** This would accelerate the training of workers, improve their solar-specific skills (for safer and better-quality work), and allow for the recognition of a single training standard by all parties involved, including authorities, companies, insurance and the ultimate client. This approach also facilitates career changes and upskilling into the solar sector, for example from the construction, telecom, electrical or fossil fuel industries, and from the solar sector into heat pump, EVs or other complementary applications.[1]

Finally, Member States must ramp up their efforts to facilitate the movement of workers, for example by mutually recognising certification schemes. Ministries must consider this as a priority to smoothen the posting of workers, or to employ local and immigrant workers in international projects. We also encourage European institutions to **place solar among the key sectors as part of the new Pact on Migration and Asylum, via the Talent Partnerships and Talent Pool.**

1 More information on our initiatives on this topic are available on the SolarWorks Platform website: https://www.solarworksplatform.org/

Policy recommendations

4. **Time to improve renewables planning and permitting; time to implement what was agreed.**

   While several Member States have made progress on improving permitting processes, most are still lagging. Many Member States are yet to define deadlines for the permit-granting process or set up one-stop-shops and granting access to digital procedures, which have been mandatory for years under the 2018 EU renewables directive.

   The same is true for the Renewable emergency regulation from last year, the so-called 'RES Booster package' in response to the energy crisis, where more than half of the Member States still need to designate renewables as overriding public interest, define simpler rules for repowering or implement the principle of positive silence for small-scale installations. On a positive note, it is good to see that most Member States have introduced the principle of simple notification for rooftop installations.

   Member States need to swiftly transpose the provisions they agreed to and provide certainty to investors, or find themselves exposed to legal challenges from project developers. It is now time to do that, to define renewable acceleration areas and to carry out comprehensive mapping of favourable areas.

   Scaling up multiple uses of land is an opportunity to accelerate the achievement of the EU's climate objectives while ensuring secure and just energy transition. **Member States should therefore encourage and promote the multiple use of space, including applications like agrivoltaics, floating PV and nature-inclusive PV through harmonised policy frameworks.** Member States should, in particular, encourage the development of designated agrisolar policy frameworks and accompany these policy frameworks with clear agrisolar and agrivoltaics definitions. Establishing a regulatory environment can provide security for investors and assurance for the solar and farming sector. In addition, Member States should promote agrisolar and agrivoltaics in their National Strategic Plans for Common Agriculture Policy and National Climate and Energy Plans to provide additional security and clarity for the farming sector, among others.

5. **Scale-up sustainable and diversified solar PV supply chains.**

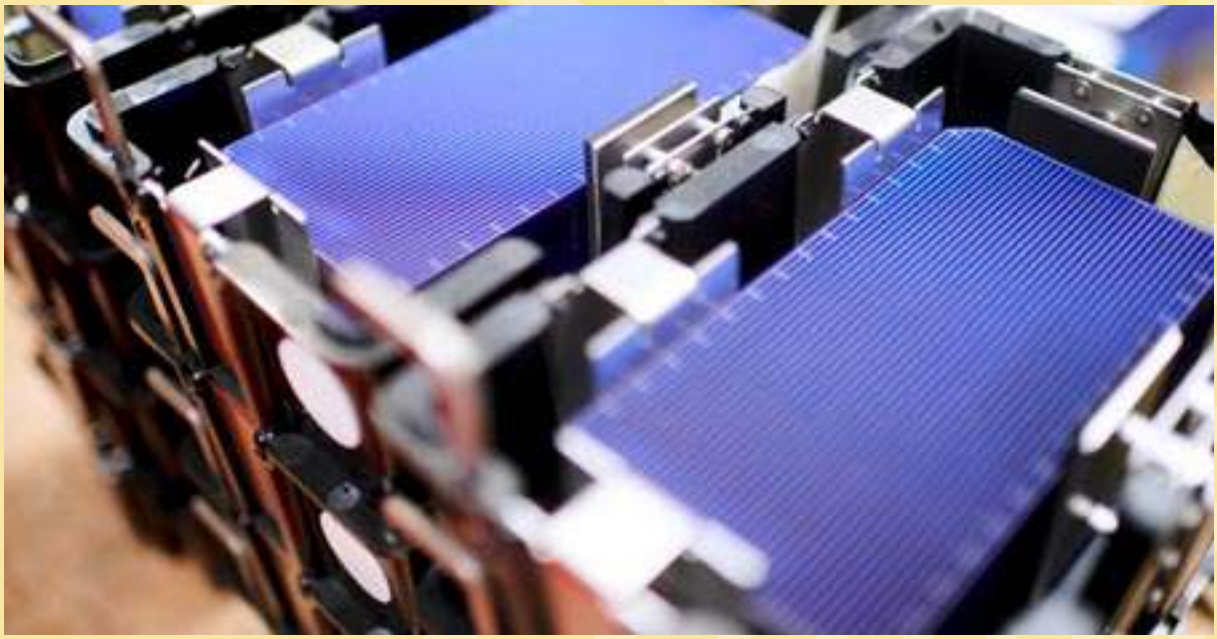
   2023 was the year of the Green Deal Industrial Plan, bringing a new industrial policy agenda to Europe, including the goal of reshoring at least 30 GW of solar production in Europe by 2030. This is very welcome for the solar sector given that Europe does not have a strong manufacturing industry and is highly dependent on imports along the supply chain. The current low module prices, while welcome for accelerating solar deployment, are making it harder for European solar PV manufacturers to scale up and reach the 2030 goals. It makes it even more important for EU decision-makers to take swift action and **land a smart and robust industrial policy for scaling-up solar PV production in Europe.**

   Unfortunately, the financing and legislative proposals are not living up to the needs and expectations as yet. Within the context of the European Solar Industry Alliance (ESIA), SolarPower Europe has been calling for three concrete and swiftly implementable solutions:

   1. **Adjust the State Aid rules under the Temporary Crisis and Transition Framework to also cover the running cost of factories (OpEx) and reduce complexity.** The experience of the German government call of interest for 10 GW of solar manufacturing, which is still not finalised as it is lacking financing, has shown the limitations and complexity of the current State Aid rules and is not necessarily setting an attractive example for other Member States to follow;
   2. **Set up a small but growing segment of resilience auctions within the Net-Zero Industry Act.** The key here is to get the segment right and phase-in resilience criteria in public auctions to reflect the scaling-up of European solar manufacturing capacity towards 30 GW in 2030;
   3. **Accompany national financing with an EU-level financial tool for solar manufacturing**, like a **Solar Manufacturing Bank**, based on the concept of the Hydrogen Bank but adapted to the needs of the solar sector. The Bank can be linked to the Innovation Fund, like the Hydrogen Bank, but ideally would be linked to a new **EU Sovereignty Fund**. This was another key financing tool for the Green Deal Industrial Plan that EU leaders have yet to deliver on. It is time for EU leaders to step up and act on our proposals.

These industrial strategy solutions need to be accompanied with clear market access standards that reflect Europe's Environmental, Social and Governance (ESG) values. We, therefore, look forward to the first ever Ecodesign rules tailored to solar PV, as well as the upcoming Forced Labour Ban Act and the Corporate Sustainability Due Diligence Directive. Together, these legislative initiatives can help global solar PV supply chains become even more sustainable, transparent and free of any links to forced labour. To speed up the effective and practical implementation of these regulations, the solar sector has recently launched the Solar Stewardship Initiative (SSI), a solar-specific value chain assurance system to enhance ESG performance and transparency across the global solar value chain. **We call on EU decision-makers to recognise the SSI and other multi-stakeholder initiatives in the relevant legislation.**

The above points together form a coherent and constructive policy answer to scaling up sustainable and diversified solar PV supply chains. **Trade defence instruments are not part of the solution. As history has shown, investigating and implementing trade barriers on solar is the ultimate lose-lose strategy for Europe.**



: Meyer Burger AG solar cells. © SolarPower Europe

Policy recommendations

BOX 1: SOLAR FOR EUROPE MANIFESTO

10 Actions for the next 5 years

Solar power is the energy of the future. Soon, solar will be the largest source of electricity in the EU. In 2022, the EU installed 40 GW of solar capacity - equivalent to powering 12 million more EU homes. With the right policy action, solar can reach, and even outperform, REPowerEU ambitions for 2025 and beyond. Through this manifesto, SolarPower Europe calls for concrete steps, drawing attention to five priorities for the EU energy agenda in the next five years.

Accelerate solar PV deployment

1. Deliver 2030 targets, in particular by aligning EU financial instruments with climate and energy goals, including a new Green Investment Plan as part of the next EU budget post-2027.
2. Set 2040 targets as soon as possible to give visibility and confidence to investors.

Improve solar PV integration in highly electrified energy systems

3. Propose a new EU Electrification Action Plan, including legislative action on grids, hybrid renewables, prosumers and cybersecurity.
4. Propose a new EU Skills for the Energy Transition Strategy.

Promote solar solutions in harmony with the environment and society

5. Land an urban renewables strategy with cities and communities.
6. Land a rural renewables strategy for ground-mounted and agri-PV with landowners and agriculture constituencies.
7. Embark on an EU-wide renewables communications campaign to ensure public support for the energy transition.

Build up diverse and sustainable solar PV supply chains

8. Substantially increase support for reshoring solar supply chains to Europe.
9. Embark on multiple international partnerships on solar supply chains and raw materials, leveraging the Global Gateway Initiative.

Secure EU's leadership on solar PV innovation by expanding R&I funding

10. Double R&I funding for innovation in PV, via programmes including Horizon Europe and the European Innovation Council.

Read the full Solar for Europe Manifesto here.

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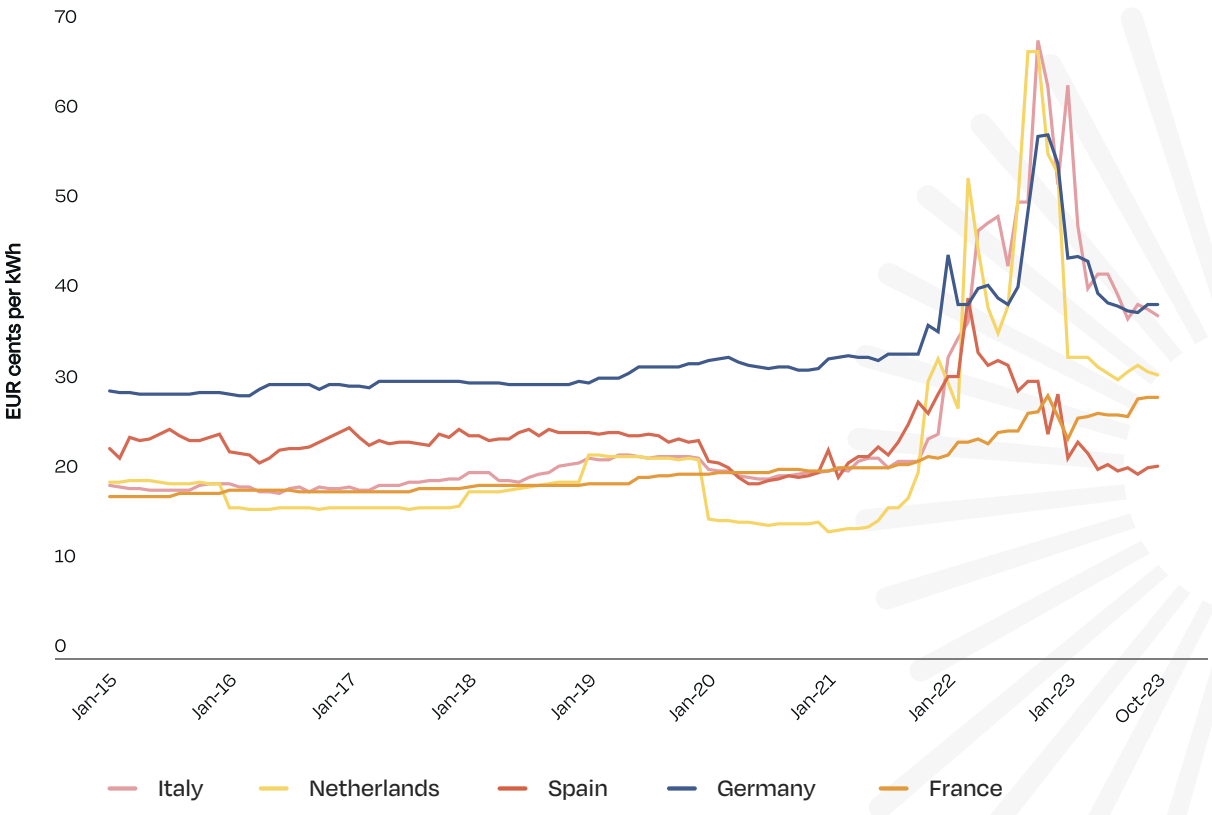
1 EU solar markets 2023

175 MW Don Rodrigo solar park, Seville, Spain. © BayWa r.e.

In 2023, EU solar PV markets surfed the wave generated by political and energy shocks that emerged in 2022. The surge in electricity and gas prices and the fear of energy supply outages fueled by the Russian invasion of Ukraine resulted in severe energy security concerns and put solar in a completely new light, making 2022 the year of solar PV acknowledgment as a pivotal, cost-effective and

FIGURE 1 RESIDENTIAL ELECTRICITY PRICE IN GERMANY, SPAIN, ITALY, THE NETHERLANDS AND FRANCE, 2015-2023



SOURCE: Household Energy Price Index, 2023.

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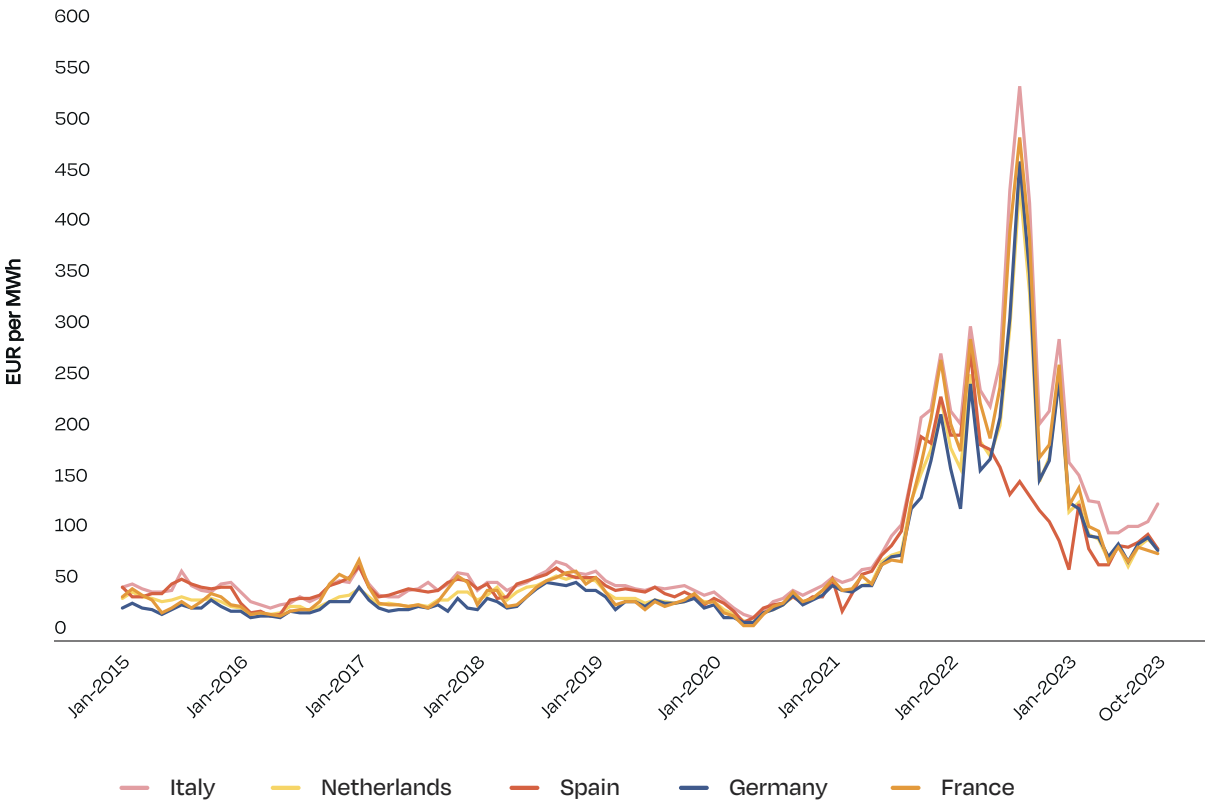
rapidly deployable technology for generation of power. More than ever, Europeans discovered the potential of solar power to electrify their heating systems via heat pumps.[2] Many European policymakers recognised solar as a crucial tool to enable citizens' access to electricity that is both green and affordable. In 2023, the impacts of this paradigm shift have become even more apparent – with new record installations across the European Union but many challenges ahead.

The demand for solar PV in the beginning of 2023 was still soaring, as many orders placed in 2022 only came to realisation in the course of 2023. However, compared to the peak of the crisis in 2022, the price of electricity has lowered significantly throughout 2023. In Germany, for example, the price of residential electricity increased to 58 EUR cent/kWh in October 2022 and fell sharply within 12 months to 39 EUR cent/kWh (Fig. 1). While still higher than pre-energy prices, the perception of urgency has declined, in particular as the fear that lights go out has vanished. Combined with high inflation rates, the demand for residential solar PV slowed down in the second half of 2023.

A similar trend can be observed in the wholesale electricity market price (see Fig. 2).

FIGURE 2 WHOLESALE ELECTRICITY IN GERMANY, SPAIN, ITALY, THE NETHERLANDS, AND FRANCE, 2015-2023



SOURCE: Ember, 2023.

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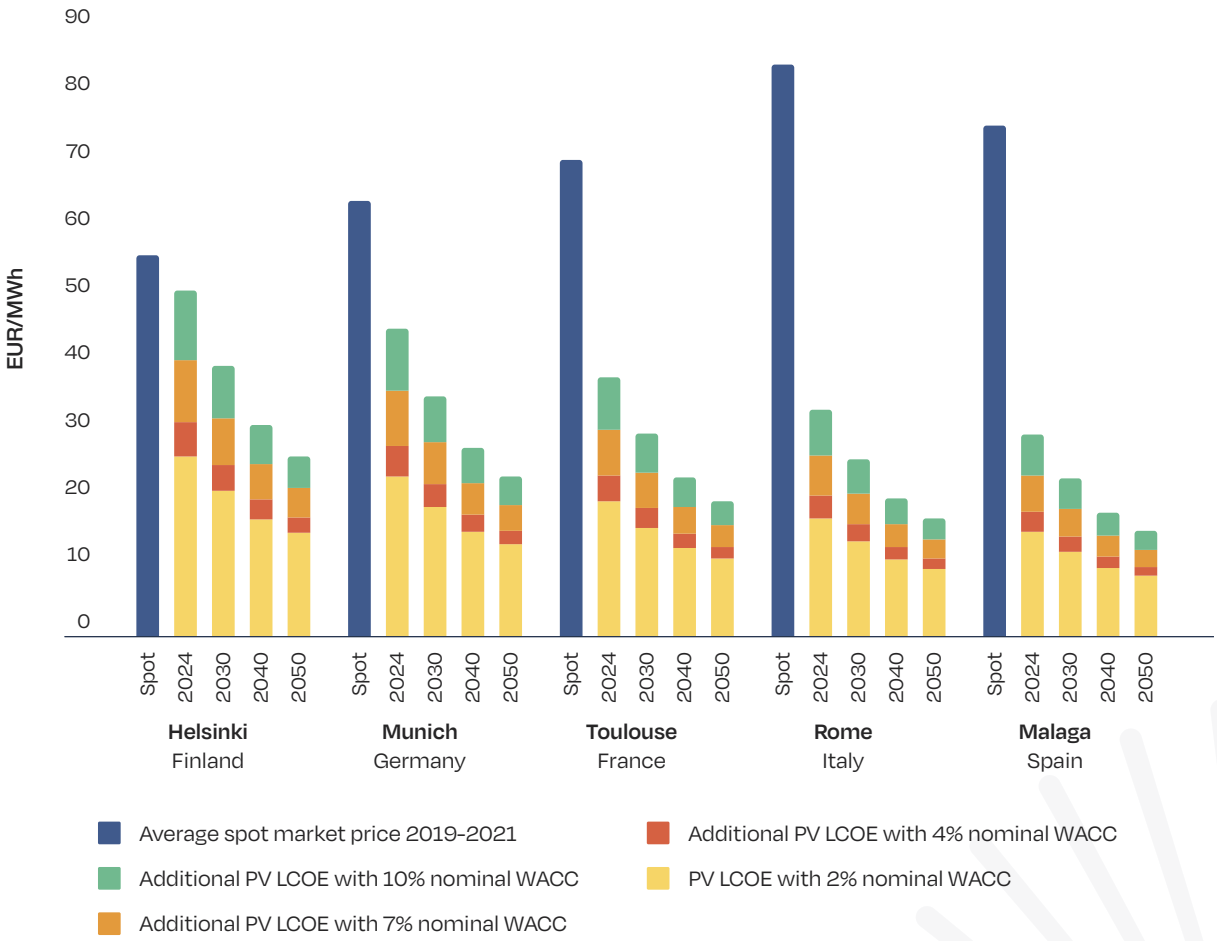
2 SolarPower Europe: SolarPowers Heat 2023 Report. https://www.solarpowereurope.org/insights/thematic-reports/solar-powers-heat-2023-2

FIGURE 3 UTILITY-SCALE PV LEVELISED COST OF ELECTRICITY (LCOE) UNDER DIFFERENT EU LOCATIONS AND INVESTMENT CONDITIONS



SOURCE: ETIP PV, 2023.
NOTE: Assuming a 100 MW PV project.

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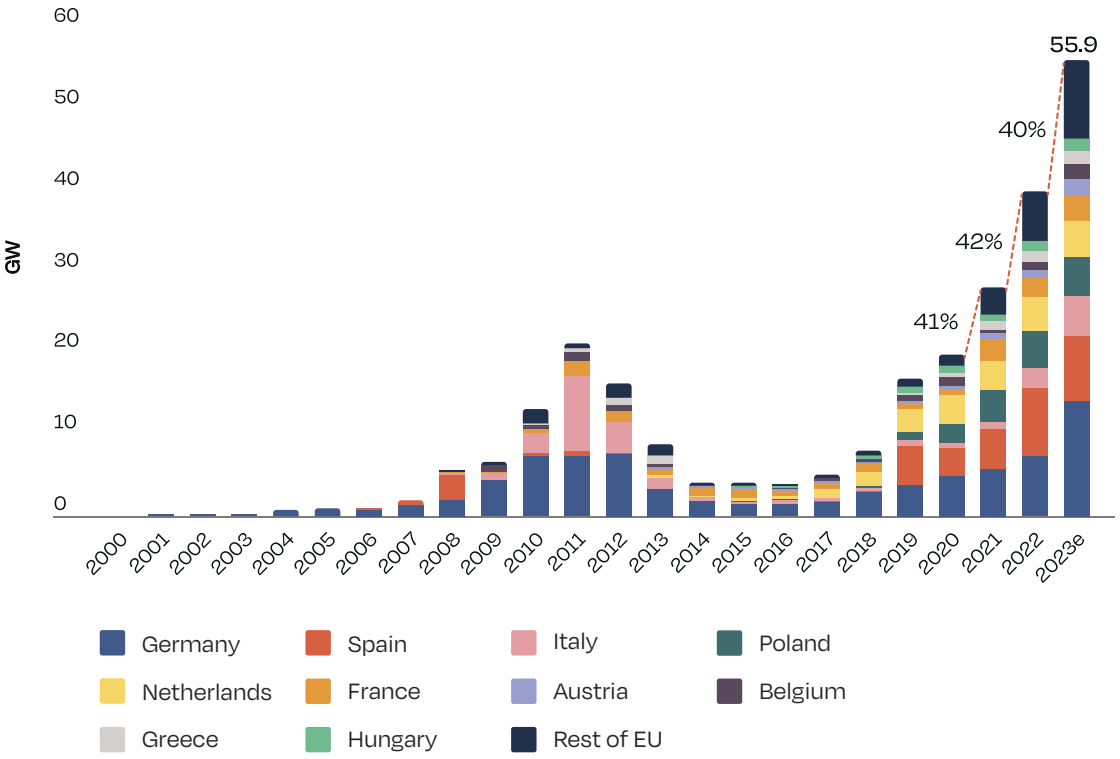
Still, even with electricity wholesale prices returning to levels in the range of the 2019-2021 period after the 2022 hike, solar's LCOE is comparatively low – and investments in large-scale power remain attractive in many EU countries at today's higher interest rates if it were not for difficult financing, permitting and grid connection conditions (see Fig. 3).

FIGURE 4 EU ANNUAL SOLAR PV INSTALLED CAPACITY 2000-2023



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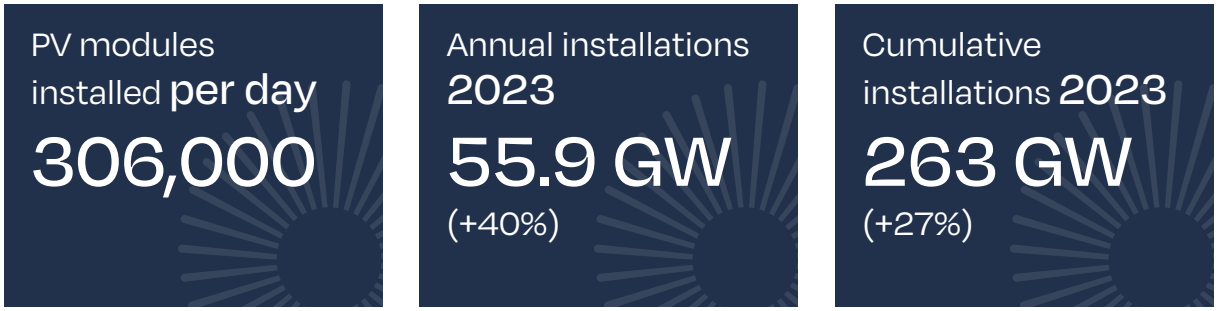
As a result, 55.9 GW of new solar PV was installed across the 27 Member States, a 40% growth rate from 2022 levels, and, for the third year in a row, a new record (see Fig. 4 & 5). What is striking to note is that, for the third year in a row, the EU-27 annual market has grown by at least 40% year-on-year. This performance also marks the 6th year in a row the EU market has grown compared to the previous year. Looking back at the start of this streak, in 2017, the market size was as low as 5.1 GW, less than one-tenth of today's volumes. Only after lifting the trade defence measures on solar PV in 2018, the market started growing strongly.

In our previous EU Market Outlook 2022-2026, published in December 2022, our Medium Scenario estimated installed capacity to grow to 53.6 GW in 2023. That estimate was slightly increased to 53.8 GW in our June released 2023 Global Market Outlook 2023-2027.[3] Now, we have further raised the expected installation volume for 2023 by roughly 2 GW.

The annual installation figure for 2023 is estimated from monthly and quarterly capacity additions observed until November 2023 and based on current and expected market developments. Although the consolidated figures will only be available in the first half of 2024, 2023 data is considered as historical in the forward-looking analysis of this report.

3 https://www.solarpowereurope.org/insights/market-outlooks/global-market-outlook-for-solar-power-2023-2027-1

FIGURE 5 EU SOLAR PV INSTALLATIONS IN 2023



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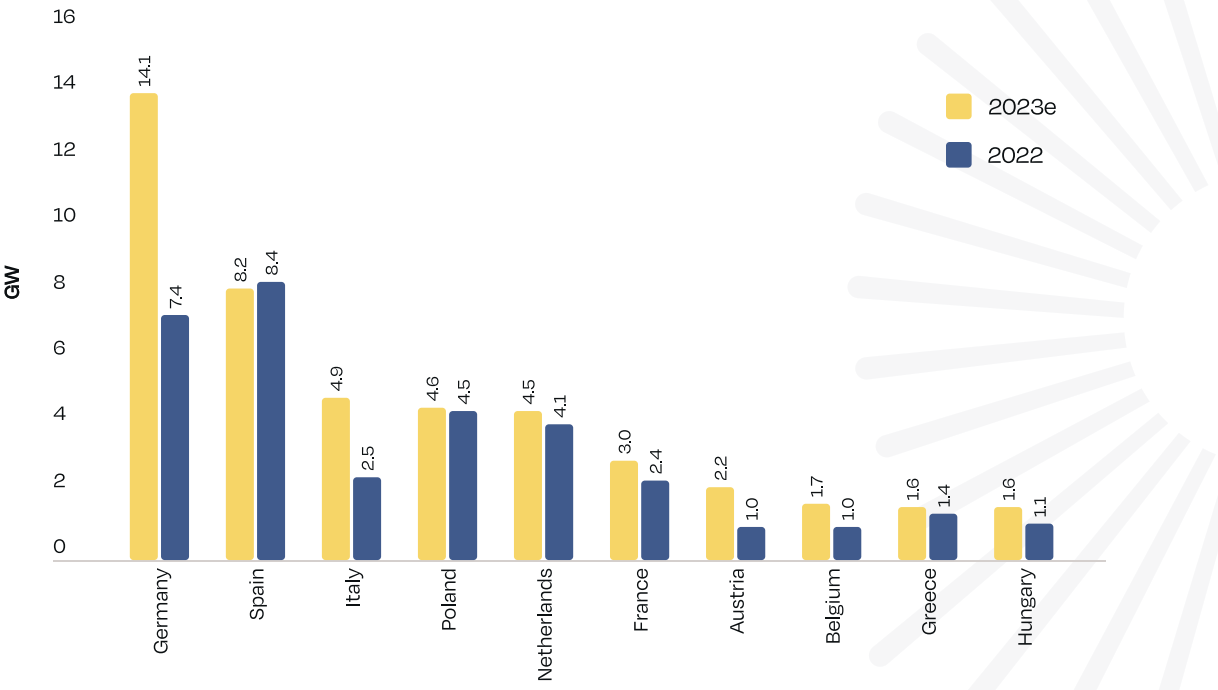
Top 10 EU solar markets in 2023

Both the order and composition of the EU-27 top 10 markets have changed in 2023. There is a new market leader, partly different country listings and changes in rankings. Missing from the list in 2022, Belgium is back in the top 10 markets in 2023, replacing Denmark.

Further countries that have not made it are Portugal and Sweden, which were anticipated to join the 2023 top 10 in last year's EMO but ended up installing less capacity than needed. Each of the 2023 top 10 countries has added over 1.6 GW new solar capacity; in 2022, only 1 GW was enough to join that list (Fig. 6).

FIGURE 6 TOP 10 MARKETS 2022-2023



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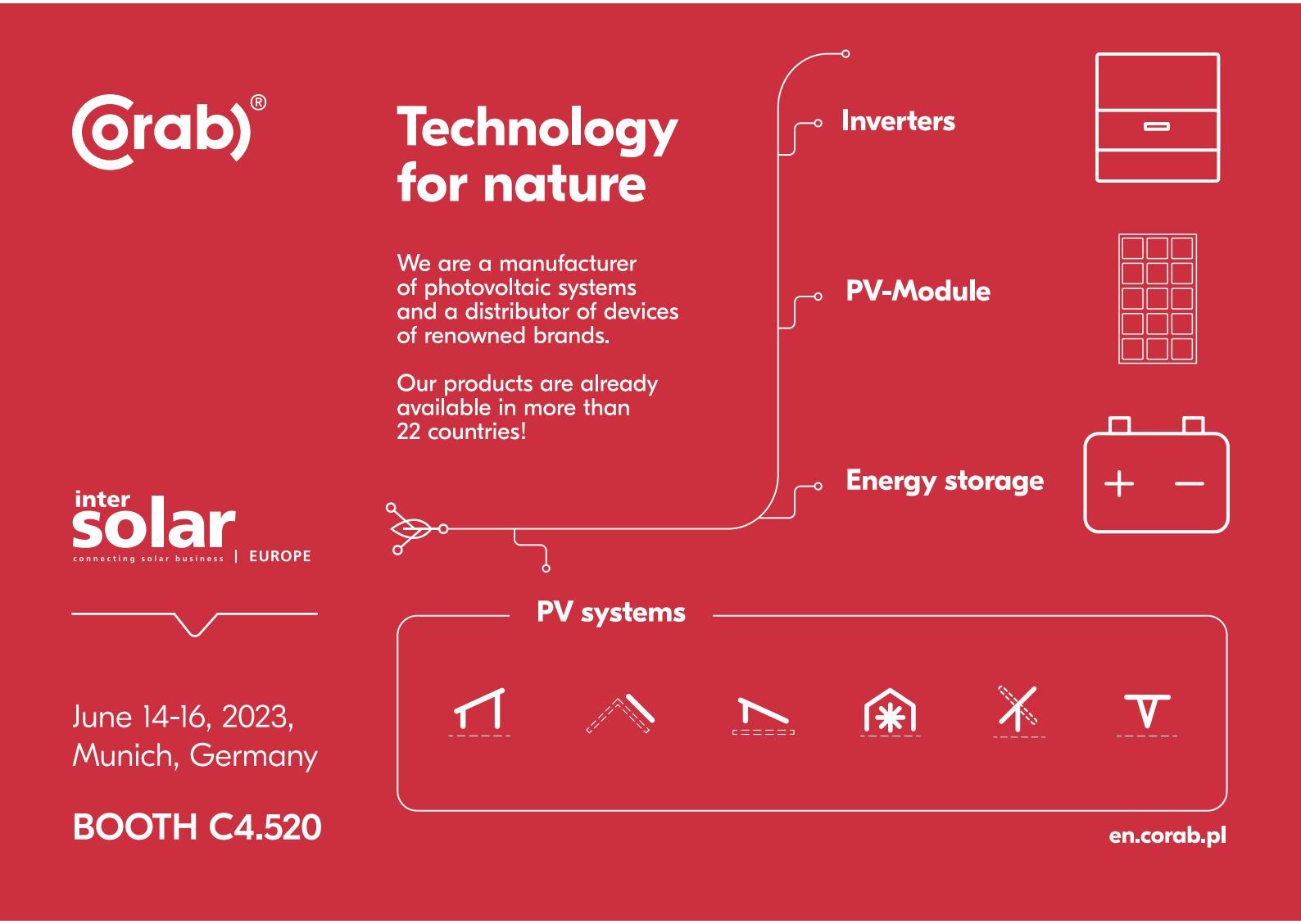
The new #1 is **Germany**, which returned to the top spot it had held in 2021 and 20 times since the start of the century. Already by end of August 2023, the country had installed 9 GW, that's as much capacity as targeted by the government for the entire year. By the end of October 2023, the country had grid-connected 11.7 GW, adding more than 1 GW installed per month since March. According to our Medium Scenario, Germany will reach over 14 GW by the end of 2023. This marks the first time a European country's annual installations have exceeded the 10 GW mark, breaking the 12-year record held by Italy, which grid-connected 9.3 GW back in 2011. The revision of the Renewable Energy Sources Act (EEG) in July 2022 took full effect at the beginning of 2023 and has been supporting the implementation of Germany's huge pipeline stemming mostly from the 2022 crises. Improvements include a raise in feed-in tariffs for new rooftop systems and a halt in monthly reductions of feed-in rates for new systems until the end of 2024, among many others. Also, no VAT has to be paid for solar systems as of January 2023.

Spain comes second with 8.2 GW newly installed capacity in 2023. After the spectacular 76% year-on-year growth to 8.4 GW in 2022, which catapulted it to 1st place, the southern European country is expected to face a slight market decrease of 3% in 2023, the only decrease among the top 10 EU markets. The residential segment, which peaked in 2022 at close to 3 GW during the height of the energy crisis, declined by around 15% in 2023. Additionally, long delays in subsidy payments



have damaged the public perception within Spain's very young solar rooftop segment. While quickly decreasing module prices backed demand in the nascent commercial and industrial (C&I) segment in the second half of 2023, ground-mounted PV parks have remained the workhorse of the Spanish solar sector, mostly realised in form of Power Purchase Agreements (PPA), underlining the country's position as a global market leader in the field of subsidy-free solar. However, grid-connection constraints for the huge utility-scale pipeline combined with today's high interest rates and falling wholesale prices have limited utilisation of this gigantic potential in 2023 as well.

One of the largest growing EU solar markets this year was **Italy** which installed 4.9 GW in 2023. This is nearly double the 2.5 GW installed in 2022, when one of Europe's solar pioneers first re-entered the GW scale, a milestone that wasn't achieved since 2013. Within the EU, only the Austrian market has a slightly higher growth rate this year. Italy jumped two positions compared to 2022 and enters the top 10 for the first time in a decade. In previous years, the residential segment had played a crucial role in driving the Italian solar market, primarily due to its generous Superbonus incentive scheme. But the subsidy programme, which offered homeowners a tax credit of up to 110% for installing solar PV among others, was strongly amended in 2023. While residential installations decreased from the monthly peak of 200 MW in March to 153 MW in October, this segment contributes still a significant share of around 40%. The major base for Italy's solar growth is provided by the C&I sector, which is responsible for about 43% of the installed capacity in 2023.

Poland's solar market basically kept its size at 4.6 GW in 2023. But the only 1% increase from 4.5 GW in 2022 was not enough to secure its third rank; in 2023, it dropped a place to fourth. Historically, the residential sector was the key driver for Poland's emergence in the European solar map; the introduction of a net-metering scheme in 2016 catapulted the country into the group of Europe's top solar markets. When this scheme transitioned from net metering to a less attractive net-billing programme in April 2022, it had no substantial impact on overall solar deployment in that year, as a final run on subsidies partly compensated for those months post net metering. The lower demand for residential solar became only fully visible in 2023, when the attractiveness to invest in solar had worsened for consumers not only through less attractive incentives, but it also coincided with falling electricity prices after the end of the energy crisis. Consequently, the share of new residential solar installations decreased from 71% in 2021 to 60% in 2022 and to around 30% in 2023, whereas the larger PV systems segment – both on rooftops and ground-mounted – seems to be growing faster.

The **Netherlands** dropped one place to rank 5 in 2023, after it installed 4.5 GW of new capacities, a 10% increase compared to 2022. Its solar market is largely based on a consistent net-metering policy for the residential sector and an auction programme for larger rooftop and ground-mounted systems. The residential rooftop market slightly contracted to 41% or 1.8 GW of the 2023 total, after the energy crisis had pushed this segment to record levels the year before. While both C&I and ground-mounted solar both gained shares, these systems are both facing grid congestion issues. Large parks also have to deal with severe space constraints, which the industry explores to overcome through multifunctional PV applications like Agri-PV, floating solar, and solar carports.

France remained at the 6th position, even though it recorded a 25% growth. But the new addition of 3.0 GW, up from 2.4 GW in 2022, was still significantly too low to enter the top 5. Self-consumption at the residential level has notably expanded, largely in response to the energy price crisis. The larger rooftop segments also continue to benefit from a policy framework revision in autumn 2021, which raised the rooftop tender threshold from 100 to 500 kW and broadened eligibility for feed-in tariffs. The primary driver of solar PV growth in the country remains its regular solar technology-specific tenders. But legislative challenges and difficulties accessing lands have led many developers to delay projects, constraining France's ability to unleash its large solar potential.

A 114% market increase resulted in 2.2 GW new solar capacity, lifted **Austria** to the 7th position among EU solar markets. Thanks to that outstanding performance – the highest growth rate across the top 10 markets – Austria improved by 3 places in the ranking, only one year after entering this group and breaking the GW-scale for the first time. The majority of new installations are attributed to residential and commercial rooftop systems, backed by subsidies available to various size categories. Additionally, large-scale projects are on the rise, particularly in the form of ground-mounted PV and Agri-PV, as four states have now identified designated areas for this segment.

Belgium's PV market experienced a thriving year, recording 1.7 GW newly installed capacity and 72% growth over the 2022 additions of 985 MW. This highest annual installation capacity recorded so far moved Belgium up 3 ranks to 8th place in the 2023 rankings. It also marks the third instance Belgium surpassed the 1 GW milestone after 2011 and 2020, albeit by a lower margin. Over three-quarters of the country's new grid-connected PV installations were realised in Flanders, mostly in the residential and commercial rooftop segments. The end of net metering in December 2023 in Wallonia led to a surge in residential installations during the last quarter of 2023. Similarly, Flanders will transition away from net metering to a nearly subsidy-free market starting from 2024.

At 9th place, **Greece** confirms its presence amongst the key EU solar PV markets. After it crossed the GW threshold in 2022 for the first time with 1.4 GW installed, the Greek solar market grew by 20% to more than 1.6 GW in 2023. This increase was primarily propelled by small ground-mounted PV projects up to 500 kW. Simultaneously, both the utility-scale and residential segments saw growth – the former supported by an auction scheme and simplified authorisation procedures.

Securing the final spot in the top 10, **Hungary** witnesses the most successful year in history for its solar sector. Annual additions reached 1.6 GW by the end of 2023, a 45% growth from the 1.1 GW recorded in 2022. The residential sector experienced a strong increase in demand as of the end of 2022, following announcements to prohibit prosumers feeding solar PV electricity into the grid from the beginning of 2023 due to reported distribution grid constraints. Consequently, the bulk of residential installations in 2023 resulted from the massive order volume placed in the previous year. This, in addition to the removal of the net-metering scheme, contributed to a gradual decline of new system installations throughout 2023. Next to the residential surge, several large-scale utility plants became operational in 2023, with a few more under construction. Yet, the grid infrastructure needs to be enhanced faster to allow for large-scale projects to be built in the future.

The EU top 10 solar markets account for 83% of total installations in 2023, a slight 3 percentage point decrease from their 86% share in 2022, and 89% in 2021, indicating a declining market concentration. This is not a new trend. The top 10 market concentration has been slowly declining over the past decade. Together, these countries installed 46.3 GW in 2023, compared to 34.4 GW in 2022. Concurrently, the top 5 solar markets lost shares as well, capturing 65% of the market compared to 67% in 2022 and 75% in 2021. This decrease in the shares of top market groups is good news as it indicates the emergence of solar power in many EU Member States and that the sector continues

92.7 kW, Hertogenbosch, the Netherlands.

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to diversify, which can also be seen in the GW-markets chapter, where a record number of countries reached that level in 2023 (see p. 82).

Looking beyond the leading solar markets at the overall picture of the EU-27, we indeed see increasing activity. Figure 7 illustrates a heatmap showcasing annual installations in each country, where darker shades indicate higher annual installations compared to the national historical average since 2000. The map underscores the substantial growth experienced by most European countries over the last three years. Around three quarters or 20 countries experienced their best year in 2023, compared to 17 countries in 2022. Moreover, 2023 stands out as the second-best year for solar deployment in five countries – the Czech Republic, Italy, Luxembourg, Romania, and Spain. Denmark and Slovakia recorded their third-best year for annual solar PV installations in 2023. This implies that, for any EU Member State, 2023 ranks among the top three best years ever.

FIGURE 7 ANNUAL MARKET HEATMAP 2000-2023

BOX 2: RES BOOSTER MEASURES, 1 YEAR AFTER – A STOCKTAKE

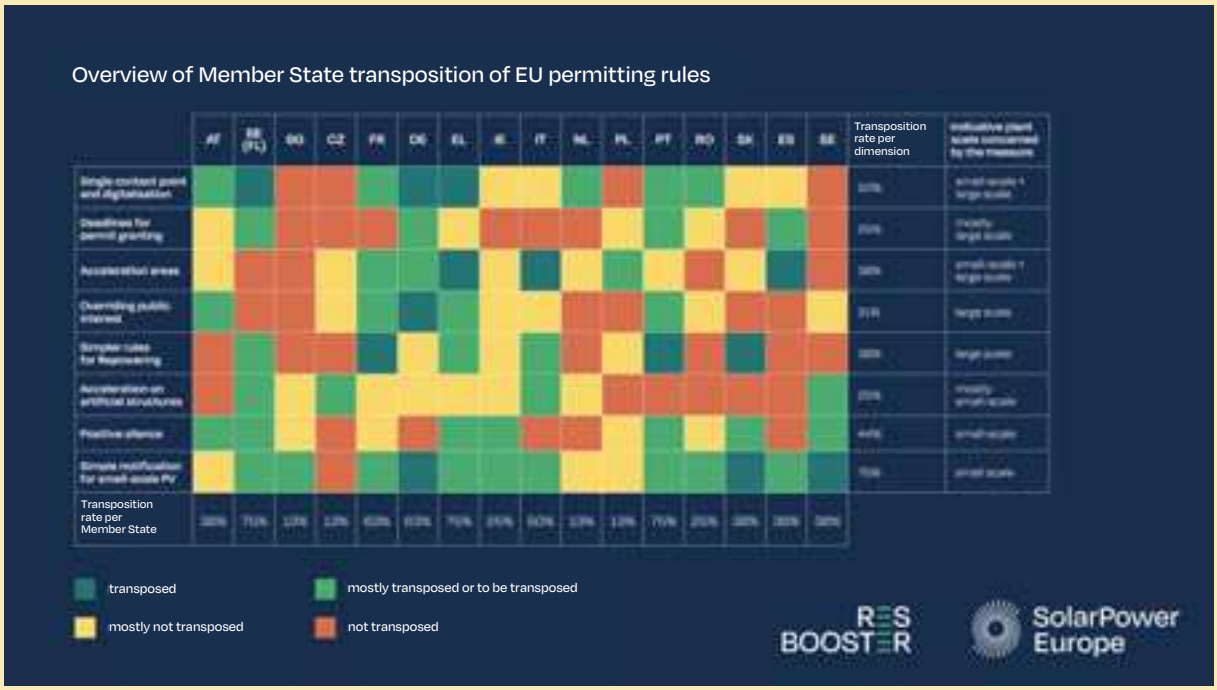
In December 2022, the EU agreed on Council Regulation 2022/2577 laying down a framework to accelerate the deployment of renewable energy, also known as the RES Booster. This was part of the immediate actions taken by the EU to accelerate the deployment of renewable energy sources in the short term to decrease the EU's dependency on Russian fossil imports. The main purpose of this emergency regulation was to significantly and exceptionally accelerate the deployment of renewable energy assets.

The emergency regulation has shed new light on the challenge of renewable energy permitting. We have seen more straightforward action to solve permitting bottlenecks, with out-of-the-box solutions to support faster delivery and approval of permits and a decisive political support to local administrations in charge of getting permits done. Member States have made substantial progress in the digitalisation of processes and in introducing single contact points. We have also seen a number of measures which have simplified the permitting procedures for rooftop PV.

However, we still have a structural lack of human resources and digital infrastructure to process permits needed for more renewable capacity, and these won't be solved overnight. On top of it, some provisions which were supposed to reconcile a swift solar deployment with environmental considerations have not been well implemented on the ground. It is the case of the principle of 'overriding public interest' that is partially or fully not implemented nationally, as well as the case of acceleration areas that sometimes leads, on the ground, to creating de facto no-go areas or areas not commensurate with the solar PV targets.

Our detailed analysis is available here. The main results can be summarised below.

FIGURE 8 OVERVIEW OF MEMBER STATE TRANSPOSITION OF EU PERMITTING RULES



DISCLAIMER: This analysis reflects the level of transposition in early 2023. It applies to the inclusion of these measures in national law rather than the physical implementation on the ground.

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1. **Single contact point and digitalisation**

   The implementation of a single contact point for the permitting process and of digital procedures has made progress. In particular, AT, BE, FR, DE, EL, NL, PT and RO have been able to implement it without too many restrictions or exceptions. And among these, only BE, DE and EL have fully implemented this dimension (although in the case of DE, lower authorities do not always, in practice, have all the technical equipment necessary, nor the trained employees, to process permits in a digital form).

2. **Deadlines for permit-granting**

   The vast majority of Member States do not have specific deadlines for permit-granting, penalties associated with delays, nor 'silence means agreement' rules. In addition, where deadlines are enshrined into law, the lack of appropriate staffing hinders meeting the deadlines effectively. BE, DE, PT and ES are the only ones that have implemented dedicated permitting reforms that have significantly accelerated project permitting.

3. **Acceleration areas**

   Member States have been advancing in defining their procedures to set up acceleration areas, leading in some cases to no-go zones for renewables. Some countries (such as FR, DE, PL) have at least a set of minimal rules, while EL, IT, and ES have fully implemented this provision. Yet, implementation can be difficult, with the creation of de facto exclusion zones like in France, Ireland, or Italy. In a number of countries, the process of designing the acceleration areas remains in the hands of local authorities, creating a patchwork of procedures and increasing the burden of the procedure, such as in FR and PL.

4. **Overriding public interest**

   Less than half of the analysed countries were able to even partially implement it – AT, FR, DE, EL, PT –, while the rest had problems doing so. More specifically, the main challenge for Member States was to fully implement Overriding Public Interest without setting out certain exemptions or conditions that may jeopardise its implementation.

5. **Simplified procedures for repowering**

   BE, FR, EL, IT, PT, SK have been the ones able to successfully implement specific permitting rules for repowering. The rest of analysed Member States have not set out any rules for these provisions, or have rules that do not in practice accelerate permitting for this type of project such as in DE, IE, PL.

6. **Accelerated procedures on artificial structures**

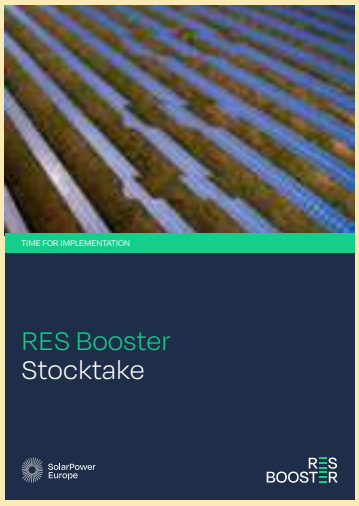
   Not all Member States have implemented accelerated procedures for solar PV on artificial land, with the exception of BE, CZ, IT and SE. However, it must be noted that a number of countries (BG, FR, DE, EL, IE, NL) have accelerated procedures, with very often an exemption from the construction permit for rooftop PV.

7. **Positive silence for small-scale projects**

   This provision has not been fully implemented since it first appeared with Council Regulation of December 2022. However, almost half of the analysed Member States were able to at least partially implement it, including AT, BE (FL), EL, IE, PT, SK, SE.

8. **Simple notification for grid connection of small-scale PV**

   Setting out of national rules for the easing of permitting procedures for small-scale PV has been the smoothest one out of all provisions. Only AT, CZ, NL and PL have not been able to transpose this provision. However, it must be noted that, despite the RES Booster allowing to extend the simple notification procedure to projects up to 50 kW, a vast majority of member states have not implemented that provision and have opted for the conservative option of 10.8 kW.



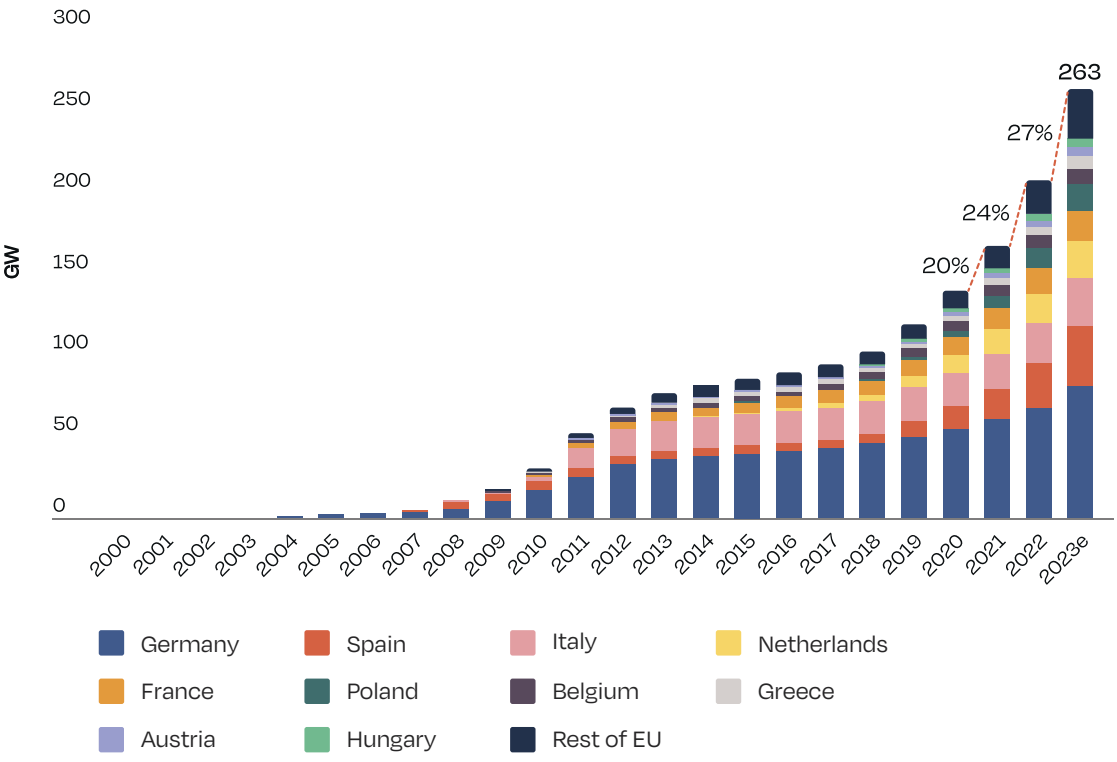
The cumulative installed solar capacity of the EU-27 Member States reflects the pattern seen in annual additions. The EU's solar power generation capacity grew by 27%, reaching 263 GW, compared to 207 GW in 2022 (Fig. 9). After the European Union's solar operating capacity surpassed 100 GW in 2018 and reached the 200 GW milestone in 2022, it exceeded 260 GW in 2023, confirming the growth trend forecasted by SolarPower Europe.

The cumulative PV capacities of the largest EU markets at the end of 2023 show minimal changes compared to the previous year. The top 10 was only joined by **Austria**, which has replaced Denmark as the EU's 9th largest solar fleet. The addition of 2.2 GW meant 57% growth of Austria's solar fleet to 5.9 GW, while Denmark's 57% drop in installed capacity to 0.7 GW in 2023 increased the country's total to only 4.9 GW, which equals the 11th spot.

Looking at the countries with the largest solar power generation portfolios in the EU, the picture is the same as for annual additions. **Germany** is the largest operator of solar power plants in the EU with 82.1 GW. It widened the gap to its closest follower **Spain**, which has cemented its position as the EU's second-largest solar power host at 35.6 GW. Spain took over in 2022 from Italy, now third in the rankings managing a capacity of 29.5 GW. Italy operated the EU's second-largest solar fleet for over a decade when its solar market grew little. While that has changed in 2023, **Italy's** annual additions are still half the capacity of Spain but slightly more than in **the Netherlands**, coming in again at 4th rank. The Netherlands surpassed the 20 GW mark and stands at 22.5 GW ahead of **France** which has kept its 5th position with 18.7 GW cumulatively installed.

With 4 countries having exceeded the cumulative GW-scale in 2023 – Slovenia (1.3 GW), Lithuania (1.1 GW), Estonia (1.1 GW), and Finland (1.0 GW) – the total number of that group has increased to 20. That leaves only 7 countries of EU-27 operating solar power capacities below the GW mark – Ireland (0.9 GW), Slovakia (0.7 GW), Cyprus (0.6 GW), and Croatia, Luxembourg, Malta and Latvia (all below 0.5 GW).

FIGURE 9 EU CUMULATIVE SOLAR PV INSTALLED CAPACITY 2000-2023



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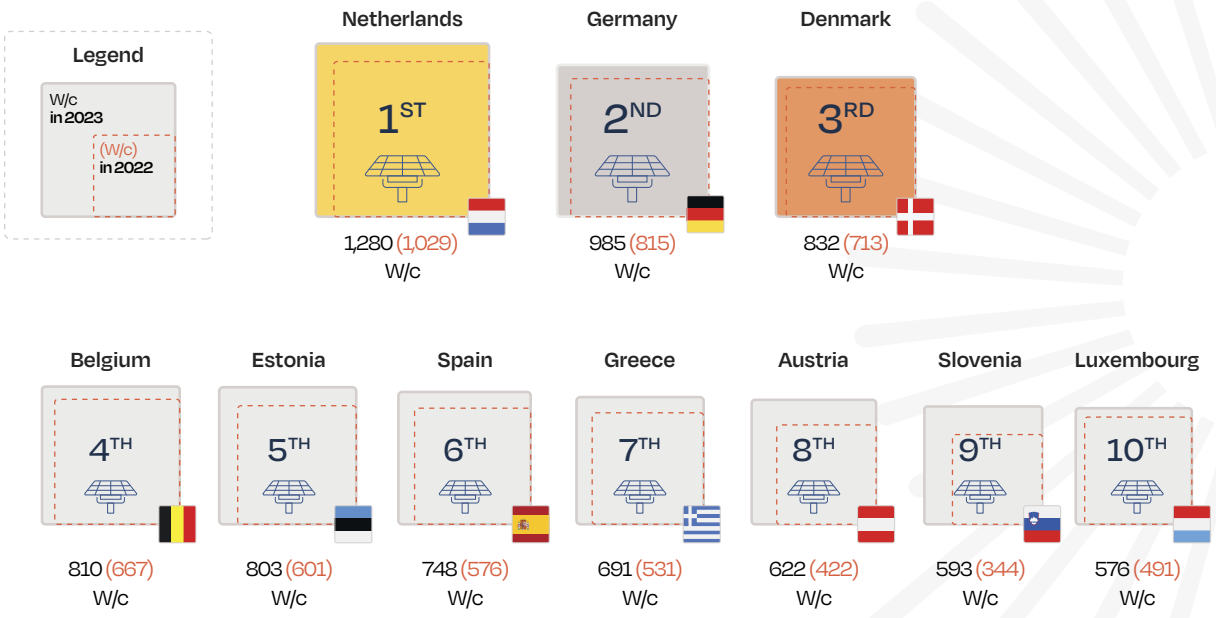
A look at the total shares of the EU's leading solar markets shows Germany having slightly lost ground despite its significant growth in 2023 that enabled it to recapture the first rank. In 2023, Germany's solar power fleet decreased 2 percentage points to 31%, which still leaves nearly one third of the EU's solar total in the hands of one country. The EU's five largest solar operators together claim a total installed capacity of 72%, a 2-percentage-point decrease from 2022. This development is in line with the larger top 10 group's cumulative share, which continues to slowly decline as well but remains at much higher levels – 89% in 2023, compared to 90% in 2022 and 94% in 2021.

When it comes to installed solar power per capita by end of 2023, the No. 1 is not the EU's solar market leader Germany, despite its massive recent growth. The Netherlands secures the leading position for the third consecutive year, reaching 1,280 W/c in 2023 — a 24% increase from 1,029 W/c in 2022. Germany maintains the second position with 985 W/c, marking a 21% raise from 815 W/c in 2022, and will become the second European country to surpass the 1 kW per inhabitant threshold in 2024. Despite the 2023 market slump, Denmark retains the third spot with 832 W/c, reflecting a 17% rise from 713 W/c in the previous year. It is followed closely by Belgium and Estonia, which stand at 810 W/c and 803 W/c, respectively. All top 5 countries are now exceeding 800 W/c, compared to just above 600 W/c in 2022.

The remaining five of the top 10 have undergone notable changes. Spain and Greece both moved up one spot from the previous year, now ranking #6 and #7 with 748 W/c and 691 W/c, respectively. Austria entered the group by securing the 8th position, after it has reached 662 W/c, representing a 57% annual growth rate from 422 W/c in 2022. The highest growth rate, however, is recorded for Slovenia, which lifted its installed capacity per inhabitant by 72% to 593 W/c, from 344 W/c in 2022, granting it a top 10 entry on 9th place. One of the smaller countries of the EU-27, Luxembourg also increased per capita installations to 576 W/c, from 491 W/c. The 2022 market size being smaller than expected means a drop by 5 ranks from the 5th place in 2022.

The EU's average solar penetration now stands at 585 W/c, compared to 466 W/c in 2022.

FIGURE 10 EU-27 TOP 10 COUNTRIES SOLAR CAPACITY PER CAPITA 2023



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EU-27 Segmentation

Solar in the European Union has been traditionally dominated by rooftop applications, and the energy crisis has pushed the scale turning further in that direction.

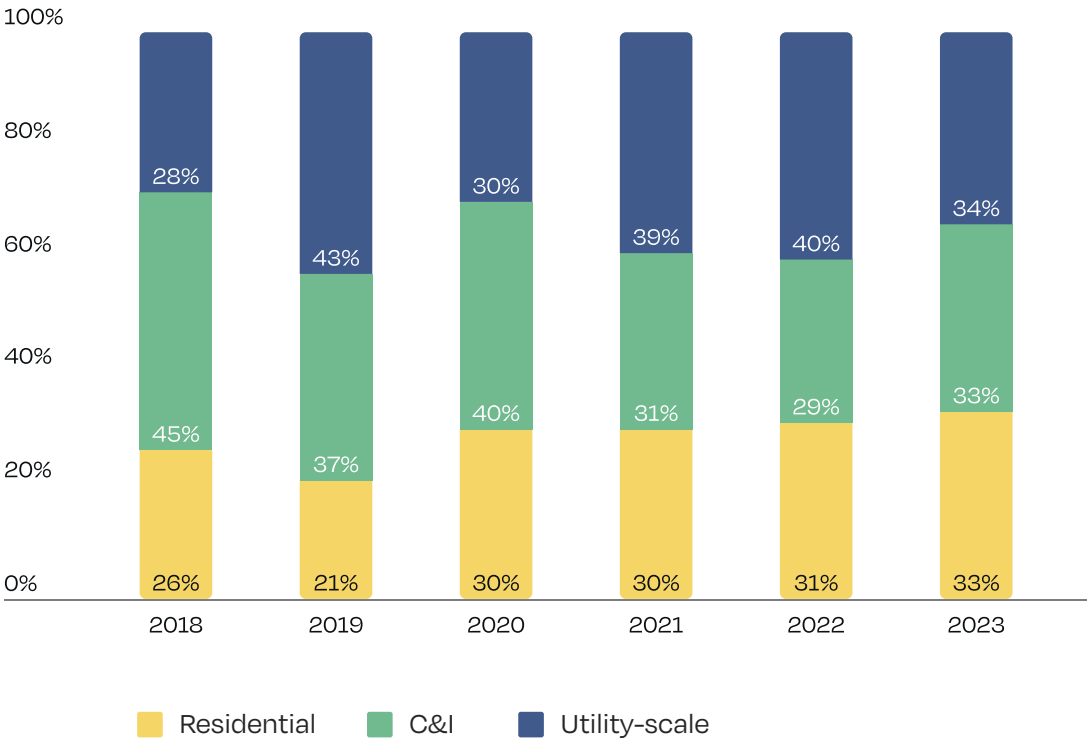
All rooftop segments – residential, commercial and industrial (C&I) – experienced a very good year in 2023, growing together by 54% year-on-year, but the C&I segment improved the most. Its share of newly installed capacities grew to 33%, from 29% the year before, while the residential segment reached the same level of 33% but grew from a higher level of 31% (see Fig. 11). While many orders for these new systems have been placed during the height of the energy crisis in 2022, the lack of installers led to a large pipeline that could only be realised over the course of the first three quarters in 2023.

Although demand for rooftop solar generally softened in the second half of 2023 after energy prices have come down significantly from their peaks, local electricity price regulations and support schemes have been impacting the markets as well.

In several EU member states, including Belgium, Slovenia and Hungary, announcements to end net-metering programmes resulted in a surge of interest for residential installations to take advantage of these attractive support schemes before they stop suddenly. While the abrupt termination of an incentive programme is mostly followed by a market downturn, a phase-out strategy that is optimally communicated from the beginning with a clear outlook to the aftermath usually helps the transition to a sustainable market if designed appropriately. Italy didn't follow this rulebook either with the attractive Superbonus scheme being strongly amended in early 2023. This resulted in a gradual decrease of Italy's core solar segment, the residential market, over the course of the year, but the C&I segment compensated due to an improved regulatory framework.

Unlike the thriving rooftop capacity, the utility-scale segment faces a 6-percentage-point market share decline in 2023 for many reasons. Delayed auctions in Portugal and France in 2022 and higher grid fees in Denmark have already left their marks. But the major

FIGURE 11 EU-27 SOLAR PV SEGMENTATION 2018-2023



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issues have been profitability and project financing in an inflationary environment characterised by high interest rates and high material and labour cost. In addition, local permitting and grid connection issues were still making life difficult for solar developers in many regions despite the positive permitting initiative of the European Commission implemented already in the Emergency Measures during the energy crises. On top, wholesale power prices have fallen close to pre-energy-crises levels over the course of 2023, making it harder to compete for subsidy-free solar plants.

In summary, 2023 marked another remarkable strong year for the European Union's solar sector, leveraging the momentum established in 2022 driven by high energy prices and increased policy support. New grid-connected capacity in the EU reached 55.9 GW in 2023, a 40% increase from the previous year and slightly exceeding our Medium Scenario forecast of 53.6 GW in the previous EU Market Outlook 2022. The growth builds even more on the rooftop segment as businesses and households invested in solar's promise of lowering electricity prices and energy security. On the other hand, the large-scale solar segment declined in an inflationary environment with often challenging regulatory environments.

Still, installed capacities rose 27% to 263 GW, reflecting the exceptional performance in annual capacity additions.

In 2023, Germany leads the EU solar market in both annual and total installations, with 14.1 GW and 82.1 GW, respectively, widening the gap to the second largest market, Spain, which couldn't continue the pace seen in 2022. Long awaited, Italy has secured the third rank after it strengthened its framework for C&I solar, overcompensating the decline in the residential market following the strong amendment of the Superbonus tax incentive. In terms of installed PV capacity per capita, the Netherlands maintained its top position, reaching 1,280 W/capita by improving over 250 W/capita in a single year.

SOLAR STEWARDSHIP INITIATIVE

THE **FIRST-EVER** SUPPLY CHAIN ESG SOLUTION **FOR SOLAR.**

BOX 3: GRID CONNECTION – SOLAR PV PROJECTS CONNECTION TIMING

In November 2023, the European Commission published a Grids Action Plan that should facilitate grid deployment and eventually grid connection of solar projects. To inform the public debate, SolarPower Europe surveyed its network of members and national associations to establish a benchmark of the average grid connection times. The survey finds that:

- The average lead time to grid connection of ground-mounted PV projects can go up to eight years, with an average of around 4 years.
- The situation is much better for small PV, with 14 countries reporting times to grid connection below six months. Yet some countries have taken around 1 year to connect small PV projects to the grid.

FIGURE 12 ESTIMATED TIME RANGE TO CONNECT A SOLAR PV SYSTEM IN SELECTED EU COUNTRIES - UTILITY SCALE PV SYSTEMS

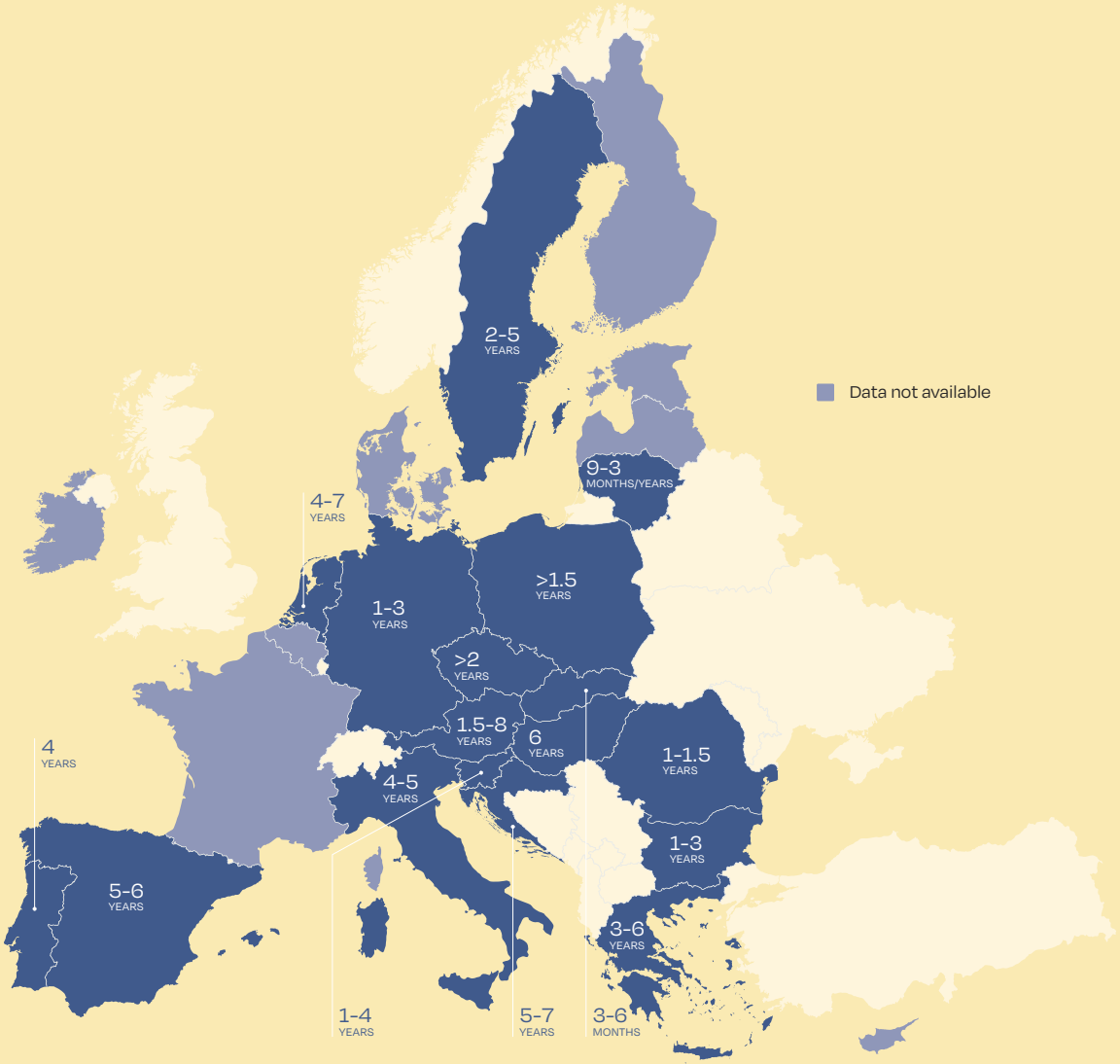

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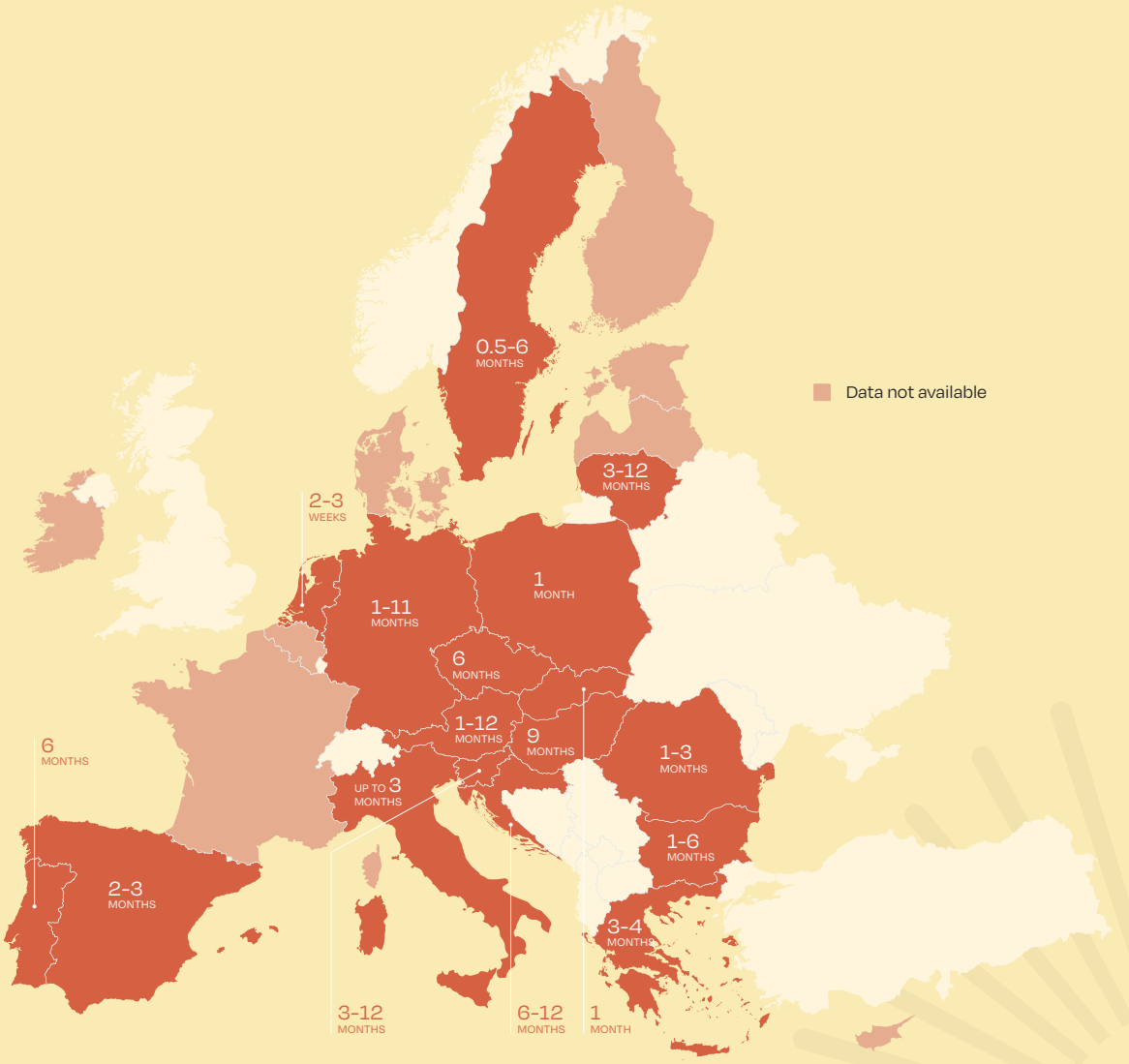
FIGURE 13 ESTIMATED TIME RANGE TO CONNECT A SOLAR PV SYSTEM IN SELECTED EU COUNTRIES - SMALL PV SYSTEMS



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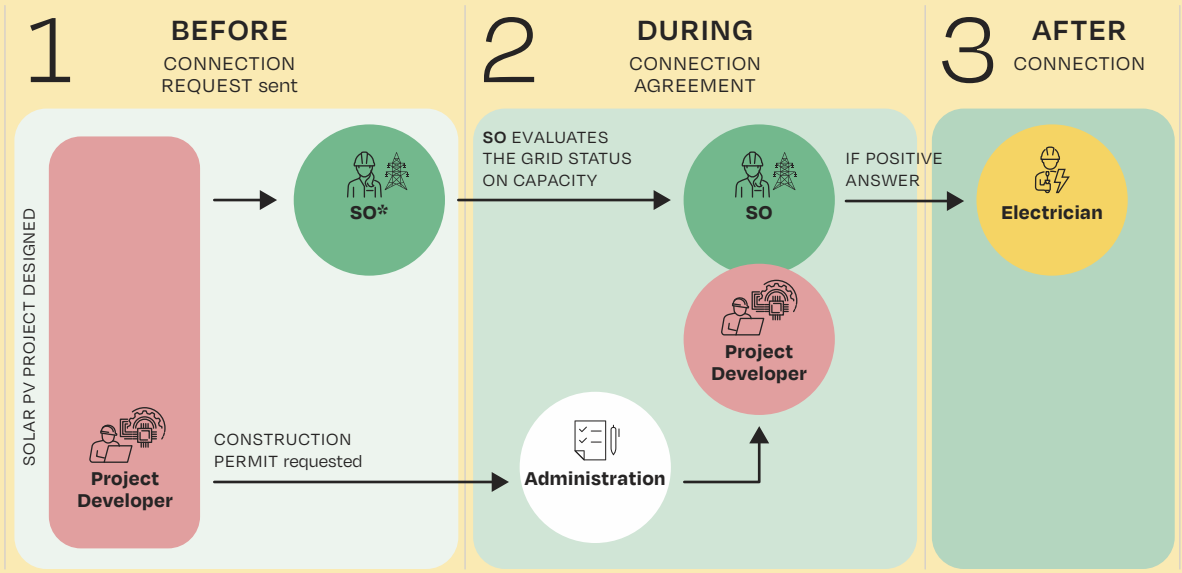
How did we make the survey?

At the moment, grid connection procedures are not harmonised across Europe. In 2023, SolarPower Europe launched the Solar Connection project – an initiative led in combination with Eurelectric and aimed at engaging with experts from the solar and the DSO sectors to better understand and improve grid connection procedures for solar. The project has established a simplified view of the procedure as shown in Figure 14 which includes three main phases - before, during and after the grid connection agreement. For this survey, the **grid connection time** is defined as the time between the permitting request and the final test (after the physical connection is complete, the solar system will be commissioned and tested to ensure it is operating as expected). This includes possible construction works of the renewable plant and the grid infrastructure.

FIGURE 14 GRID CONNECTION PROCEDURE PHASES (SIMPLIFIED) BASED ON THE SOLAR CONNECTION PROJECT



*: SYSTEM OPERATOR.

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On that basis, we surveyed the solar industry on the grid connection times in 18 countries, excluding possible outliers. Figure 12 and 13 shows the time it takes for a utility-scale/large (blue) or small (red) PV system to be connected to the electricity grid at the transmission or distribution level, depending on the grid infrastructure in each country. This benchmark is not based on official permitting and final connection data, which is not made available by public administrations and is crucially lacking to inform the debate, but on a survey of the industry, across Europe, to the best of their knowledge.

What do we know about the national situations?

In Austria, the time to grid connection for ground-mounted PV systems depends on whether the power plant is constructed in a go-to area or not. In addition, the possible need for grid reinforcement or extension, and the time that it takes to have grid extension and reinforcement, can delay the connection process. Finally, the voltage level influences the time to grid connection: higher voltages take more than 2 to 3 years than medium voltage and at least more than 4 years than low voltage.

In **Belgium** (Flanders region), the grid scenario is more positive, small PV systems have shorter connection periods. Grid permitting takes around 6-8 weeks for most projects and a rooftop grid connection on the DSO level can be re-used. For other projects, permitting will take around 6 to 9 months. The majority of Flemish projects are rooftop systems, where no grid reinforcement is needed. If a reinforcement is needed, this takes on average 12-18 months and in case road works are needed, this can take 24-36 months. Projects up to 10 kW can be built without a grid or building permit. The DSO is currently working on a map that will give users an indication of available grid capacity and potential reinforcement lead times and costs for this region.

In **Croatia**, the connection to the grid represents one of the major obstacles to the development of RES

projects, special at the TSO level. The origin of the problem is the lack of investment in the grid. At the moment a crucial project on TSO infrastructure, where most of the demand (Zagreb metropolitan area) is necessary and where most RES are to be connected is not advancing. The new Electricity Market Act came into force on October 22, 2021, while the new Rules on Connection to the Transmission Network came into effect only on September 1, 2023. However, as of today, the connection cost is still unknown. As a result, new investments have been on hold for almost two years. The procedure for obtaining pre-connection and connection to the power grid only began in September 2023. According to the new Rules on Connection, the duration of the pre-connection process is 90 days, while obtaining the electro-energy consent (EES) will take investors between 9 and 12 months. Only after this will investors be able to apply for a location permit, necessary to obtain a building permit. After obtaining the energy approval, investors are obligated to obtain all permits and complete the facility within 7 years. When it comes to small PVs, in some cases, it took 10-12 months from the day users would pay the connection fee to when the DSO would connect their device to the network. Regarding the anticipated deadlines for small PV, there are various connection procedures. According to the rules on connection to the DSO, the quickest timeline achievable is a 2-month period, provided that all conditions on the simple connection procedure for new buildings are met.

In the **Czech Republic**, applying for a grid connection is one of the first steps, before leasing or purchasing land, and applying for a zoning and building permit. In general, the time between the first contact and the signing of a connection contract is 6 to 9 months. The capacity is reserved for 2 years but can be extended if the investor shows that they are making progress but are hindered by permitting problems. Once the project is commissioned and the investors apply for the actual connection this is usually within a few weeks. This means that in an ideal grid capacity scenario the full process would take 1 to 2 years. However, at the moment most of the grid connections are being rejected, due to grid congestion and it is difficult to estimate how much time it will take for these projects to be connected. Since forming project queues is not part of the country's procedure, when there is no capacity the project is simply refused and obliged to start the process again when capacity is available or in another location. However, in the Czech Republic, there is no real-time capacity mapping or sufficient information for project developers to optimise their choice of location which extends even more the period of this process. Aside from the lack of grid infrastructure to allocate new projects, current projects are already suffering curtailment, as happened in the Spring of 2023, due to the congestion and the lack of regulatory framework on flexibility solutions, such as energy storage that could be an efficient solution to support solar projects.

In **Germany**, the lack of grid capacity is a main blocker, as well as inefficient and non-digitalised grid connection procedures. Every grid operator can define their own requirements and processes, making it challenging for installers. There are policies in the works to harmonise some of these requirements and processes. Furthermore, there is no transparency on available grid capacities in Germany and grid operators only have to answer if the specific capacity applied for in the grid connection requests is possible, but not which capacity would be possible at this grid connection point. Therefore, investors often have to do several grid connection requests with different plant sizes until they know, which capacity would be possible. This process can take a lot of time. There are no defined periods in which PV systems have to be connected to the grid. From the industry estimation, in Germany for small PV systems this can take between 1 to 6 months without an intelligent metering system and depending on the business model (1 month without response by the grid operator allows self-connection). With an intelligent meter, the process can take more time, estimating an additional 4-5 months. So, the connection range can be 1 month to 11 months, depending on if it is added to an intelligent/smart metering system or not. There are now defined periods after which installers can connect to the grid if they do not receive an answer from the system operator. This works for systems up to 50 kW, following the EU emergency regulation requirements. Further, there is an obligation to be able to connect the system to the grid, even if the grid needs to be developed/reinforced. However, SOs do not have sanctioned deadlines, so even if there are

obligations to connect to the grid, there are no sanctions. Currently, connections are being rejected. In Italy, starting from 2023, small PV systems have a new regulation from the Energy Authority which allows any installer to connect the plant to the grid without the in-site involvement of the DSO technician. Today the most accurate and precautional estimates would be "up to 3 months" with a tendency to decrease as both installers and DSO technicians become more confident with this new regulation.

The **Netherlands** is at the top of the most congested European countries, so grid capacity is currently the main blocker at the utility-scale segment. The connection time depends a lot on the location, and grid congestion is delaying many projects. The maximum times are now being redefined in the new 'Energy Law' in the Netherlands. There the maximum timing will depend on the specific grid situation per location with maximum times where the grid operator has to support the reason for not meeting those deadlines. New alternatives for connection, such as flexible grid connections, are now being assessed. At the small-scale, the current period of connection is shorther than in previous years, because the demand from households at the moment is lower.

In **Poland**, currently, there is very little available capacity and it is increasingly difficult to obtain a grid connection. At the utility-scale segment, in an ideal grid capacity scenario the grid connection time (indicated above) would be around 1 to 1.5 years for the full process, however, grid congestions are blocking a high quantity of projects from connecting and the estimated time for available capacity is not clear. The main reason is the lack of infrastructure. This means insufficient development of the transmission and distribution grids, resulting in a lack of sufficient capacity and connection points. Another hurdle is the connection procedure. This is ambiguously and inefficiently regulated in the law, which gives DSOs a lot of space for prolonging the process, or even unilaterally finishing it. Moreover, there are problems with the transparency of connection procedures from the system operator's side. In 2022, the DSOs issued more than 7,000 refusals to issue connection conditions for a total capacity of more than 51 GW. This is more than in the last decade. The refusals are mainly given to renewable energy sources, such as utility PV systems but also wind farms, energy storages and other DERs. New important regulations such as cable pooling, hybrid RES systems and direct lines have been adopted. Project developers are currently waiting for the interpretation and application of new provisions by the TSO and the DSOs.

In **Portugal**, currently, the process extension is mainly due to the entities' difficulty in responding to all requests. They lack means and human resources, among other issues and operational challenges at the municipal level. At the moment the lack of network availability does not affect the process because once capacity has been allocated the connection will proceed. It will only affect the possibility of advancing new projects.

In **Slovakia**, the data mapped represents the best scenarios for grid connections, with a great improvement due to the digitalisation of the grid connection process. There is the possibility of the extension of these periods due to grid constraints, however, there is no estimation for these scenarios.

In **Spain**, grid connection timing is particularly slow at the DSO level due to the unclear connection procedure. The processes are not as transparent and straightforward as it is at the TSO level. The TSO sends clear requests and maintains grid users informed through public webinars. On the other hand, the DSOs' process is chaotic and less transparent.

Utility-scale is still at a very early stage in **Sweden**. The larger DSOs are now drowning in requests for connection of utility-scale projects. They have about 6 months to just give an indicative answer to requests and about 1.5 years to give a final answer. Smaller DSOs are typically faster. Then the construction of the grid connection might take up to 2 years if no new grid concession is needed. If a new grid concession is needed it will take much more time. Sweden has very

complex permission processes for new grids where it can take up to 10 years to build new grids. There are no PV installations that have been waiting that long, but there are examples from wind power connections and general grid reinforcements. Regarding small PV systems if the grid is constrained, the time can grow for up to 9 months or even more depending on the size of the DSO. Smaller DSOs are faster than large DSOs. The largest DSO in southern Sweden says that about 5% of small PV systems need grid reinforcement before being connected.

What are the causes of such delays?

Two reasons explain the growth of this queue. Grid developments are delayed, infrastructure is not growing at the same pace as renewables and the available lines are getting more congested every day. Grid connection procedures are still not modernised, they lack clear communication and visibility on-grid status and project progress.

In 2023 SolarPower Europe together with Eurelectric DSOs developed a set of recommendations for grid connection procedures, network planning & investment and flexibility deployment, under the Solar Connection project. The main recommendations can be summarised in 6 steps:

1. Optimising the full procedure of grid connection is the first step to reducing this queue and achieving an efficient and faster integration of assets, from small to large-scale solar PV projects. This requires **improving transparency, communication, digitalisation, and standardisation in the different phases**.
2. Second, addressing the grid connection bottlenecks before they even arrive. **Network planning shall be strictly aligned with national REPowerEU targets** and shall include a perspective towards 2050. **Anticipatory investments shall be allowed and conducted, in close alignment with renewables needs**. During this process, it is imperative to maintain close coordination with industry stakeholders and regional political authorities.
3. **Accelerate grid permitting as much as renewables permitting.** The exponential growth of renewables requests a faster development of grid works. Grid infrastructure depending on the voltage can take around 10 years to be built. The revised Renewable Energy Directive's (RED) timescales and proposals for accelerated grid permitting are qualified as overriding public interest, and they should be enforced until climate neutrality is achieved.
4. **Make hosting grid capacity maps an obligation for all Member States to implement.** Where available network capacity is regularly updated and published for all grid users at all voltages, such transparency would enable PV developers to make better-informed decisions about their project size and location.
5. When achieving the **grid connection step, procedures need to be simplified, standardised and digitalised**, where the relevant stakeholders are aligned and the process, timelines and requirements to be fulfilled are clear for all parties.
6. **Incorporate flexibility at all stages – from network development, to grid connection agreements through grid operational stage.** While additional grids are being built, Europe needs to make the most of existing infrastructure by incentivising flexibility both at the time of connection and operation. This requires developing a true framework of price signals for flexibility assets, including tools such as flexibility services, flexible grid connection agreements, and system hybridisation. Grid users, such as project developers and prosumers, would then be able to choose the optimal price signal from a technical and economic point of view.

These recommendations are the first step to having better coordination between all the entities involved in the grid connection process and reducing the queue of projects to be connected.

EU Solar Market Prospects 2024-2027

After exceptional years for the solar sector during the pandemic and energy crisis that triggered very high growth rates of 40% and more, the coming 4 years will likely see more moderate market development in the low 2-digit range, according to our Medium Scenario. But even this should not be taken for granted. Several challenges have been mounting up that need urgent attention from policymakers, otherwise the sector that offers the lowest cost and most versatile clean power source might turn towards our 'hardly to no-growth' Low Scenario, for which we see higher probabilities than in the past. While the market in 2023 still benefitted from the 2022 demand surge as the pipeline had grown to levels that installers could not handle, the situation will be very different in 2024. Already in the second half of 2023, when much of the previous year's overhang was built, demand for rooftop solar was curbed in many countries, except where local subsidy programmes continued to fuel extraordinary solar market activities.

In 2024, the severe lack of installers limiting deployment of solar won't be the sector's major issue anymore. While PV companies continue to search for qualified employees (like many other industries), the existing installers have expanded and trained new staff, and new players have moved into solar, among others from the ailing construction sector. This has created a market environment that is forcing installers to spend on marketing strategies and decrease system prices to levels that attract customers after the threat of very high energy bills has mostly vanished, as well as the urgency to invest in a solar system at any price. However, solar will thrive in particular in those countries that have dedicated solar strategies and continue or even expand support for solar, like Germany, which is expected to finalise its ambitious Solar Package I by the end of 2023, or Austria, where the VAT exemption for solar will go into effect in 2024 (for details in policy details in the main markets, see our GW-markets chapter on p. 82).

We are also likely to see a strong uptick in the field of ground-mounted solar power plants. As a consequence of global solar production expansion, the sector is facing a stark drop of solar product prices – from silicon to solar modules – that have dipped to record low levels in the fourth quarter of 2023, a situation that is helping project developers to manage the inflationary environment with high interest rates.

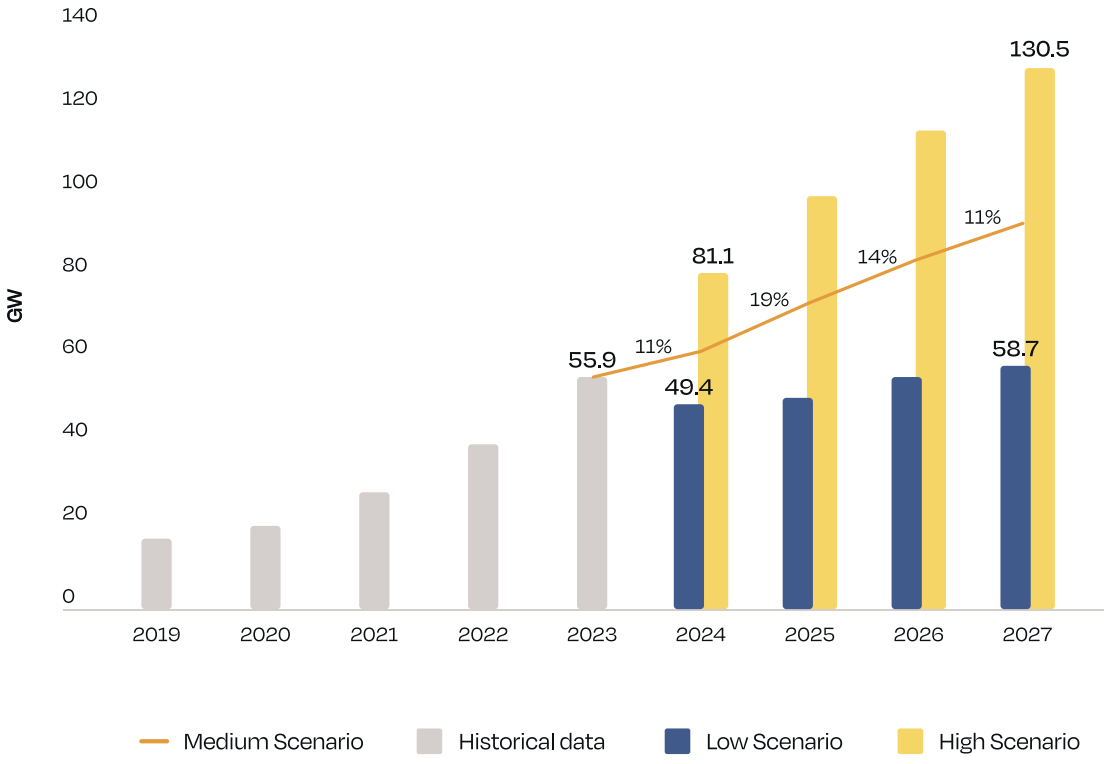
However, major markets are anticipated to face slowdowns in their expansion rates in 2024 as they will require time to adjust to this new scale of solar deployment and deal with the needs of electricity systems with notable solar power shares. In the short run, this means implementation of EU policy frameworks from planning to permitting, while keeping an investment-friendly environment for solar, and bringing flexibility, in particular battery storage, and grid improvements to the next level. For 2024, we anticipate 11% market growth to 62 GW in the Medium Scenario (see Fig. 15). This is the same market assumption as in our EMO 2022. It reflects a consolidating market that digests its high growth phase under exceptional circumstances.

Assuming the latest solar-related policy framework are executed as intended, our Medium Scenario predicts market growth of 19% (73.8 GW) in 2025, before growth rates are supposed to decline again to 14% (84.2 GW) in 2026 and 11% (93.1 GW) in 2027 because, as the market grows in absolute term, the yearly upward fluctuations in percentage get smaller.

In our previous EMO editions, we had been more optimistic on EU solar market development every year, but that has changed in this outlook. For the years 2023 to 2026, we have more or less maintained our growth forecast from the EMO 2022 due to the many challenges we see ahead of the solar sector (see box 'Looking back and forth', p. 36). Our conservative market assessment makes it worth to take a closer look at our Low Scenario that includes a threat we haven't had on our agenda for many years – Trade Defence Measures.

With European solar manufacturers and production start-ups struggling for survival as they can't compete with today's prices of Chinese import products that have reached record low levels in a cyclical oversupply situation, the European Commission's DG Trade and DG Grow have started looking into this topic. The consequence could be an investigation that potentially leads to tariff on imported PV products. The oversupply cycle comes at a time when the EU is trying to support the renaissance of a local solar manufacturing sector with different funding tools to create resilience for the lowest cost and most versatile power generation technology that is considered a major pillar in Europe's long-term carbon-neutral energy supply system. While SolarPower Europe is lobbying for resilience auctions and other CapEx and OpEx measures to support

FIGURE 15 EU-27 ANNUAL SOLAR PV MARKET SCENARIOS 2024-2027



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sustainable growth of the EU solar manufacturing industry, we expect import trade defence measures on solar PV products to slow down deployment drastically. Not only would about half of today's around 800,000 solar jobs be lost, according to our modelling, but trade defence measures would also severely impact the solar supply chain of Europe, which is home to less than 2% of the integrated module capacities needed to satisfy its demand.

Further major challenges on the horizon that have surfaced during solar's strong expansion phase include: imminent grid congestion that, if not solved, could result in high curtailment rates and even stops of new grid connections, decreasing the attractiveness of solar for investors. Solar's growing share in the electricity mix could also lead to dramatically lower capture prices for developers, reducing their returns, and again the attractiveness of the technology. On top come securing workforce availability over the long term, solar investment conditions, supply chain concentration, and still permitting. Our assessment of the most crucial challenges, and how to overcome them, is outlined in the policy recommendations on p. 6. If they are not solved, our Low Scenario might become reality. Considerably decreased compared to our previous EMO reports, we see installed capacities hardly increasing to 58.7 GW by 2027, and the gap to the Medium Scenario widening from 20% in 2024 to 37% in 2027.

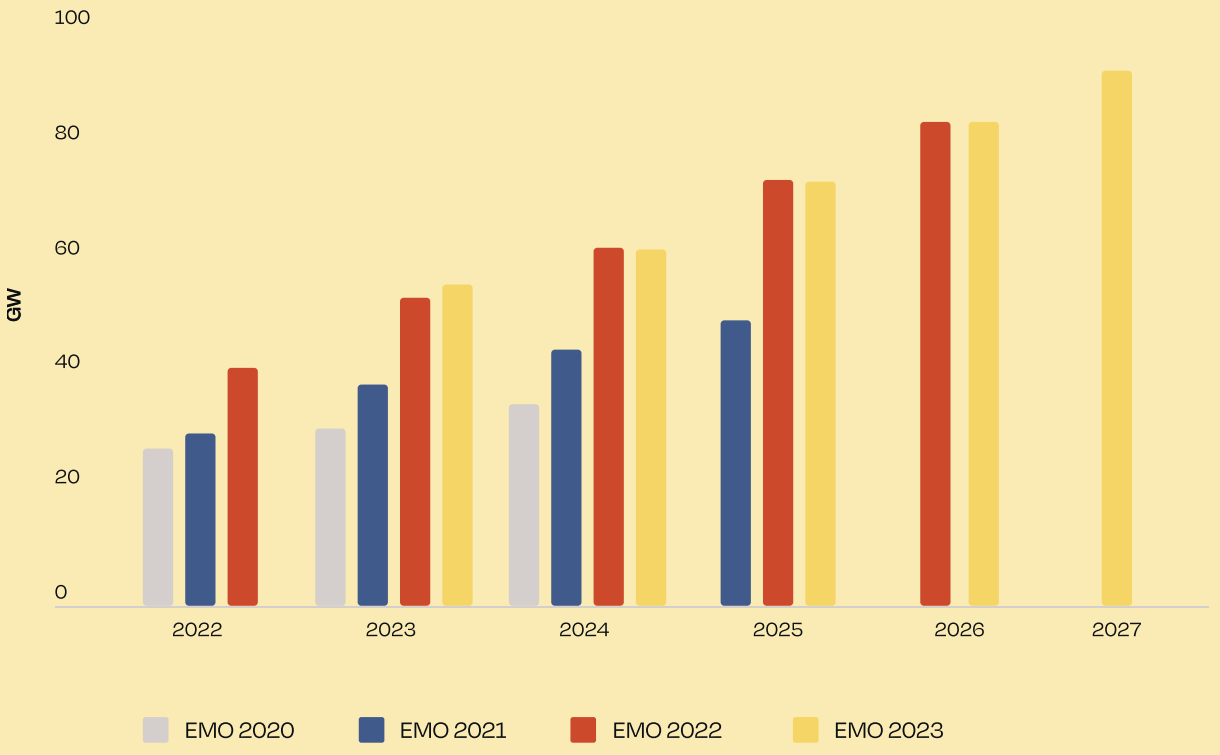
As the challenges are obvious and the solutions too, concerted efforts could result in the High Scenario that forecasts a market of 81.1 GW in 2024 (a 45% increase from 2023) and up to 130 GW in 2027. The High Scenario assumes that the price shocks of the energy crisis and the solar sector's immediate response to the gigantic demand of citizens and businesses in Europe has fundamentally changed the perception about solar power. The challenges mentioned earlier will all be quickly addressed. In such a scenario, market developments could lean towards deployment levels of up to 131 GW in 2027.

BOX 4: LOOKING BACK AND FORTH

The previous EU Market Outlook released in 2022 showed a strong upward revision of the forecasted market growth. The annual market was estimated to be around 40% higher for 2022, 2023 and 2024 compared to forecasts made in the EU Market Outlook of 2021. The 2025 market was even expected to grow nearly 50% higher than originally expected. Frequent readers of the EU Market Outlook should not be surprised by this. Revision has become a regular development as barriers and bottlenecks were lifted and ambition rose faster than expected. Over the past three editions especially, forecasts were revised strongly. Each time again, the growth potential of the market was underestimated. This plagued basically all solar market analysts. For example, over the period 2019 – 2022, the IEA revised the forecasted 2022 global solar market four times, starting with 114 GW in 2019 and reaching 209 GW in 2022, still 30 GW below our latest global forecast of that year. It is a global phenomenon, and the EU market is not immune to it. On the contrary, the energy price crisis and the raised ambitions through the REPowerEU targets have elevated the volatility of the market to new heights.

This year, noticeably, the forecast of the Medium Scenario remains almost untouched as shown in Fig. 16. The positive and negative national market changes (see chapter 4) more or less outbalance each other and no longer cause strong changes in EU market

FIGURE 16 COMPARISON ANNUAL MEDIUM SCENARIO EU MARKET OUTLOOK 2022-2027



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expectations. In total, the revisions for the annual markets 2024-2026 are no bigger than 1%. This shows that the exponential solar market growth should not be taken for granted. There is no groundbreaking, EU-wide policy development in the pipeline, such as the REPowerEU package with an EU Solar Strategy of last year. Instead, there are more than ever industry threats that could slow down the growth of the EU market to even below the minimal EU target of 750 GW. Despite the large price decline of solar PV modules over the course of 2023 and the uplifting of many barriers, the economics of large scale solar are endangered by high interest rates, lower land availability and grid congestion. Small scale solar is exposed to other risks, among others: public acceptance, sudden changes in incentives and the availability of adequate policy frameworks. one of the mentioned challenges come close to the risk of trade defence measures, which is further elaborated in Chapter 2.

Uncertainty is higher, and the Low and High Scenarios are showing this. In comparison to last year, the Low Scenario for 2026 is 16% lower than last year, while the High Scenario is only 3% lower. The furthest forecast for 2027 has a Low Scenario that is 37% lower than the Medium Scenario. In last year's edition, the furthest forecast (2026) showed only a 22% difference between both.

FIGURE 17 COMPARISON CUMULATIVE MEDIUM SCENARIO EU MARKET OUTLOOK 2022-2027

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The cumulative PV capacity projections for the EU spanning between 2024 and 2027 shows double-digit annual growth rates (Fig. 18). In the Medium Scenario, total capacity reaches growth rates of 24% in 2024 and 23% in 2025. As the EU solar fleet further expands, the annual percentage growth is expected to decrease slightly. The Medium Scenario projects a relative reduction of total capacity growth in 2026 to 21% and in 2027 to 19%. In any case, the upcoming growth rates will be lower than those achieved during the energy crisis impacted solar boom years 2022 and 2023, which reached levels of 24% and 27%, respectively.

In absolute terms, new additions between 2024 and 2027 will contribute 313 GW, bringing up total installed PV capacity to 576 GW by the end of 2027, according to the Medium Scenario. This means a 119% increase of the EU solar power generation fleet within four years from the 263 GW in operation end of 2023. The High Scenario assumes much higher solar additions of 438 GW until 2027, resulting in a total solar capacity crossing the 700 GW mark, while the Low Scenario would mean a mere 79% growth from today to 471 GW in four years.

On the most likely path, the European Union's solar fleet will reach 399 GW by 2025, so our Medium Scenario very well coincides with the REPowerEU interim target of 400 GW (320 GW_{AC}) in the same year. For the final years of the decade, 2027-2030, however, our Medium Scenario anticipates a faster uptake of solar PV compared to REPowerEU's ambition, reaching the 750 GW (600 GW_{AC}) 2030 target in 2029. For 2030, our most likely Medium Scenario assumes much higher total installed solar capacity of 902 GW operating in the EU. Both the REPowerEU target and SolarPower Europe's 2030 forecast overshoot the Member States' revised National Energy and Climate Plans (NECPs), which aggregate to around 607 GW, an extrapolated number as not all countries had provided their updated numbers before our editorial deadline. More on our scenarios until 2030 and our detailed NECP analysis can be found in Chapter 3 (see p. 51).

FIGURE 18 CUMULATIVE SOLAR PV MARKET SCENARIOS 2024-2027

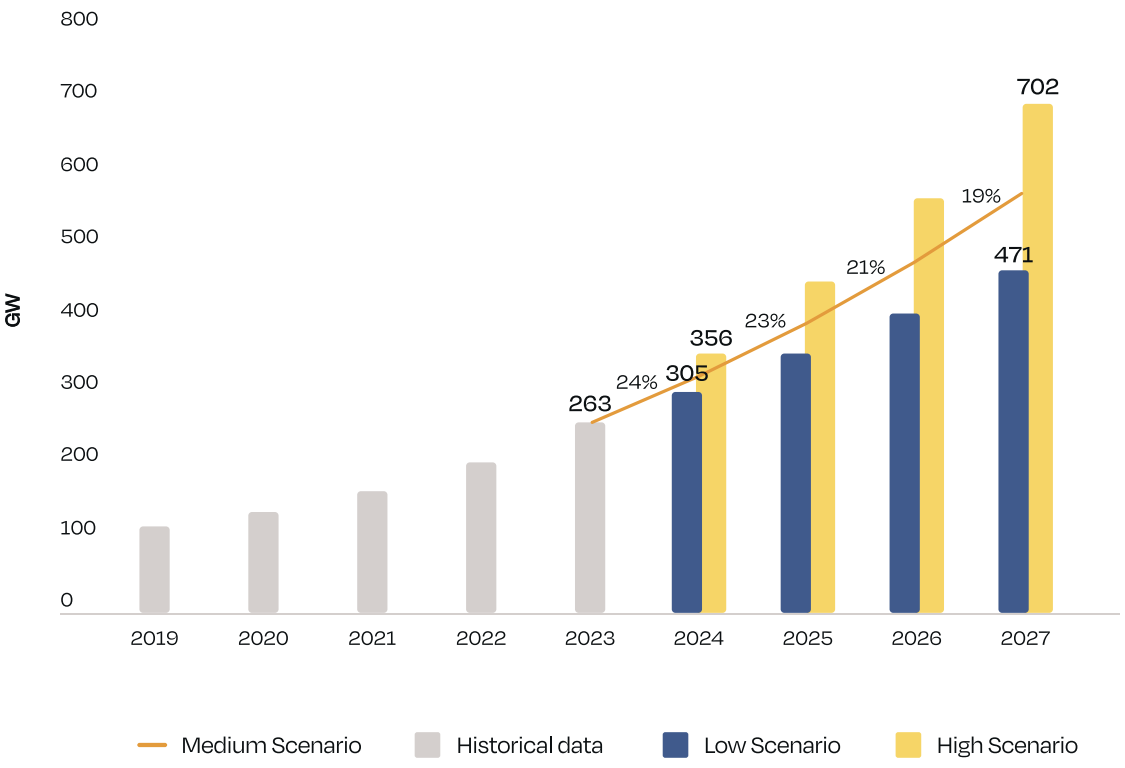

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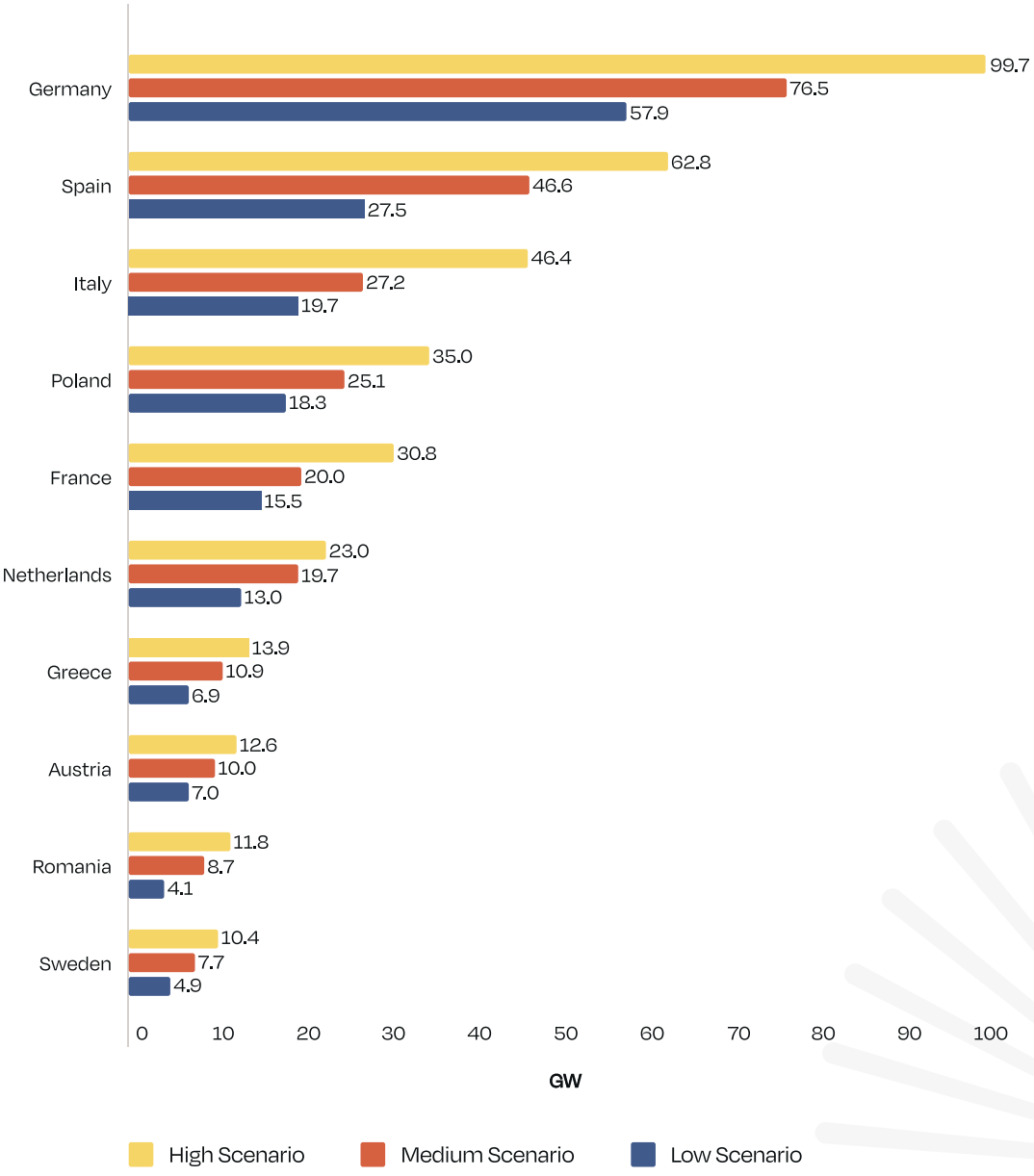
FIGURE 19 EU-27 TOP 10 MARKETS SOLAR PV ADDITIONS 2024-2027



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Despite the looming challenges, our Medium Scenario outlook for the top 10 markets remains fairly bright for the coming 4 years until 2027.

Considering Germany's overachievement in 2023, our optimistic expectations for the country have been even revised slightly upwards. Our Medium Scenario now projects the addition of 76.6 GW from 2024 to 2027, 1% higher from our forecast in the Global Market Outlook 2023-2027 (GMO 2023) published in June 2023. Very good news is that the country has confirmed its ambitious solar strategy target of 215 GW by 2030 and 400 GW by 2040 in its revised draft National Energy and Climate Plan.

Numerous auctions were conducted throughout 2023 for ground-mounted, rooftop, and innovative PV, which will be reflected in the coming years' installations. Moreover, the country raised the maximum price cap for large-scale PV which has turned undersubscriptions into oversubscriptions of auctions. With all its solar engagement, we anticipate Germany to almost double its existing solar fleet within a span of just four years. While our Low Scenario predicts additions of 57.9 GW, the High Scenario envisages nearly 100 GW new PV capacity in the next four years.

Although Spain maintains its position as the second-largest solar market, we have significantly revised downwards our solar projections compared to the GMO 2023. The country is now foreseen to connect 46.6 GW until 2027, which is 26% less than the June 2023 expectations. Challenges in the self-consumption segment, delays in processing of permits, grid constraints and most importantly, the threat of lower solar capture prices in the absence of appropriate flexibility deployment, have led us to this more cautious outlook. We still see significant upside of 62.8 GW in our High Scenario, as we take into account the gigantic potential of Spain's nascent rooftop segment, its substantial PPA pipeline, and advancements in the first hydrogen initiatives. At the same time, Spain's new-old government coalition is very fragile, the opposition parties not known to be strong solar supporters; the Low Scenario pegs growth until 2027 at only 27.5 GW.

Having been identified last year as a country poised to unlock its solar potential, Italy has indeed fulfilled the expectations, unlocking significant growth primarily through the implementation of new permitting regulations for C&I systems. Anticipating continued growth in the utility-scale segment in the years ahead, Italy is forecasted to install 27.2 GW over the next four years, marking an 11% upturn from our previous assessment.

Poland is no longer among the top 3 solar growth markets over the next four years. The country faces a transition period away from very lucrative net metering to net billing and other market drivers, and from a residential focus to larger systems. Still, we anticipate Poland to connect 25.1 GW in the 2024-2027 period, representing an increase of 1.4 GW from our prior estimate.

Despite a 9% decrease to 20 GW of new capacity until 2027 in our updated market projection compared to our GMO 2023, France has advanced one position from last year's ranking and now secures a spot among the top 5 solar growth markets in the EU. We see a lot of potential in the under-developed self-consumption sector, which has shown recent progress. On the other hand, the legislation outlining rules for building large-scale projects is still a major hurdle for developers, leaving Agri-PV basically as the only practical option today.

On the contrary, the Netherlands slipped one position to sixth place after we decreased our deployment forecast by 4% to 19.7 GW compared to our GMO 2023 assessment. Despite maintaining a robust rooftop market and a reliable auction scheme, uncertainties have arisen due to ongoing negotiations about the phase-out of its major support scheme net-metering and new regulations negatively impacting ground-mounted projects. While it is too early to see the consequences on demand, the results of the November 2023 national elections only add to the uncertainty for the solar sector.

Though much smaller, the solar market of Greece continues its positive move, marked by significant growth mostly in the industrial and the utility-scale segments. Solar is likely to dominate most of the renewable auctions until 2025 and new support schemes are expected in early 2024 to support residential PV and storage. As a result, Greece is anticipated to add 10.9 GW between 2024 and 2027.

Entering this top 10 ranking of the largest solar growth markets for the first time in 2022 on rank 10, Austria was able to secure the 8th position this time. Its attractive capital support scheme for residential systems is set to transition from subsidies to a VAT reduction in early 2024, potentially causing a temporary slowdown in the deployment of this segment. However, demand for rooftop PV is estimated to remain robust, and any decline in this sector is expected to be offset by increased activities in C&I and large-scale PV systems. Anticipated to add 10 GW in the next four years under the Medium Scenario, Austria could reach up to 12.6 GW in the High Scenario.

Making its debut among the major solar growth markets, Romania is the only newcomer to the list. Projected to install 8.7 GW until 2027, this means a 14% increase from our previous assessment. The

residential sector benefits from a subsidy program, and despite regulatory challenges for new projects exceeding 50 hectares, there is significant interest from developers and investors in constructing larger plants, including the largest PV project planned in Europe to date at over 1 GW.

Finally, Sweden is capitalising on the expansion of residential and large C&I rooftops. With support from various tax incentives, the residential sector will continue to be a primary driver of new installations in the upcoming years. At the same time, the utility-scale segment is set to play a notable role in market growth as the first major PV park commences operations. We have slightly upped our former forecast by 4% to 7.7 GW additions over the next four years.

In our analysis, the leading 10 EU solar markets are projected to install 252 GW from 2024 to 2027 in the Medium Scenario. This represents a 6% decrease from our 2024-2027 forecasts published in June 2023 in the Global Market Outlook 2023. The Low Scenario anticipates 175 GW, while the High Scenario envisages additions of 346 GW.

FIGURE 20 EU-27 TOP SOLAR PV MARKETS PROSPECTS

Country	2023 **Total capacity** (GW)	By 2027 **Total capacity Medium Scenario** (GW)	2024-2027 **New capacity** (GW)	2024-2027 **Compound annual growth rate** (%)	**Political support prospects**
Germany	82.1	158.6	76.5	18%	
Spain	35.6	82.2	46.6	23%	
Italy	29.5	56.7	27.2	18%	
Poland	16.8	41.9	25.1	26%	
France	18.7	38.7	20.0	20%	
Netherlands	22.5	42.2	19.7	17%	
Greece	7.2	18.1	10.9	26%	
Austria	5.9	15.9	10.0	28%	
Romania	2.9	11.7	8.7	41%	
Sweden	4.1	11.8	7.7	30%	
Bulgaria	2.9	9.8	6.9	36%	
Belgium	9.5	16.1	6.7	14%	
Czech Republic	3.6	10.2	6.6	30%	
Denmark	4.9	11.5	6.5	24%	
Portugal	3.6	9.8	6.2	29%	

Our weather forecast for the 15 largest EU solar markets shows a very different picture from last year. For five countries, we see clouds on the horizon when it comes to political support: France, the Netherlands, Romania, Denmark, and Portugal.

France's solar story has been mostly disappointing considering its huge potential – being one of Europe's leading economies with vast space and plenty of sunshine. While the majority of upcoming installations are anticipated to be ground-mounted, they are meant to take place in designated go-to areas, which are not yet fully defined. Agri-PV also holds significant potential but remains a subject of heated debate in the country, currently hindering the emergence of very large solar power plants. Considering the slow pace of legislative progression, we have a cloudy outlook for the country, which, by 2027, is expected to have only less than half the installed capacity of Spain, and a fourth of the German installed power fleet.

At first sight, **Romania's** prospects look splendid based on our Medium Scenario's 41% compound annual growth rate (CAGR) until 2027, but key challenges already highlighted in our previous edition persist. Large PV projects planned on agricultural lands exceeding 50 hectares still face obstacles from the Ministry of Agriculture and Rural Development (MARD) to secure permitting, among others. If not lifted, our high growth expectations, leading to a quadrupling of Romania's total PV capacity to 8.7 GW within four years, are at risk. Our Low Scenario's estimate only 4.1 GW additions in that period.

Denmark is another country facing difficulties in the solar segment. While utility-scale, subsidy-free projects have played a crucial role in Denmark's recent solar boom, the implementation of higher grid connection fees in January 2023 led to a substantial slowdown in the segment. The impact was evident in 2023, with a significant market decline, and it is anticipated to extend into 2024. While we anticipate the issue to be resolved, the market is expected to take a couple of years to recover to its previous levels.

Clouds have formed over **the Netherlands'** solar segment lately. The country witnessed a significant surge in solar adoption in recent years, propelled by the net-metering scheme and the SDE++ auction scheme for larger projects. However, concerns arise as the net-metering scheme is set to phase out by 2030, with the exact practicalities still undefined, creating uncertainty in the market. Additionally, restrictive conditions for ground-mounted PV construction have been established, and the recent election results in November might alter political support for renewables. While the impact of these recent changes on the market is challenging to assess at this stage, the uncertainties they introduce justify a cautious take on the Netherland's political support prospects.

11 MW, Gouts, France. © Akuo

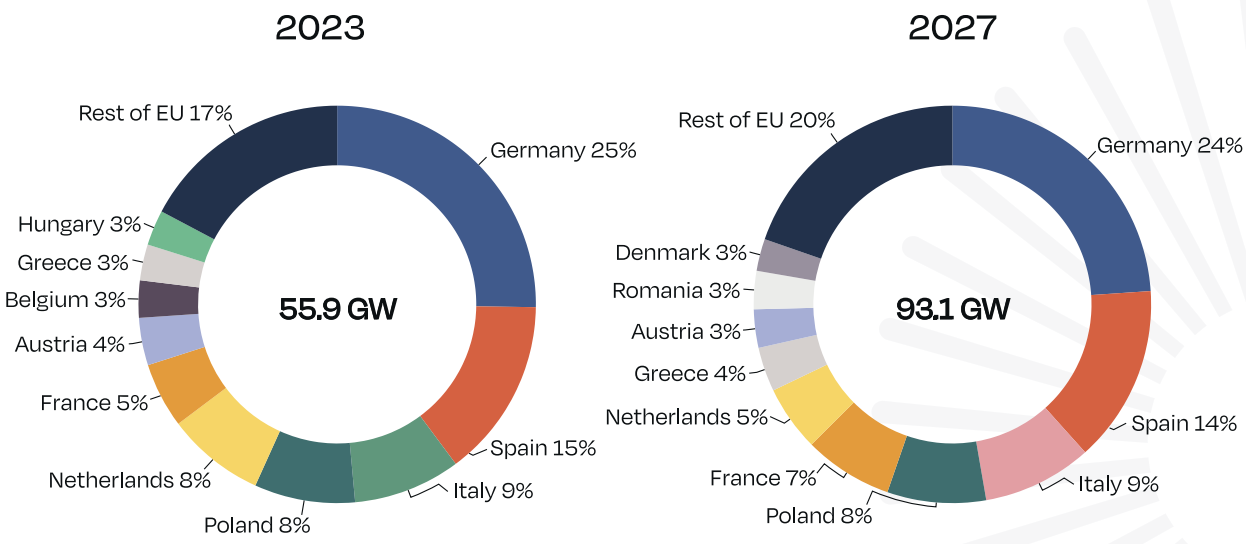
Meanwhile, **Portugal** faces gloomy prospects primarily due to complicated and slow permitting procedures, hindering the growth of large-scale solar projects. Despite the ambitious targets outlined in its revised draft NECP, the time required to translate these aspirations into on-the-ground installations poses a potential obstacle to progress.

On a different note, **Hungary** won't feature among our top 15 largest growth markets anymore. The prohibition on feeding electricity from new solar installations into the grid, coupled with the conclusion of the net-metering scheme, has significantly reduced the attractiveness of solar PV for households. Moreover, limited grid capacity and scarce opportunities for proposing new projects further contribute to Hungary's diminished presence in the solar market.

In 2027, the EU annual solar market is expected to grow 67% to 93.1 GW, from 55.9 GW added in 2023. Fuelled by its ambitious long-term solar targets, Germany is supposed to continue its leading role in solar deployment among EU Member States; its share will only marginally decrease to 24% in 2027, compared to 25% in 2023.

In our Medium Scenario, Germany, Spain and Italy will be still the three largest markets in 2027 and are only expected to experience a slight decrease in their combined market share, from 49% to 47%. The only noteworthy change in the top 5 is the switch between France and the Netherlands, now ranking #5 and #6 respectively. The top 5 combined annual market sees a marginal decrease from 65% to 63%, while the top 10 market share will decline from 83% to 80%, indicating a broader distribution of solar demand across more EU Member States.

FIGURE 21 EU-27 SHARES OF TOP 10 SOLAR MARKETS IN 2023 AND 2027



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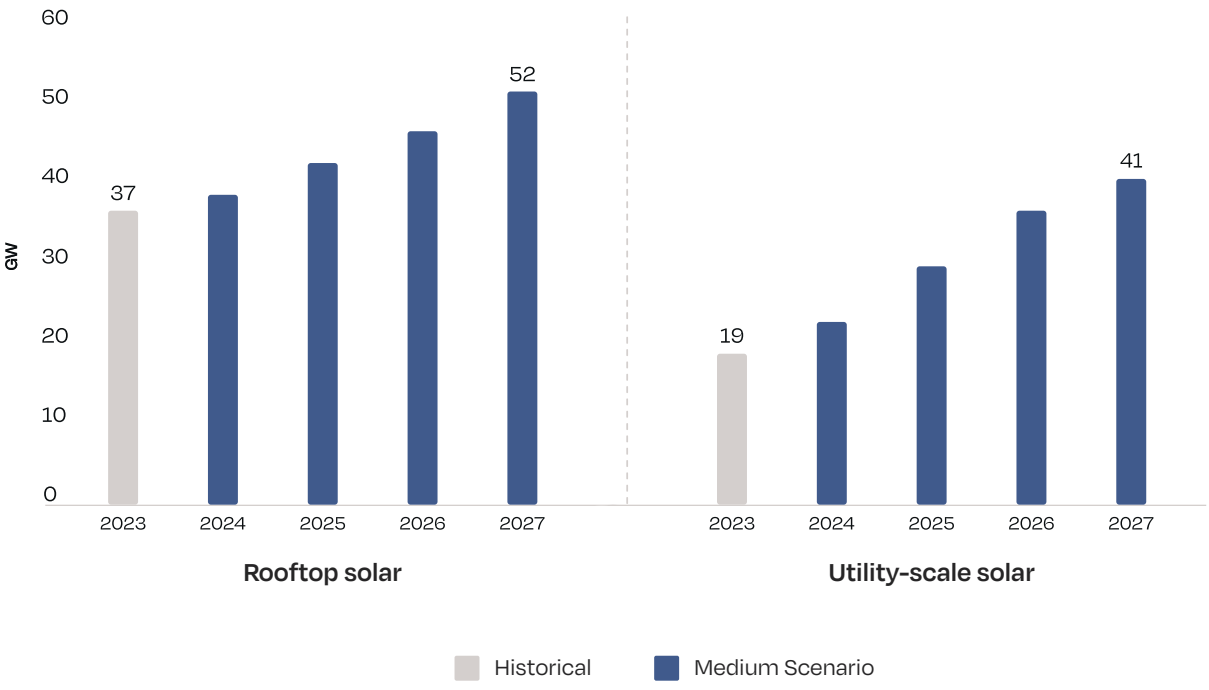
Segments 2024-2027

Solar rooftop systems and ground-mounted solar installations are both expected to grow significantly over the coming years – with solar rooftop additions improving 41% from 37 GW in 2023 to 52 GW in 2027, and solar plants annual deployment more than doubling from 19 GW in 2023 to 41 GW in 2027. This shows a very different picture than in the previous edition, when we had forecasted balanced installation volumes between the two segments to be reached by 2026. But the energy crisis has significantly reshaped the dynamics of the PV landscape in Europe. Sensitised for solar power as an effective tool to control energy bills and a continuous trend to electrify heat and transport will drive rooftop solar both in the residential and commercial segment in the long run, but at more sustainable levels than during the rush of the energy crisis. Ground-mount solar will grow as well though at a lower rate than anticipated earlier. Challenging economic boundary conditions in today's inflationary environment, unresolved permitting challenges and grid connection issues on local levels are making life difficult for utility-scale power plant developers and IPPs. That's why low solar system component prices are key for the well-being of the utility-scale business.

In cumulative terms, utility-scale solar is projected to grow from 89.6 GW in 2023 to 222 GW in 2027, equal to a 4-perentage-point growth from a share of 44% in 2023 to 48% four years later. Rooftops on the other hand are expected to increase their installed capacity from 174 GW to 355 GW, while losing, in relative terms, 4 percentage points from its 66% share in 2023 to 62% in 2027.

FIGURE 22 EU-27 SOLAR PV ROOFTOP AND UTILITY-SCALE SEGMENTS SCENARIOS 2023-2027



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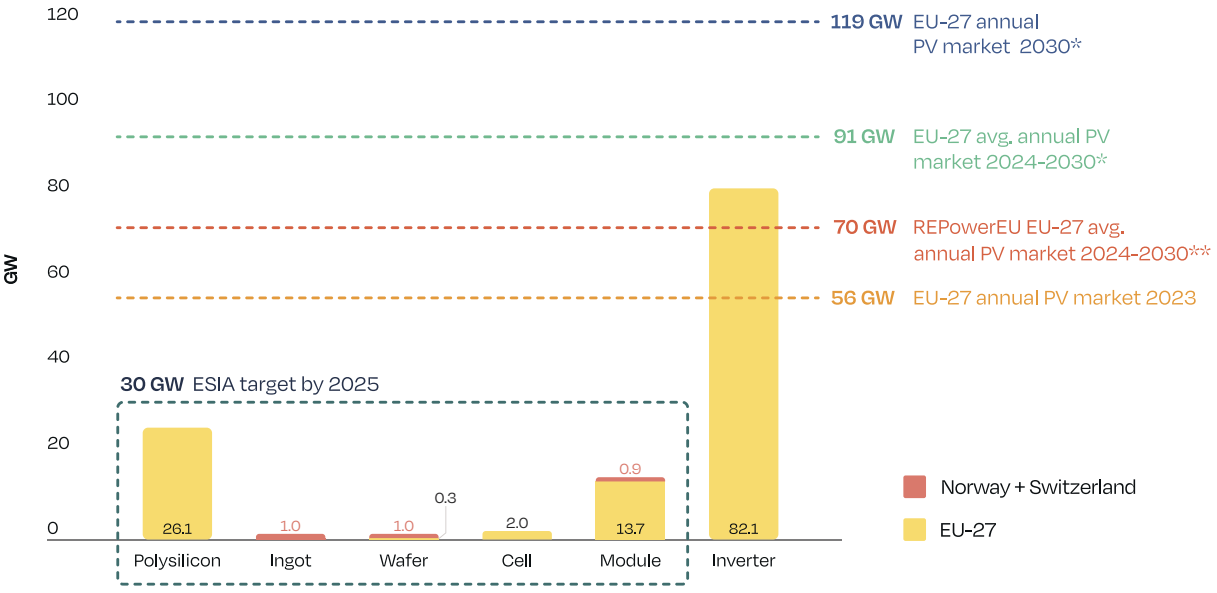
2 The European Solar Manufacturing landscape in 2023

Sattledt, Austria. © Fronius

The following section analyses both the current state of European solar manufacturing and the necessary steps to reach the targeted capacities. The original goal of reaching 30 GW by 2025 no longer seems feasible. Instead, 30 GW by 2030 is commonly referred to as the target for re-shoring solar manufacturing capacity. When looking at the total current capacities, this level is nearly reached for polysilicon (Figure 23). Here, one single firm holds all this capacity, it has long established customers, and some part is bound to semiconductor products. Module manufacturing capacities are roughly half those of polysilicon and manufacturers are unable to source cells locally due to the lacking middle segment. Ingot and wafer factories' capacities are around 1 GW and are located outside the EU-27 region. Therefore, the 2 GW of European cell capacity, which is used for in-house made modules, relies mostly on outside-EU wafer

FIGURE 23 ESIA MANUFACTURING TARGETS AND SOLAR PV DEPLOYMENT SCENARIOS



*SolarPower Europe Medium Scenario projection to 2030

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

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imports. This means that, if these module capacities were fully utilised, less than 2% of the current demand could be met with European-produced solar PV. On the bright side, inverter manufacturing remains the backbone of the European solar industry employing over two thirds of all solar-related manufacturing personnel in the EU.

The next 7 years will be crucial to deploy manufacturing capacity to the level of at least 30 GW. Upstream production capacity takes years to set up, and reshoring expertise to the level of international competition will be a major challenge as well, because not all production equipment needed is available from European manufacturers today. Nonetheless, global supply chain diversification efforts are reaping results. Both the US Inflation Reduction Act (IRA) and the Indian Production Linked Incentive scheme (PLI) have steered large quantities of private and public capital towards the deployment of scaled factories. In the EU, lessons can be learned from these policies as (upstream) developments are currently frozen. As in other geographies, there is a clear need for an EU solar industrial policy. Currently, no adequate framework is in place to launch the development of a well-integrated and scaled EU manufacturing chain. To unlock bankability and attract the necessary investments in the industry, SolarPower Europe recommends three actions that could be implemented in a matter of weeks:

1. Adjust EU State Aid Rules to allow Member States to support the running costs of factories.
2. Create 'resilience' auctions and procurement under the Net-Zero Industry Act.
3. Set up a dedicated EU Finance tool – like a Solar Manufacturing Bank.

Demand security is crucial to attract private capital and for the overall long-term sustainability of these future factories. While resilience auctions and a dedicated Solar Manufacturing Bank can ensure offtake agreements are made for a few years, on the long run, a stable and sustained domestic market is a key criterion. Therefore, it is crucial that no trade barriers are placed that could harm the attractiveness of solar PV as an energy source. History has shown that solar trade defence measures intended on creating a local industry do much more harm than good, both for overall deployment and solar-related jobs. In the EU, protectionist policies in the early 2010s (a Minimum Import Tariff for cells and modules was implemented in 2013 for 5 years) have contributed to a several-year solar demand slump. In the US, multiple trade defence measures were ineffective at creating a local industry and seriously harmed solar deployment. Only after the implementation of the IRA, manufacturers started notably expanding into the US. In India, the taxation of cells and modules plus the exclusion of certain module manufacturers from the market has halted the

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forecasted growth of solar deployment. Most recently, the Indian government paused the ALMM policy since local solar developers were not able to bring to life their projects without imported modules. Our analysis shows that, just like in these examples, trade defence measures would not be in line with the interest of the EU. In total, an estimated 400,000 solar jobs could be lost, and the deployment could slow down to far below the REPowerEU target of 750 GW (600 GW_{AC}) by 2030.

European Solar Manufacturing Map

The map of the solar manufacturing landscape in the EU and Norway has been updated, based on the industry developments that took place throughout 2023. The objective of this map is to illustrate the today's production capacities across key segments in the solar value chain within the EU-27 Member States, Norway and Switzerland. 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 2023, are illustrated on our solar map (see Fig. 24).

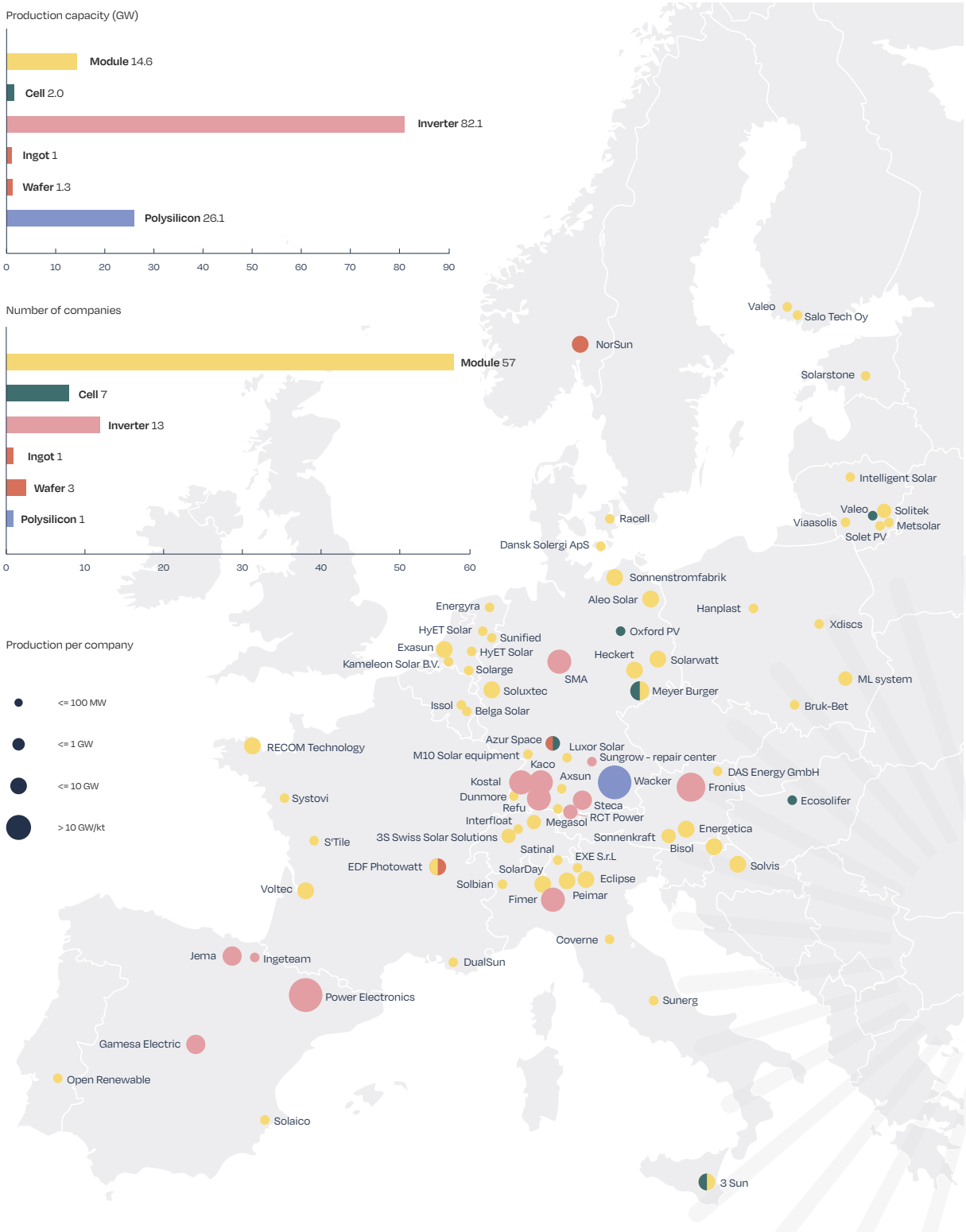
Inverter production remains by far the largest European solar manufacturing segment, with a production capacity reaching over 82 GW, about 14% more than in 2022 (72 GW). Today, inverter manufacturers are still the backbone of solar employment in the EU, as shown in our latest EU Solar Jobs Report 2023. With at least 13 organisations employing more than 70% of all manufacturing jobs, several of these European companies are also international leaders like SMA from Germany and Fronius from Austria. Despite the fierce global competition and high stockage in Europe, the major European inverter manufacturers are still holding their ground. Most companies present in the sector have either maintained their 2022 production levels, or even increased their manufacturing scale.

When looking into the European solar module value chain, the largest manufacturer remains the only one active in the solar silicon segment. Wacker Chemie is the sole EU company to operate polysilicon production facilities with a capacity of around 60,000 metric tons in Germany, which translates into over 26 GW of cell/module products. REC Solar Norway, the other producer of solar silicon in Europe, announced the closedown of its activities in November 2023 amid negative market developments, high production costs and volatile power prices. The shutting of its Norwegian operations means the loss of around 8,500 tons of production capacity for upgraded silicon material (around 3.7 GW) and over 100 workers.

Silicon **ingots & wafer** manufacturing, the next step in the solar value chain after polysilicon production, has also been negatively affected by current market conditions and lack of policy support. The bankruptcy of monocrystalline silicon ingot production start-up Norwegian Crystals, announced in August 2023, is bad news for the rebuilding of the supply chain of the PV industry in Europe. The company had been seeking long-term equity capital to finance its planned expansion from an annual production capacity of 500 MW to 4 GW for a long time. Basically, all of Europe's around 1 GW wafer capacity is still located in Norway, with NorSun providing around 1 GW of ingot/wafer production. However, NorSun has announced in September 2023 a provisional suspension of production until end of 2023, resulting in temporary employee layoffs. In Germany, promising wafer start-up NexWafe announced in May 2023 that it has raised over 100 million EUR to fund its operations. The company aims to produce ultra-thin, highly efficient, next-generation monocrystalline green solar wafers in the eastern town of Bitterfeld and plans to start production in 2025, with 250 MW of yearly wafer production.

The EU's solar cell production capacity increased to 2 GW in 2023, from around 1.4 GW last year. There are now seven companies active in the segment. The EU's largest solar cell manufacturer is Meyer Burger, which currently owns 1.4 GW of cell and module production in Germany. The Swiss manufacturer more than tripled its existing capacity in 2023 and might scale up production to 3.5 GW by 2025, depending on the right policy and financing framework. The company started to ramp up a second module production line for its high-efficiency heterojunction solar cells in September 2022, but rather focuses now on its expansion in the US. The other ambitious module producer with internal cell capacities is Enel's 3Sun, which built a 200 MW HJT cell/module line in Catania, Sicily in 2019/2020, which is now the base for a 3 GW capacity cell/module project. Enel was the first to win a grant for a solar manufacturing plant in the first round for large-scale projects of the EU Innovation Fund in November 2021, which is being used to increase production to 400 MW in 2023, and 3 GW in 2024. At the same time, attracted by the US Inflation Reduction Act, both Meyer Burger

FIGURE 24 EU-27, NORWAY AND SWITZERLAND SOLAR MANUFACTURING MAP



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and Enel announced their expansion of production activities into the US. Enel announced to build 3-6 GW production capacity and Meyer Burger intends to establish 2 GW of cells/modules production in the US.

Apart from the two EU-based cell/module manufacturers that produce cells for internal consumption, a large number of EU **module manufacturers** have decided not to manufacture their cells but instead import them from Asia. Due to the relatively low investment cost associated with pure solar module manufacturing compared to other stages of the solar module manufacturing chain, this segment has witnessed the highest level of activity. However, this segment is primarily driven by numerous small and local companies, each operating with capacities in the sub-GW range. As of 2023, a minimum of 57 module manufacturers have established factories in the European Union. The total module production capacity currently stands at around 14.6 GW, 59% higher than in 2022 (9.1 GW). The largest module manufacturer is RECOM Technology, which has expanded its production capacity to 3.2 GW.

Looking ahead, some notable announcements that are planned to materialise by 2025 include Carbon's ambition to build a 5 GW vertically integrated gigafactory of ingots, n-type wafers, and TOPCon cells, and a 3.5 GW module assembly line in France. The firm plans to employ more than 3,000 direct workers by 2027. In the Netherlands, MCPV is actively working to construct a 3 GW heterojunction cell and module manufacturing plant by 2026, starting with a 300 MW line.

While **processing materials** and **production equipment** for cell and module production are mostly made in Asia these days, there are still European leaders active in this field, though much fewer than during the heydays of solar manufacturing in Europe in the first decade of the century. Such companies include vacuum machine equipment supplier von Ardenne in Germany, and chemical company Borealis, which is supplying products for module encapsulation.

The EU is also home to world-leading players in the **Balance-of-System (BOS)** field, including fixed mounting structure suppliers, such as K2 from Germany, and solar trackers, such as Soltec and Trina Solar's TrinaTracker in Spain, and companies offering both, like Schletter from Germany.

The core of Europe's in-depth solar technology knowledge is a vast and well-connected **research and development (R&D)** ecosystem. Europe's solar manufacturers can rely on specialised PV research institutes in several countries, such as AIT in Austria, IMEC in Belgium, Fraunhofer ISE & CST, FZ Jülich and ZSW in Germany, CEA-INES and IPVF in France, TNO in the Netherlands, and CSEM in Switzerland, among others.

This PV Manufacturing Map is an ongoing project – and is also published on our website. If you believe that your company should be featured, please contact us at info@solarpowereurope.org.

3 NECP solar targets and outlook to 2030

Nolato 7.2 MW solar park Åhus, Sweden. © Alight

We have conducted an updated review of all EU Member States, assessing their progress towards achieving their 2030 solar targets as indicated in their National Energy and Climate Plans (NECPs). The new review builds on the publication of new draft updated NECPs in 2023. While Member States were due to submit their updated draft NECPs by 30th June 2023, only a handful of documents were submitted at that time. By our editorial deadline at the end of November, 22 Member States had published a new NECP draft, with 5 others still missing.[2] In our analysis, we have compared national solar PV targets provided in the latest NECPs available, with our most-likely scenario projections until the end of the decade.

In 2022, 5 Member States – Estonia, Latvia, Ireland, Poland and Sweden – had already reached their 2030 solar targets.[3] Poland's solar capacity was 8 years early even 72% higher than its 2030 target, an indication that the technology wasn't on the radar at the time of writing the NECP. In last year's analysis, we estimated that 21 EU Member States would reach their 2030 goals no later than 2025, and the remaining 6 would do so no later than 2027. According to our updated market development projections, and considering the most recent targets available, 5 EU countries have already reached their 2030 target, 13 will do so by the end of 2027 – when our 5-year forecasting period ends –, and 9 will reach it after 2027 (see Figure 25). Looking only at the 22 countries that have updated their NECPs, we expect 5 to meet their 2030 targets already by 2025, and 12 by the end of 2027.

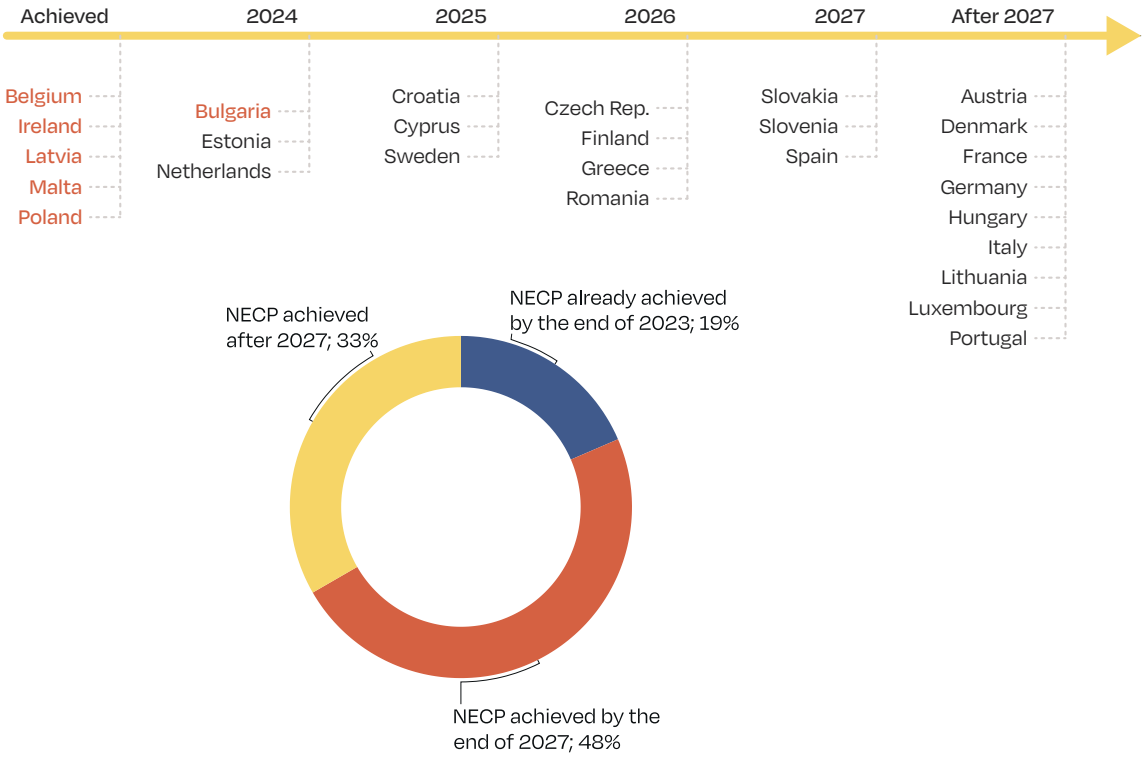
2 Member States that did not update a 2023 NECP draft by end of November 2023: Belgium, Bulgaria, Ireland, Latvia, Poland.

3 Latvia's NECP does not include a solar target.

3 NECP and EU 2030 market outlook

/ continued

FIGURE 25 SHARE OF EU COUNTRIES REACHING THEIR NECP TARGET WITH THE NEXT FOUR YEARS



Note: Countries in red are without an updated NECP target.

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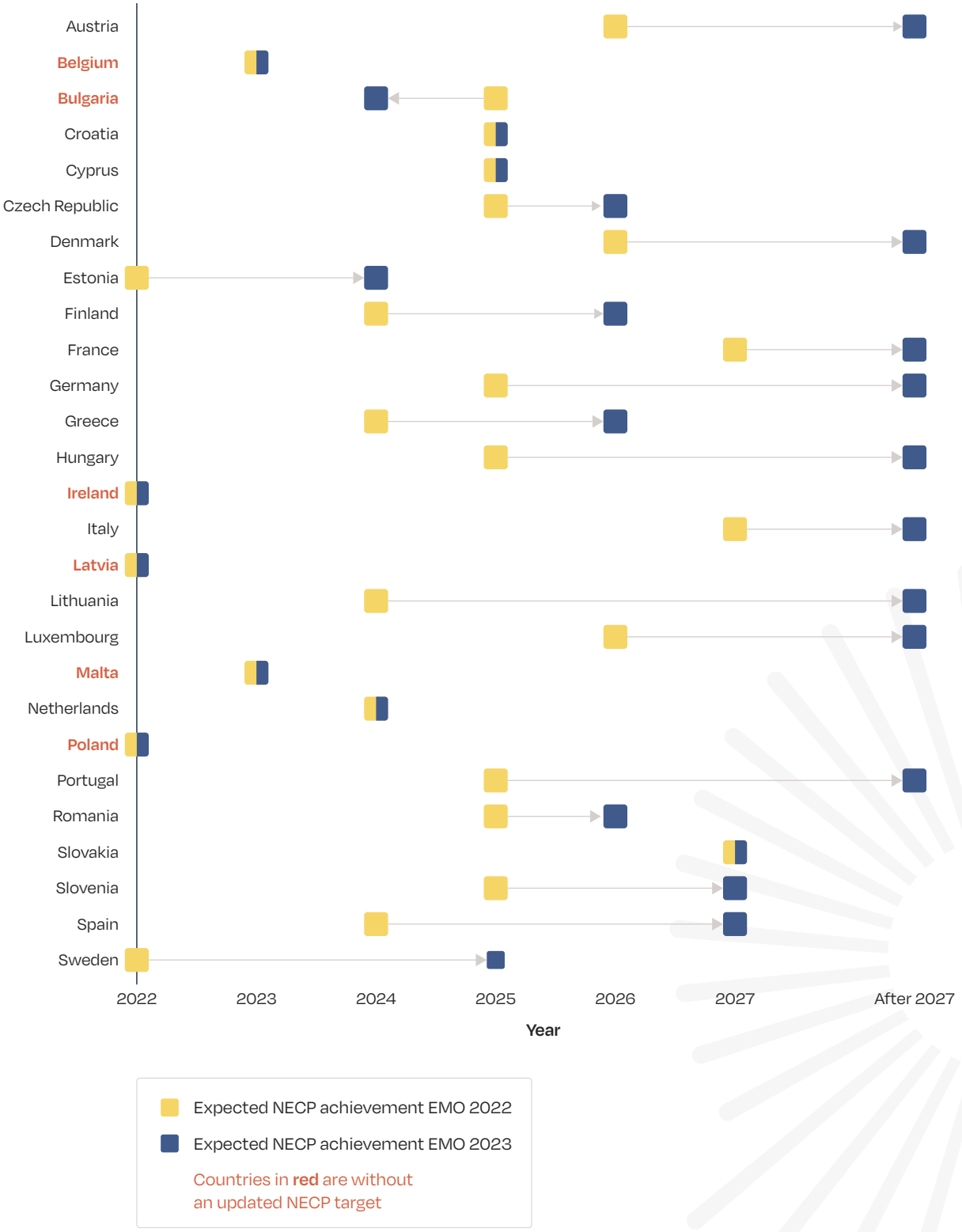
The NECP update process has significantly raised solar ambition in Member States who have submitted a new draft. Some notable cases include Lithuania, which saw a five-fold increase of its target to 5.1 GW; Spain, whose target grew 94% from 36.8 GW to 76 GW; Portugal, which more than doubled its target to 20.4 GW; and Germany, whose ambitious 215 GW solar target is now also manifested in its new NECP, a 119% increase compared to the former NECP.

In several EU countries, the pace of PV deployment has accelerated further, bringing more capacity online than previously expected. Despite this trend, the increase in solar ambition through the setting of revised targets has resulted in many Member States now projected to reach their goals at a later point in time (see Fig. 26). According to our updated market development projections, 18 EU Member States will reach their most recent NECP target later than we predicted last year. Out of the six Member States without a new NECP target, five have already reached their targets, while Bulgaria, the only country from this list that has not yet met its 2019 target, is also the only country that is expected to achieve its target earlier than previously thought.

FIGURE 26 TIMELINE OF EXPECTED NECP SOLAR TARGET ACHIEVEMENT



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3 NECP and EU 2030 market outlook

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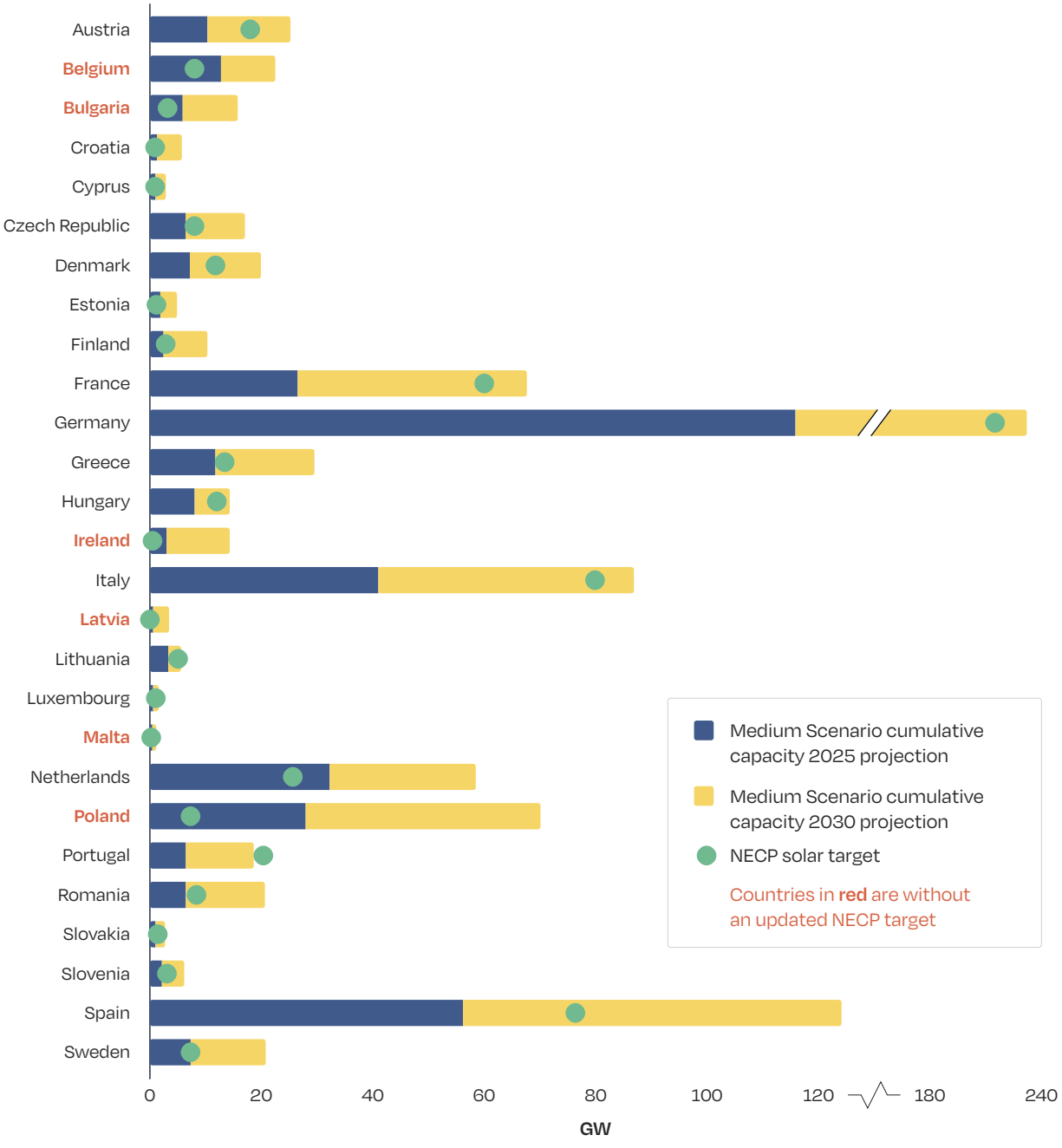
Figure 27 displays each Member State's most recent NECP target in comparison to the Medium Scenario solar capacity operating in 2025, and to the Medium Scenario projection to 2030 based on expected market dynamics. The chart also shows the size of individual countries' contribution to the aggregate NECP target. Intuitively, the largest Member States – Germany, Italy, Spain and France – are those with the highest absolute targets, although there are stark differences within this group as well. While Germany clearly stands out, France, the only market in Europe facing declining annual market growth in 2022, is also lagging behind in the group of Europe's largest economies, despite abundance of space and sunshine.

FIGURE 27 EU-27 SOLAR PV CUMULATIVE CAPACITY IN 2025 AND 2030 COMPARED TO NECP TARGET



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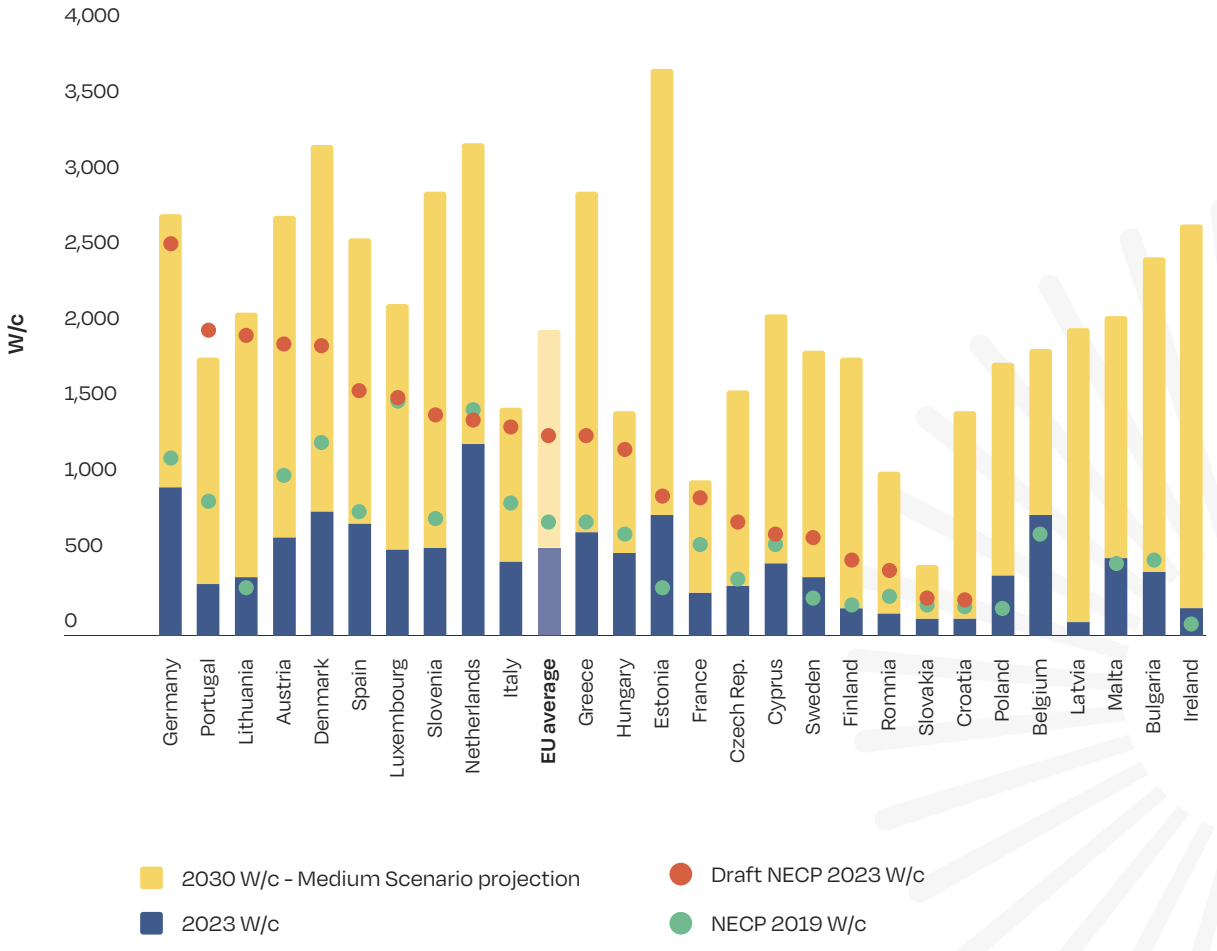
Analysing the 2030 solar targets and market projections using the W/capita dimension is illustrative to compare the varying levels of ambition across Member States. Figure 28 displays current installed PV capacities, solar NECP targets and projected 2030 capacities under current market conditions in each Member State using the W/capita indicator. Germany, the country with the largest EU fleet and the highest NECP target, comes first in this ranking, too – its 215 GW solar target corresponds to 2.6 kW per person reached in 2030. The new NECP targets from Portugal, Lithuania, Austria and Denmark also correspond to very high per capita levels, ranging between 1.9 and 2.0 kW/c. Only the Netherlands, today's European per capita solar leader, is expected to have lower levels in 2030 based on the NECP 2023 compared to the earlier target, and at 1.4 kW per person even below the new average in 2030. On average, the new NECP targets would bring 1.5 kW per person, a 158% growth compared to the 0.59 kW/c level reached in 2023 across the EU. However, several NECPs – including all those that have not been revised – remain substantially below this threshold, indicating wide differences in the level of solar ambition across Member States.

FIGURE 28 EU-27 NECP TARGETS PER CAPITA VS MARKET PROJECTION



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3 NECP and EU 2030 market outlook

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Against this background, it is fundamental that the NECP revision process keeps going, remaining on par with market developments and ensuring that each Member State effectively contributes to the EU's renewable transition. As illustrated in Chapter 1, the EU annual PV market is poised to grow more than 67% from 55.9 GW installed in 2023 to 93.1 GW in 2027. For the period 2028-2030, we expect that further growth in new capacity additions will take place thanks to improved policy conditions and further technology cost reductions. In our Medium Scenario projections beyond 2027, we foresee a 119 GW annual solar market in 2030, increasing 28% from 2027 levels and 113% compared to 2023 (Figure 29).

Such an expansion in the annual market will be reflected in cumulative installed capacities. According to our Medium Scenario long-term projections, the total solar fleet in the EU will increase from 263 GW installed at the end of 2023 to 399 GW in 2025 and 902 GW in 2030 (see Figure 30). The 2030 cumulative capacity projection is 2% lower than last year's EMO projection, which stood at 920 GW, but remains substantially (20%) higher than the EC's 750 GW_{DC} (600 GW_{AC}) REPowerEU target.

FIGURE 29 EU-27 ANNUAL SOLAR PV MARKET SCENARIOS 2023-2030

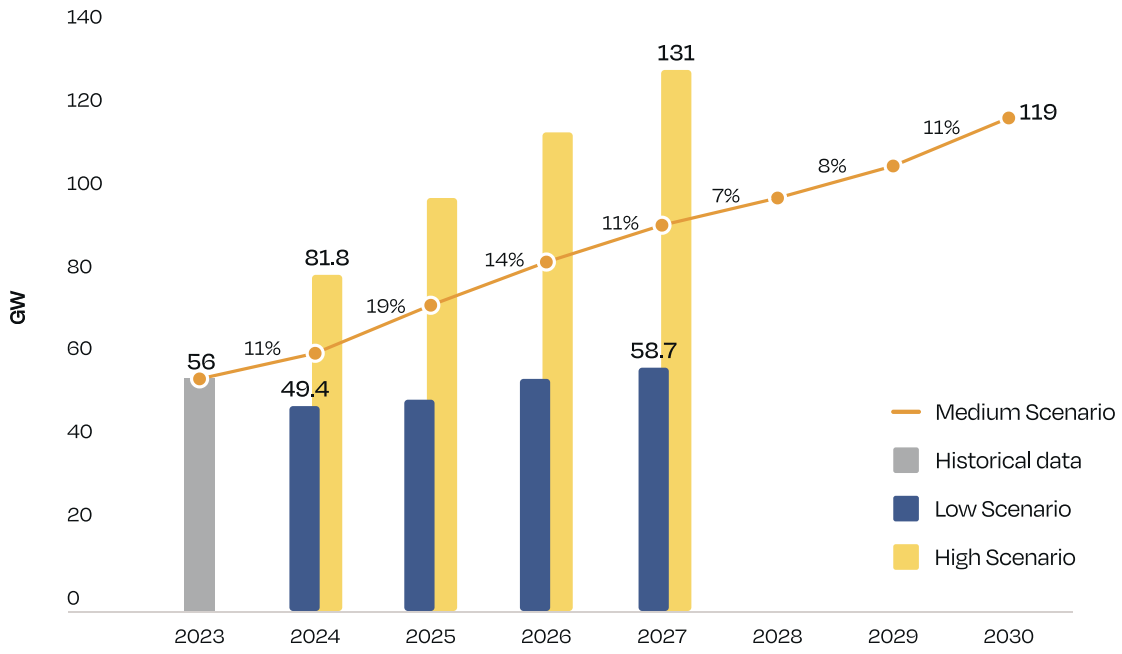

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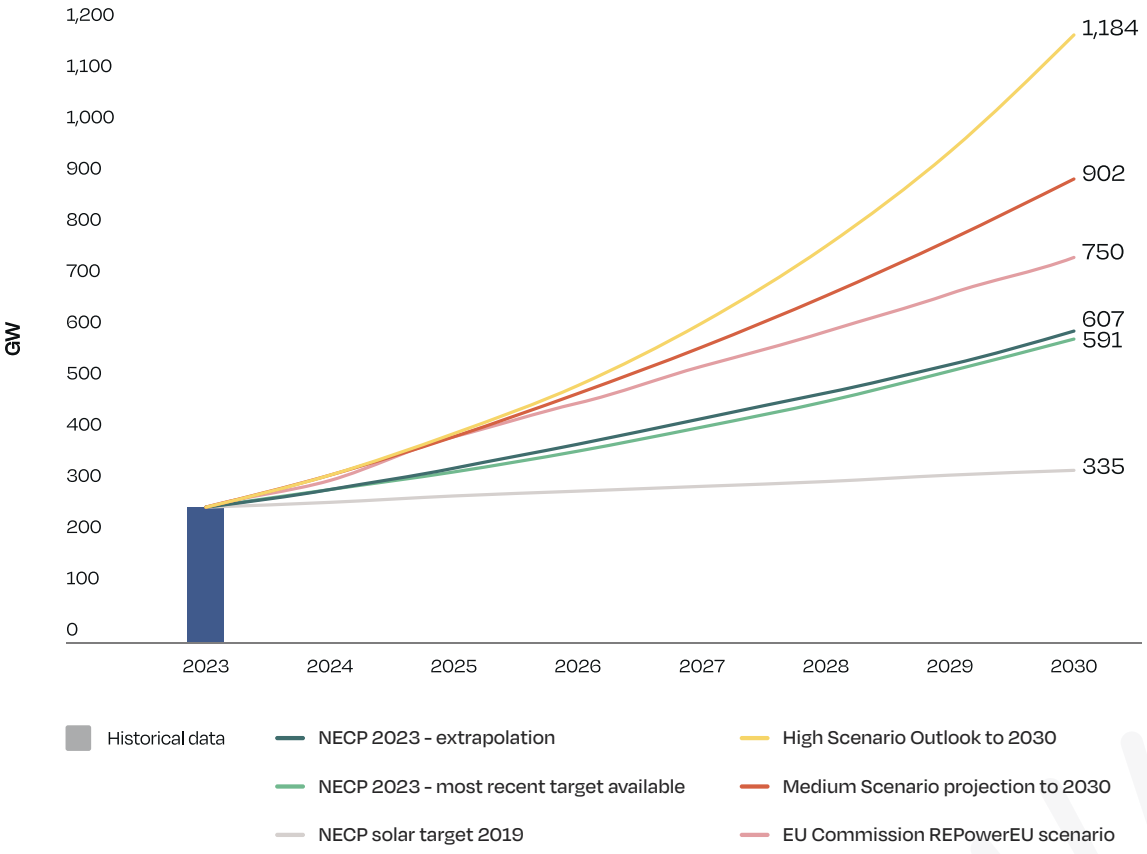
FIGURE 30 EU-27 TOTAL SOLAR PV MARKET SCENARIOS 2023-2030



NOTE: Based on data available as of end of November 2023.

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Within the 22 Member States that submitted their 2023 draft NECP, the aggregate solar target increased 81% from 316 GW to 572 GW.[4] Adding to this total the 2019 solar targets of the 5 laggard Member States brings the aggregate solar target based on the most recent available national targets to 591 GW. Lastly, if we extrapolate the 81% target growth rate from the Member States with a 2023 NECP draft to the broader EU-27, the increase in solar ambition leads to a cumulative target of 607 GW.

While this is striking growth compared to the previous 335 GW aggregate target, it remains substantially below our 902 GW market projection, and also the 750 GW REPowerEU target, which should be the absolute minimum level of ambition considering the current market dynamics.

For long-standing EU Market Outlook readers, it should no longer be a surprise that the aggregate NECP solar target severely falls short in ambition. The analysis above shows that several Member States have not yet grasped solar's tremendous potential, and only a few have set targets that can be considered in line with the success of this unique power generation technology. As long as those low-ambition national solar targets bring down the EU average, the aggregate EU-27 PV targets will be met well before 2030: the most-recent 591 GW NECP target will be passed more than three years in advance, and the 607 GW extrapolated target more than two years in advance.

Like last year, the 902 GW total market size in our Medium Scenario projection to 2030 overshoots the

4 Malta submitted a new NEPC draft but did not include a revised solar target.

3 NECP and EU 2030 market outlook

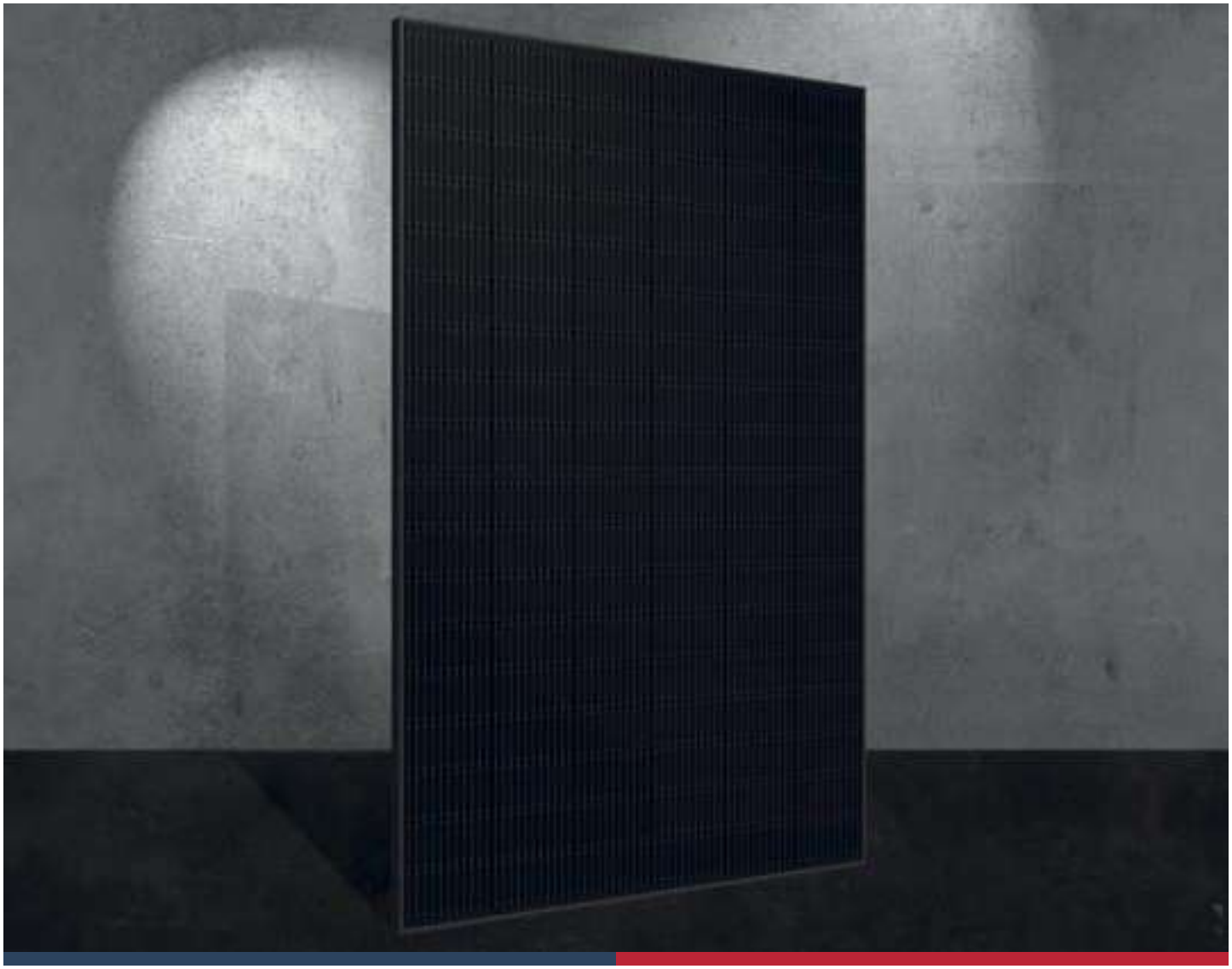
/ continued

REPowerEU strategy's 750 GW solar target by a large margin, with 152 GW more than the Commission's goal. According to our model, the current policy and investment conditions will enable the EU to meet its REPowerEU solar target already in 2029, one year ahead of schedule.

While this is very positive news for the sector, and for the entire EU, it also indicates that the ambition could be raised even further. In fact, for the EU to remain on track to deliver on a 1.5 °C Paris Agreement scenario, ambition on renewable energy deployment must be raised. Our High Scenario projection to 2030 illustrates that if the obstacles to solar development are lifted, and all Member States set appropriate levels of ambition and enabling policy frameworks, the EU could cross 1,184 GW of solar installations by the end of the decade, which is 50% higher than the REPowerEU goal. Reaching the TW-level milestone by 2030 would pave the way for a multi-TW solar development towards 2050, which is needed for the EU to remain on its clean electrification track to deliver on its climate ambitions.

300 MW Talayuela solar park, Caceres, Spain.

© Statkraft



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NECP – AUSTRIA

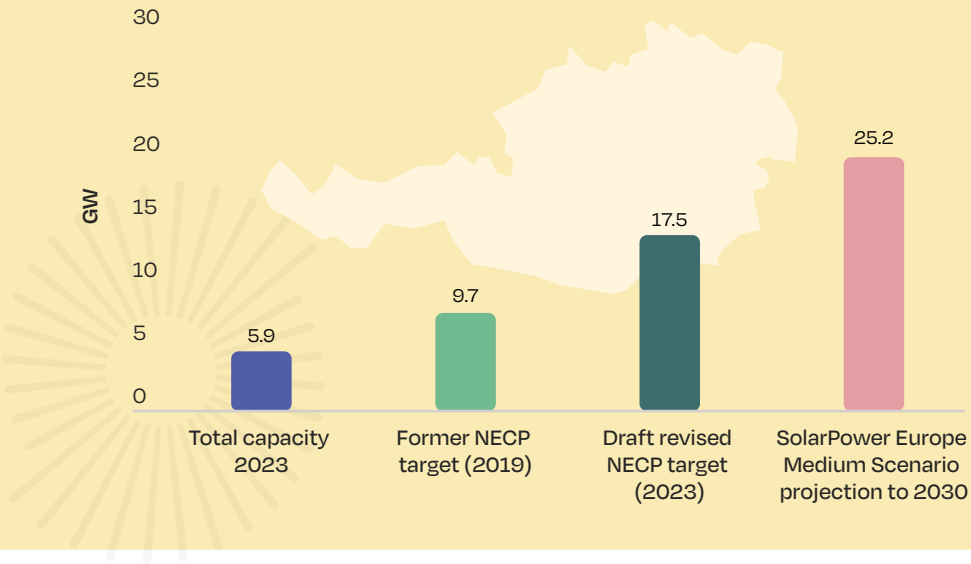
Targets

Austria has updated its renewable energy target following the amendment of the renewable energy Directive to at least 60% by 2030, compared with 46%-50% from the previous NECP. In the scenario with additional measures (WAM), Austria reaches 52.6% RES by 2030. The gap will need to be filled with additional measures. In the electricity sector, Austria is among the few Member States that are planning to produce 100% of their generated electricity exclusively with renewables by 2030. It is to be noted that Austria plans to be climate neutral (almost 100% RES) already by 2040.

To reach this goal, in 2021 Austria published a national renewable expansion law (ger. EAG), which determines an increase in annual PV-production from 2 TWh/a (2020) to 13 TWh/a until 2030. In autumn 2023, those figures were revised by the federal environment office. According to it, a PV production of 21 TWh/a by 2030 and 41 TWh/a by 2040 is necessary to reach both goals – 100% renewable electricity production by 2030 and climate neutrality by 2040. This is a massive increase compared to the previous NECP target of 3 TWh and compared to the 2020 figure of 2 TWh. Assuming an average 1,200 GWh/GW conversion rate, this results in 17.5 GW by 2030, and above 1,900 W/capita, one of the highest scores in the EU. Despite this high level of ambition, the target is still somewhat below SolarPower Europe's Medium Scenario projection to 2030, whereby Austria deploys about 25 GW of solar capacity thanks to improved market conditions. The plan mentions the one million roof initiative for solar PV but does not indicate any breakdown in capacity between rooftop and ground-mounted. The industry estimates the breakdown of rooftop vs. ground-mounted at around 50% / 50%.

Enabling measures

- **Support schemes:** The rapid expansion of solar PV will be supported by the Government's "photovoltaic offensive" with a 596 million EUR budget in 2023, and a budget of 150 million EUR per year for investment support under the Climate and Energy Fund. The expansion law plans tax reduction for installations <35 kW starting in 2024, but the visibility on the exact measures is still unclear. The plan provides no visibility post-2030 on the support system for solar PV.
- **Prosumers and citizens:** Austria foresees the possibility for energy communities and active consumers to participate in the market; however, with no clear targets in terms of the deployment of community schemes . In general, the plan fails to provide clear quantitative targets for prosumers.
- **Flexibility and storage:** Austria has set a target for smart meters roll-out of 40% for 2022 and 95% for 2024. It also foresees investments in storage systems, with a total of 50 million EUR for innovative electricity and heat storage. It is also expected to integrate prosumers in the electricity markets via aggregators. The plan provides targets to reduce peak demand but doesn't provide more details on the enabling measures and targets for demand-response.
- **Grids:** In terms of interconnection capacity, Austria is already well above the 15% target required by the EU. Austria is, therefore, not planning any further interconnection targets, but will maintain its current high electricity interconnection ratio, in the context of increased generation from wind and solar. Austria plans to accelerate the permitting process for grids and provides details on the power lines to be built in each region. The plan also mentions the Pentalateral Energy Forum between Belgium, France, Luxembourg and the Netherlands to integrate markets for increasing RES integration. The plan also mentions investments in distribution grid, with no quantitative target, however.



NECP – CROATIA

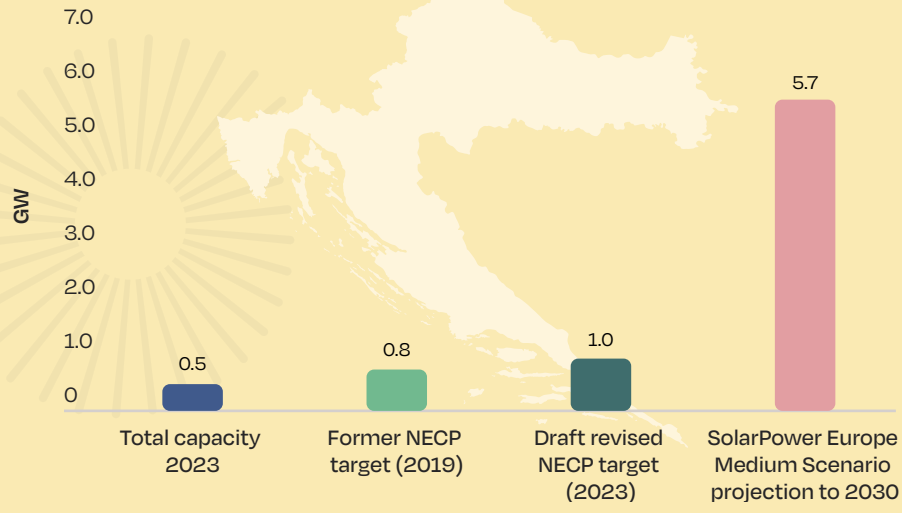
Targets

Croatia has set a target of 42.5% renewable energy by 2030, an increase of 6 percentage points compared with the previous NECP, and almost an 11 percentage points increase compared with 2021. The increase is even more pronounced in the electricity sector, where the former target of 63.8% has been increased to 73.6%.

When it comes to solar PV, the plan, based on scenario with additional measures, foresees a total deployment slightly below 1 GW by 2030, a slight increase compared with the previous 0.8 GW target. This is still very low in terms of W/capita, with 249 W/capita, one of the lowest scores across the EU. This target also remains much below SolarPower Europe's Medium Scenario projection to 2030, whereby Croatia operates a 5.7 GW solar fleet by that year. A positive aspect to be noted, the plan provides a clear breakdown between rooftop PV (576 MW) and utility-scale (384 MW), although both segments are expected to be reached much sooner than 2030.

Enabling measures

- **Support schemes:** The plan mentions the three-year RES planning and the corresponding tenders for market premia, with a gradual evolution into a market-based scheme. The overall budget for support to RES will be 1 billion EUR from 2021 to 2030. Most of this fund, however, will be targeted at thermal renewable and hydro, while large-scale wind and solar will be supported through market-based mechanisms. A clear agenda with the volume of auctions would, however, have been welcome. The plan could also have mentioned the need for additional regulation of the PPA market.
- **Prosumers and citizens:** the plan foresees an information programme targeted at prosumers, communities, aggregators, system operators and installers. It also mentions the development of support schemes adapted to RES communities and citizen energy. As a very positive feature, the plan mentions a monitoring of the number of and energy generated by energy communities. The plan could have also mentioned the expected volume of prosumers among rooftop PV installations and the volume of financial aid for prosumers.
- **Flexibility and storage:** The plan foresees a public call for the implementation of demand-response projects between 2023 and 2030, as well as new regulatory frameworks for aggregators and ancillary services. Regarding storage, the plan mentions the deployment of a whole range of technologies including battery, hydrogen, pumped storage, heat, EV, compressed gas and other innovative storage. The amount is estimated to be 19.8 and 13.3 million EUR respectively at the transmission and distribution level, mostly coming from the EU Modernisation Fund. Also, the plan foresees a support scheme for energy storage only via EU-funds.
- **Grids:** The interconnection level of the country is already exceeding – by far – both peak load and installed capacity. The plan does not provide any capacity figures nor a timeline for the reinforcement of interconnections with other Member States. On internal transmission capacities, while the plan clearly identifies the importance of RES-integration, it only mentions one power line, the 400 kV line Split-Rijeka.
- **Spatial planning and permitting:** the plan foresees development of sensitivity maps for RES projects, i.e. defining the so-called 'go-to' areas. RES Croatia (RESC) together with the experts identified 7,424 locations with a total area 101,825 ha for the solar PV. The plan envisioned the inclusion of Agri-PV within the Spatial Planning Act that was officially incorporated through the Amendments to the Spatial Planning Act on June 29, 2023. The plan fails to establish and define all the conditions and requirements necessary for establishing a single contact point that would be the sole point of contact with the investors. Also, the plan does not provide development of the National Maritime Spatial Plan, which is the first step in establishing renewable go-to areas for offshore renewables. RESC in the study *Action Plan for the Uptake of Offshore Renewable Energy Sources in Croatia*, funded by the EBRD, identified more than 29,000 km² of available area for offshore renewables.



NECP – CYPRUS

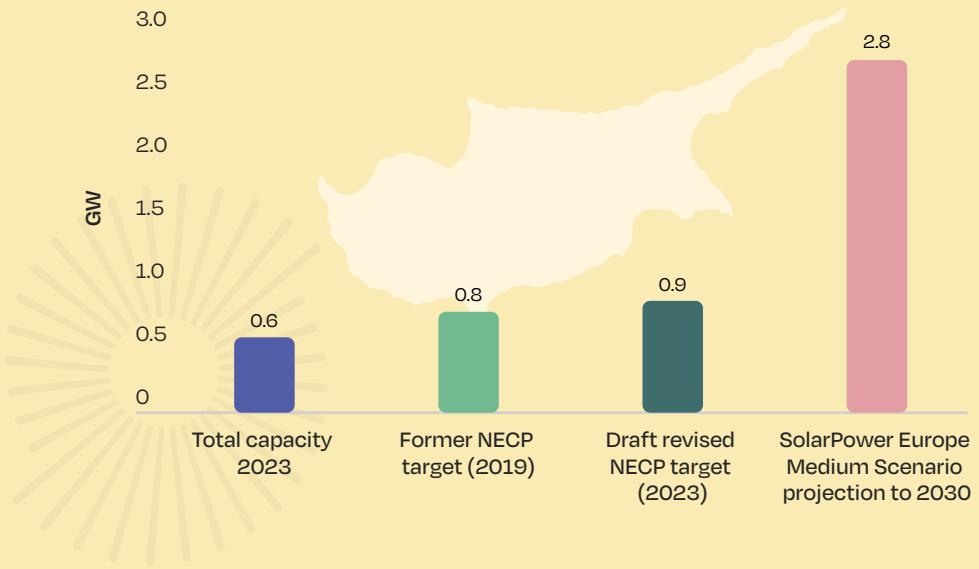
Targets

Cyprus has chosen to keep its renewable energy target of 23% for 2030, as described in the previous NECP. However, based on more recent scenarios introduced in the NECP, the country could reach 24.3% to 26.5% renewables in gross final consumption. It is however unclear if Cyprus is envisioning to update its renewable target accordingly. In the electricity sector, based on the scenarios described above, the RES-E share could reach 28.2% to 31.5%, a slight increase compared with the previous NECP.

When it comes to solar PV, Cyprus foresees a total capacity of 869 MW in the scenario with additional measures (WEM), a moderate increase compared with the previous NECP figure of 804 MW. This result is less than half of the EU average in terms of W/capita, with less than 700 W/capita. This target also remains far below SolarPower Europe's Medium Scenario projection to 2030, whereby Cyprus could deploy 2.8 GW of solar capacity by the end of the decade. Also, the plan does not provide a clear breakdown between rooftop PV and utility-scale.

Enabling measures

- **Support schemes:** In general, the chapter on support schemes is limited to a short description of measures, with no information on the investment timeline or volume. The plan also fails to provide details of the support scheme that has been developed for ground-mounted PV.
- **Prosumers and citizens:** Cyprus has developed a plan for self-consumption and net metering from 2013 to 2024 for residential buildings and from 2018 to 2030 for commercial/industrial buildings. Regarding energy communities, a regulatory framework is being developed. However, the plan does not provide details on the continuation or even the level of support of the plan for self-consumption and net metering. The plan neither provides objectives in terms of prosumers nor energy communities.
- **Flexibility and storage:** Currently, the electricity market in Cyprus does not support flexibility, aggregation or demand response. These services will be allowed by 2024. The plan also includes a target of 10 MW / 20 MWh flexibility in the form of storage by DSOs. The plan also provides a target of 1,000 kVA for each demand-response agent and 50 MW of demand-response capacity by 2030.
- **Grids:** Cyprus mentions EuroAsia Interconnector (between Greece, Cyprus and Israel) to fulfil its obligations of 15% electricity interconnection by 2030. The plan also mentions two measures in the transmission grid for the integration of RES: smart compensation system on transmission substations, and upgrading of transmission lines with re-ducting, to increase transmission capacity. However, the plan could have detailed the new transmission capacity (or equivalent) resulting from the network upgrades, and the provisional agenda. The plan does not provide an analysis nor an investment plan for distribution grid upgrade.



NECP – CZECH REPUBLIC

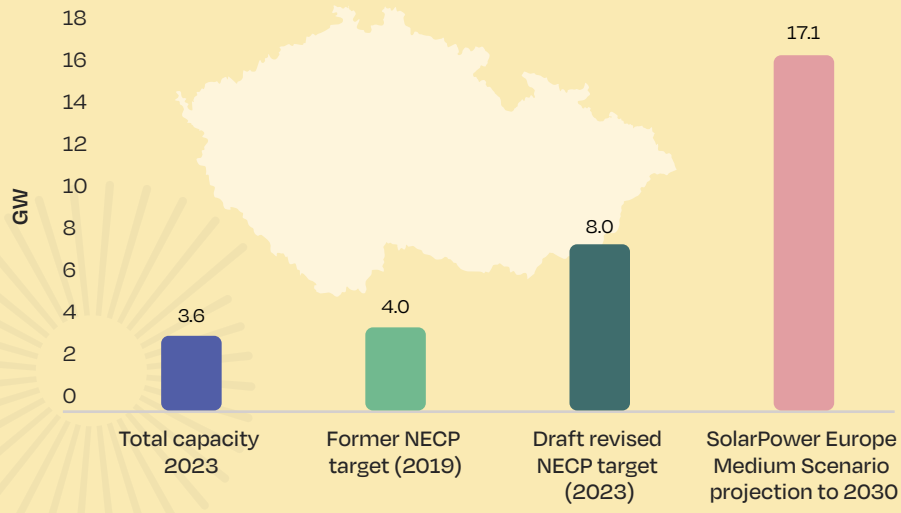
Targets

The Czech Republic has set up a renewable energy target of 30% for 2030, an 8% increase compared with the previous NECP. However, the plan does not include an updated target that matches with the 42.5% at the EU level. In the electricity sector, this is translated in the highest scenario with a share of 37.5% RES-E.

When it comes to solar PV, the Czech Republic foresees a total capacity ranging from 4 GW (with existing measures) to 8 GW (with additional measures). This latter target is twice the former NECP target, and above three times the currently installed capacity. However, in terms of W/capita, the Czech Republic is still far below the EU average, with 761 W/capita by 2030. While the original NECP target was set extremely low (1.9 GW additional PV in 10 years) and will be surpassed in 2024 already, the draft 8 GW target also remains below SolarPower Europe's Medium Scenario projection to 2030, whereby the country installs 17.1 GW of solar PV thanks to favourable policy and market conditions. According to the industry, there is a risk that the low target in the NECP could be used to limit solar growth. Also, the plan does not provide a clear breakdown between rooftop PV and utility-scale.

Enabling measures

- **Support schemes:** The plan proposes an à la carte approach for RES financial instruments, based on the fulfilment of the NECP trajectories and targets. The expected allocation of total public aid will be set by the Ministry of Industry in 2023, 2025 and 2027. However, no detail is provided in the plan as regards the nature (CapEx, OpEx, auction...) or the volume of support. In general, the chapter on RES support schemes is relatively short and lacks details on implementation.
- **Prosumers and citizens:** The plan presents the existing measures with a simplification of administrative procedures for small-scale PV below 10 kW. This is a minimum requirement under the Renewable Energy Directive. Since January 2023, Act No. 19/2023 provides that small-scale installations below 50 kW are not submitted to building permit. The plan also mentions the introduction of the recognition of energy communities, as provided in EU legislation, and the mobilization of the Modernisation Fund for energy communities. In January 2023, Czechia introduced an easier framework for energy sharing in apartment buildings, which is however yet to manifest in a relevant number of projects. According to the table in 5.3, the amount dedicated to energy communities could be 530 million EUR (13 bn. CZK). However, the plan does not provide any target for prosumers or energy communities in terms of installations. In addition, the legislative framework currently put forward for energy communities is extremely limiting (e.g. 10 members per community), which could significantly hamper the rollout of energy communities.
- **Flexibility and storage:** Demand-side flexibility, aggregation, smart metering and dynamic pricing are identified as strategic objectives. The plan foresees the design of an independent aggregator model for this purpose. However, no roadmap for the rollout of flexibility and storage is provided by the plan and the Czech law still does not define the framework for storage and flexibility.
- **Grids:** The Czech Republic is planning to deploy interconnection capacities corresponding to the EU target of 15% for 2030. The plan provides a rather detailed investment pipeline in transmission grid, with a reinforcement of 400 kV lines by 2040, and an increase in transformation power. It also mentions the introduction of new technologies in the power system; however, with no clear number on their penetration. A good point, the plan mentions the development of distribution networks, with a total of 81 new 110 kV substations. The plan also mentions the acceleration of investment in the modernisation of the distribution network by deploying software and hardware solutions. Nevertheless, no further information as to the volume of investment is provided.



NECP – DENMARK

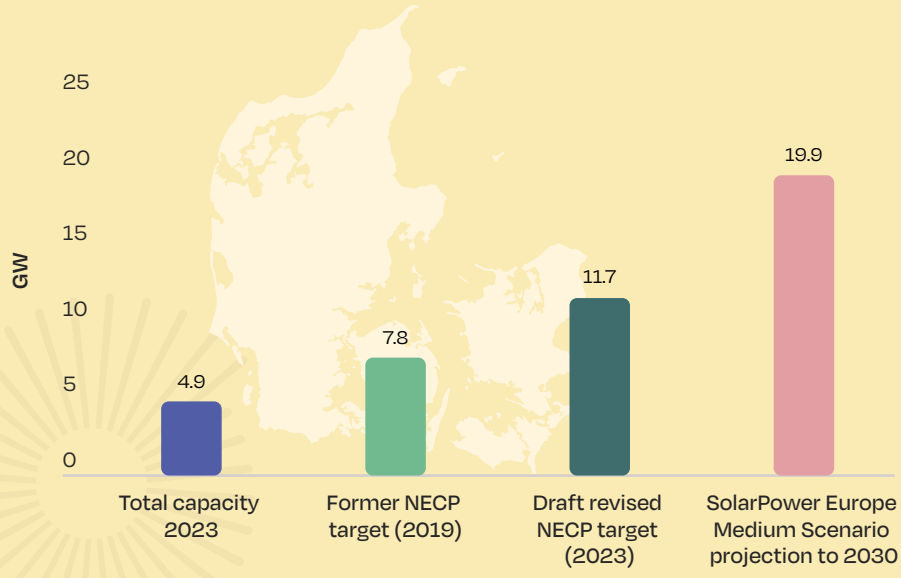
Targets

Denmark is expected to reach 71% of renewable energy by 2030, a substantial increase compared with the 55% of the previous NECP, based on a decision by the Parliament from 2018. In the electricity sector, Denmark is expected to exceed 100% of RES-E by 2030, due to new investment in renewable energy and the phase-out of coal power.

When it comes to solar PV, Denmark foresees a total capacity of 11.7 GW, a 50% increase compared with the previous NECP figure of 7.8 GW. This goal is above the EU average in terms of W/capita, with over 1,900 W per inhabitant by the end of the decade. However, this target remains substantially below SolarPower Europe's Medium Scenario projection to 2030, whereby Denmark reaches almost 20 GW of solar capacity. Also, the plan does not provide a clear breakdown between rooftop PV and utility-scale.

Enabling measures

- **Support schemes:** The plan provides a comprehensive overview of legislative acts to support renewables, especially wind power, between now and 2030. For solar and heat pumps, it mentions the phase-out of PSO tariff on electricity bill. Technology-neutral tenders will be phased out to gradually move to market-based support mechanisms. The deployment of solar and wind is expected to be market-based only. However, a timeline of existing support schemes and their planned evolution would have been welcome.
- **Prosumers and citizens:** Renewable energy communities benefit from simplified procedures by requiring the Danish Utility Regulator to identify and monitor the removal of unjustified barriers and to oblige grid companies to cooperate with communities. Denmark has also enabled energy sharing and self-consumption through exemption of grid tariffs and electricity taxes.[5] However, the plan could have provided more details on the measures to accelerate the uptake of prosumers, with clear figures on the expected uptake of self-consumption and community schemes. It is still very challenging to set up an energy community or an energy sharing scheme in Denmark.
- **Flexibility and storage:** The Danish Energy Agency's reporting on Market Model 3.0 has set out a number of recommendations for continuing to improve the framework for flexibility and active customers in Denmark, including the framework for aggregators. While the plan identifies flexibility as a major challenge, it provides no clear milestone or measures for the implementation of market-based flexibility measures, including the participation of prosumers.
- **Grids:** Denmark's current level of interconnectivity is 44.2%, significantly higher than the 2030 EU target of 15%. Through the Climate Agreement on Green Electricity and Heat of 2022, Denmark is planning to support the upgrade of both transmission and distribution networks. The plan also mentions the obligation for DSOs to publish network development plans and promote a flexible market. Denmark mentions the assessment of new interconnectors but does not provide any figures on the capacities involved. This would be particularly important given the planned RES-E deployment.



5 This is a mandatory requirement. However, these schemes are still extremely difficult to deploy in practice.

NECP – ESTONIA

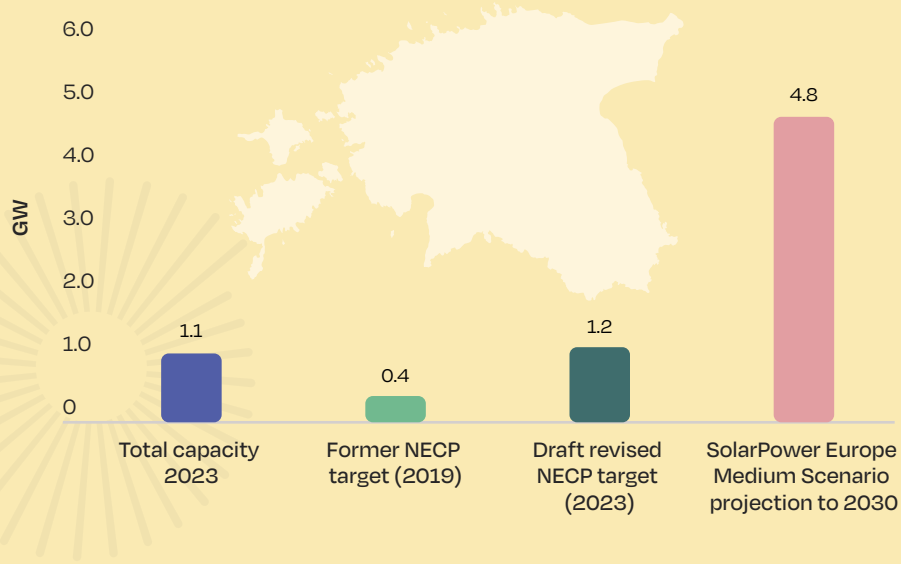
Targets

Estonia is expected to reach 65% of renewable energy by 2030, a very important increase compared with the 42% of the previous NECP. This new target is based on projections that take into account today's trends in renewable energy production and consumption, and the recent Energy Economy Organization Act. The increase is even more pronounced in the electricity sector, where Estonia is expected to exceed 100% of RES-E by 2030, more than doubling its previous ambition.

While the overall increase of ambition must be acknowledged, when it comes to solar PV, Estonia foresees a total capacity target of 1.2 GW for 2030. This target appears quite low, considering the current market dynamics and the fact that the previous target of 415 MW has been already reached in 2022, and remains below the W/capita EU average, with 931 W per person. As highlighted in the plan, actual solar growth could be higher. This is also reflected in SolarPower Europe's Medium Scenario projection to 2030, whereby Estonia reaches 4.8 GW of solar capacity. Also, the plan does not provide a clear breakdown between rooftop PV and utility-scale.

Enabling measures

- **Support schemes:** The plan provides a clear timeline for the volume of auctions between 2019 and 2025. The plan also foresees a phase-out of direct support for renewable energy by 2021, to be replaced by lower bid systems, with 500 GWh planned by 2024 and 2025. However, no further information is available since ANNEX IV is missing.
- **Prosumers and citizens:** No further information is available since ANNEX IV is missing.
- **Flexibility and storage:** No further information is available since ANNEX IV is missing.
- **Grids:** Estonia already exceeds the 2030 EU interconnection target, reaching 63% today. The next major step for Estonia will be the synchronization of the Baltic States' electricity system in the synchronous area under EU law around 2025. It also mentions the completion of the EE-FI interconnection by 2030. The plan provides a comprehensive overview and timeline of planned interconnectors. However, the plan could have provided a more detailed investment plan on domestic transmission networks reinforcement, esp. in the view of integrating high shares of renewable energy.



NECP – FINLAND

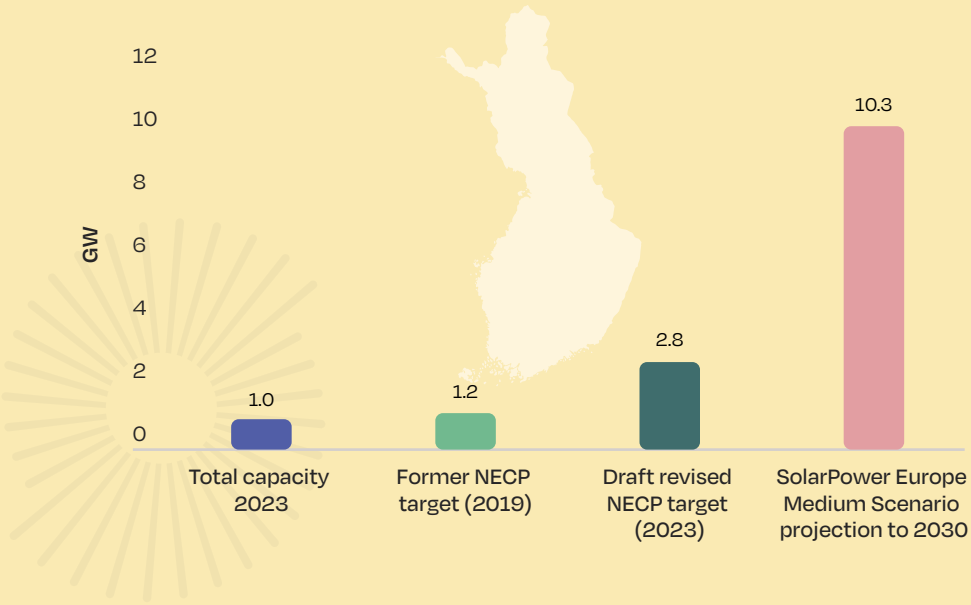
Targets

Finland has set a target of 51% renewable energy for 2030, which remains the same compared with the previous NECP. It however foresees a re-assessment of the target when the Renewable Energy Directive is adopted. Additionally, it foresees a higher share of RES of 60% on the WEM (With Existing Measures) scenario. It is however unclear whether this figure will be the updated target. In electricity, the share of renewables would be, according to the same scenario, 57%, a 4 percentage points increase compared with the previous NECP.

When it comes to solar PV, the plan foresees a total deployment of 2.8 GW by 2030, more than doubling the previous 1.2 GW target. This result is, however, still low in terms of W/capita, with 503 W per person, significantly below the EU average. The target also remains far below SolarPower Europe's Medium Scenario projection to 2030, whereby Finland deploys 10.3 GW of solar capacity. The plan also provides no breakdown between ground-mounted and rooftop PV.

Enabling measures

- **Support schemes:** The plan describes the existing premium system for renewables but provides no visibility on future auctions (if any). The energy aid scheme, which provides investment subsidies, could have been more detailed regarding the expected contribution to different technologies.
- **Prosumers and citizens:** Renewable energy communities are recognised and enabled in Finland. The plan describes the proposals to facilitate demand-side response but could provide a clear action plan and legislative measures on top of it. No information is provided on the volume, the type of support or the rollout of decentralised renewables.
- **Flexibility and storage:** Nearly 100% of end-consumers in Finland already have smart meters, and Finland includes the plan to rollout second-generation smart meters with a 15-minute resolution by 2028. Dynamic pricing is already an option offered in all electricity contracts. On top of it, demand-side response is well-developed with already 1 GW of DSR in 2022. The plan provides a comprehensive description of energy storage facilities, while the new investment should be mostly market-based. An indicative target on storage would however have been welcome.
- **Grids:** The plan provides a comprehensive overview of the existing and planned interconnection capacities, with a 400 kV – 800 MW line between Northern Finland and Northern Sweden by 2025, bringing the transmission capacity to 27% peak load in 2025. In terms of internal transmission grid, Finland provides clear extensions by 3,200 km of 400 kV lines and 2,000 km of 110kV lines. Although the increase in capacity is clearly detailed, a map of different interconnectors would have been welcome. While the plan mentions market-based mechanisms for investment at the DSO level, it could have been more detailed regarding the investment plans at the distribution level.



NECP – FRANCE

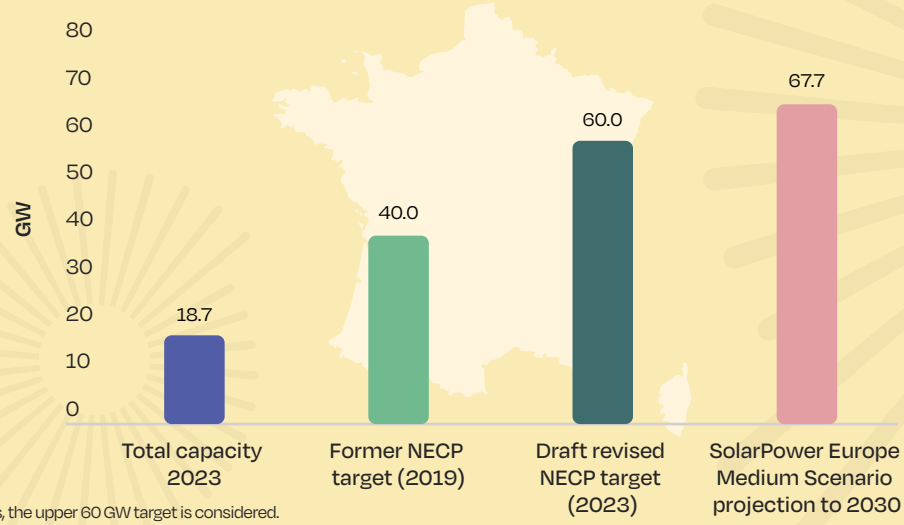
Targets

France plans to reach a 33% share of renewable energy in final energy consumption, which corresponds to the previous NECP target. The country, however, plans to revise these targets in the forthcoming Multi-Annual Energy Programme (MAEP) as well as in the future law on energy production. In the electricity sector, France plans to deploy at least 640 TWh of decarbonised electricity by 2035, including renewables and nuclear. To be noted that, on the latter, France envisions a recovery of the nuclear sector with continued operation of existing nuclear power plants, the construction of 6 EPR2 reactors and a study of possible further reinforcement of the nuclear power programme. In terms of capacity, this would mean 9.9 GW of new nuclear capacities committed by 2026 and a possible second step of at least 13 GW.

When it comes to solar PV, France plans to deploy 54 to 60 GW by 2030, a substantial increase compared to the target between 35.1 and 44 GW for 2028 in the previous NECP.[6] By 2035, the figure announced is 75 GW to 100 GW. The 2030 target translates into 824 to 915 W/capita, an increase compared to the previous NECP but still substantially lower than the EU average. This target is also below SolarPower Europe's Medium Scenario projection to 2030, whereby France installs 67.7 GW of solar PV by 2030. On a positive note, the plan provides a breakdown between ground-mounted PV (65%), commercial and industrial rooftop (25%) and residential (10%).

Enabling measures

- **Support schemes:** The plan proposes the development of mix tenders for renewable energy, including a part of complement to remuneration and a part of PPAs without support but with a guarantee scheme. As a good point, the plan mentions Agri-PV and repowering, the latter being mostly directed to wind projects. The plan, however, fails to provide a clear investment pipeline up to 2030.
- **Prosumers and citizens:** The plan mentions increasing incentives for residential or corporate consumption to self-consumption, with the target of 25% of total installed capacity for C&I buildings and 10% for residential. France is actively supporting the deployment of citizens' projects with e.g. bonus in invitations to tender and legislative provisions in the law on accelerations of renewable energies. France, however, does not intend to set a target for community energy schemes. The plan mentions the recent Renewable Acceleration Law, which will also improve the sharing of the value generated by projects for the benefit of residents, local and regional authorities and businesses. More details on policy and measures will be brought forward with the final version of the NECP.
- **Flexibility and storage:** France plans to deploy 25 GW of flexibility capacity by 2030 and 35 GW by 2035. In terms of smart-meter rollout, France is already quite advanced, with 36 million low-voltage customers equipped with smart-meters today. However, the plan does not provide any quantitative milestones with regard to further deployment of smart-meters and smart grids. In terms of storage, the plan foresees an increase of 1,700 MW of hydro pumped storage capacities by 2035 and provides an increase from 5% in 2022 to 51% in 2030 in new registrations of battery electric light commercial vehicles. The plan could, however, have mentioned a target in distributed battery storage.
- **Grids:** The plan mentions the need to reinforce the grid in light of increased penetration of renewable energy sources. The plan mentions a 20% increase in investment in distribution grids by 2032, which should be revised in the long term to match the recommendations by Eurelectric to increase by 84% between now and 2050.[6] The plan mentions the High Level Group on Interconnections in South-West Europe and the EPP multiannual programming to reinforce flexibility and interconnections, but fails to provide any quantitative assessment on the reinforcement of cross-border and national transmission capacities.



6 In this analysis, the upper 60 GW target is considered.

NECP – GERMANY

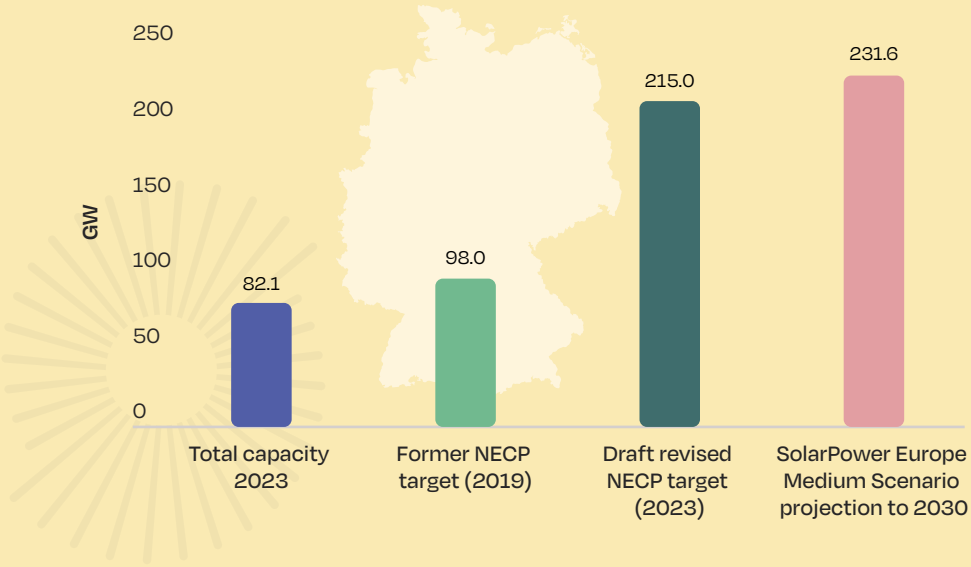
Targets

Under the reference scenario, Germany would reach 40.4% RES shares in 2030, a substantial increase compared with the 30% of the previous NECP, and almost a doubling compared with the 2023 projections. In the electricity sector, Germany is planning to reach a share of 80% renewables by 2030, a substantial increase compared with a 65% share by 2030 from the previous NECP.

When it comes to solar PV, Germany is planning to deploy up 22 GW of photovoltaics per year, which will translate into 215 GW by 2030 and 400 GW by 2040. Although this target had already been agreed at the national level for some time, its official implementation in the NECP constitutes a massive increase compared to the previous NECP target of 98 GW, and it means huge growth in installed capacity compared to the 2023 figure of 82 GW. This results in almost 2.6 kW/c in 2030, the highest score across EU Member States. This target is aligned with SolarPower Europe's Medium Scenario projection to 2030, whereby Germany, driven by its high annual installation targets, reaches a solar fleet of 232 GW. The plan, however, does not provide any breakdown between ground-mounted and rooftop solar.[7]

Enabling measures

- **Support schemes:** The expansion of renewables is encouraged and controlled by the Renewable Energy Act (EEG). On top of it, 300 million EUR was deployed in 2023 for supporting rooftop solar deployment coupled with electric vehicles and storage. The plan, however, does not provide visibility beyond 2024 on the volume and characteristics of support schemes.
- **Prosumers and citizens:** On energy communities, Germany is equipped with a comprehensive enabling framework, including access to consumers on a non-discriminatory basis, access to support schemes, and exemption from tender participation for installations below 6 MW. The plan, however, does not include a specific target on prosumers or installed rooftop capacity.
- **Flexibility and storage:** For real-time balancing of production and consumption, Germany is relying on the development of a liquid, integrated energy-only market under a single German bidding zone, and sector-coupling. The plan, however, provides no targets in terms of installed demand-response or storage capacities, neither at the distributed nor at the centralised level.
- **Grids:** The plan recognizes the paramount importance of grid deployment to integrate renewables and complete the European energy market. The rapid expansion of renewables in Germany requires swift extension of interconnection capacity, which will be realized simultaneously with national grid expansion. Regarding transmission infrastructure, Germany plans to implement around 14,000 km of lines, including 1,400 km of interconnections. There is, however, no detail on which Member States should be connected to on priority at what capacity. Regarding the distribution grid, Germany mentions grid expansion and network-related measures, with however no quantitative targets.



7 The amendment of the EEG currently discussed in the Parliament will likely state that half of the newly installed capacity is supposed to be installed on or in buildings.

NECP – GREECE

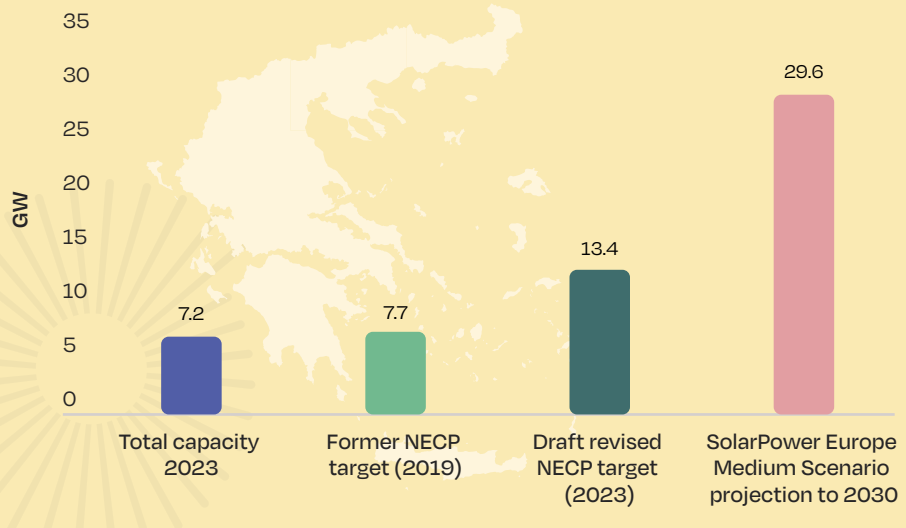
Targets

The Greek NECP foresees an increase in the national renewable energy target from 35% in the 2019 NECP to 44% in the 2023 draft. Greece should be climate-neutral by 2050 and reach 95% of renewables in gross final consumption by 2045. In the power sector, this translates into an 80% RES-E, a substantial increase from the previous target of 61-64%. This share is to reach 94% by 2035 and 96% by 2040. This increase will be supported by the development of solar and wind, adding more than 12 GW to existing capacity by 2030 and by exploiting the country's remaining hydroelectric potential. A specific programme will be set to support PV on roofs, the expansion of energy communities and a focus on the development of industrial and commercial PV installations.

When it comes to solar PV, the national plan foresees a capacity of 13.4 GW installed by 2030, almost doubling the 7.7 GW target from the previous NECP. This translates into 1,332 W/capita for 2030, a figure slightly below the EU average. The solar target also remains slightly below SolarPower Europe's Medium Scenario projection to 2030, whereby Greece reaches 29.6 GW of solar capacity. Also, the plan does not provide a clear breakdown between rooftop PV and utility-scale.

Enabling measures

- **Support schemes:** Greece plans to support the uptake of RES and storage via competitive tender procedures through Contracts for Difference. It also foresees developing the framework for bilateral contracts (PPA), with the development of a digital platform. However, no clear agenda is provided on the amount and capacity expected under these calls.
- **Prosumers and citizens:** The plan mentions a reserved capacity of 10 MW per substation to accommodate the needs of households, farmers and SMEs. The plan also mentions the programme 'Photovoltaic at STEGI' with 238 million EUR in resources from the Recovery and Resilience Fund to support PV and battery systems for exclusive self-consumption. Regarding energy communities and consumers, a dedicated envelope of 100 million EUR under the RRF will be mobilised. Additionally, specific technical assistance and advisory mechanism will be established to support Communities.
- **Flexibility and storage:** The plan has clearly identified storage and demand-response as indispensable technologies to enable the penetration of RES. The total capacity of accumulator storage system is expected to reach 3.1 GW by 2030. In terms of support, the existing support scheme for RES will be extended to storage, with a capacity of battery storage of 1,000 MW. The possibility to extend the support to domestic PV with integrated storage is envisaged, with a target of >150 MW of small PV battery plans. The plan also envisions the inclusion of 240 MW of hybrid power plants by 2026.
- **Grids:** Greece plans to substantially reinforce its interconnection capacities with neighbouring countries, to reach the 15% interconnection target already by 2025, with an objective to reach an interconnectivity rate of 23.1% by 2030. The plan provides a clear and detailed investment plan in cross-border interconnection capacities up to 2035. Note that Greece has a particular situation with many autonomous islands that will also require internal connection capacities. The plan provides a good overview of the internal connections. However, the plan does not provide sufficient details on the necessary upgrade of the distribution grid.



NECP – HUNGARY

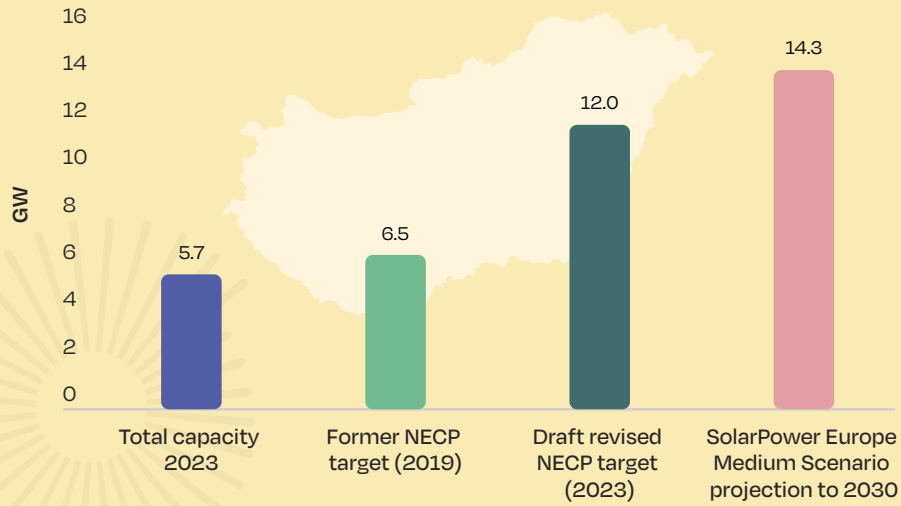
Targets

Hungary has set a target of at least 29% renewable energy for 2030, an increase of 8 percentage points compared with the previous NECP, and more than doubling the country's share in 2021. The increase is even more pronounced in the electricity sector, where the former target of 21.3% has been increased to 31%.

When it comes to solar PV, the plan, based on scenario with additional measures, foresees a total deployment of 12 GW by 2030, almost doubling the previous 6.5 NECP solar target. In terms of W/capita, this target is somewhat below the EU average, at 1,244 W/capita. The target is also slightly below SolarPower Europe's Medium Scenario projection to 2030, whereby the country installs 14.3 GW of solar capacity by the end of the decade. Additionally, the plan does not provide a clear breakdown between rooftop PV and utility-scale.

Enabling measures

- **Support schemes:** The plan mentions the use of Renewable Energy Support Scheme (METÁR) to allocate capacity through technology-neutral tenders. Until 2026, the maximum annual new grant amount is 45 billion HUF. On solar power, the plan indicates, as part of the Recovery and Resilience Plan, the investment "Supporting of residential solar panel systems and equating heating systems in combination with solar panel systems." By 2026, the aid could result in around 140-175 MW installed solar capacity. The mobilisation of RRF to support residential solar systems will be 185.9 billion HUF. However, the plan does not provide an overview of the support schemes and the investment pipeline past 2026.
- **Prosumers and citizens:** The plan mentions that an initial legislative framework for aggregators and energy communities was established in 2021, with the plan to prepare the necessary legislative amendments by 2024 to ensure their proper functioning. While the plan indicates that the target of 200,000 households with an average of 4 kW rooftop solar panels will be significantly exceeded by 2030, it does not provide an updated trajectory for prosumers. While the plan recognises the importance of energy communities, it fails to identify the expected volume of energy communities by 2030.
- **Flexibility and storage:** The Government intends to build energy storage facilities in Hungary with a total capacity of around 500-600 MW by 2026, which could increase to 1 GW by 2030. While demand-response is identified as an upcoming challenge, the plan fails to provide any details on volume, support and rollout of technology such as smart-meters and connected appliances. On storage, the plan mentions that the energy storage market is practically non-existent today (currently around 20-25 MW installed battery capacity), but does not provide clear milestones and pipeline for future capacities.
- **Grids:** The transmission capacity of cross-border high voltage lines already reaches 50%, far above the 15% EU target for 2030. Additionally, Hungary will increase its cross-border capacity to 60% by 2030, with i.a. the planning of the Serbian-Hungarian cross-border capacity. However, in general, the plan does not provide any detail on the interconnections or reinforcements of internal transmission capacities, neither in terms of capacity nor in terms of timeline of investment. The reinforcement of the distribution grid is also absent from the NECP.



NECP – ITALY

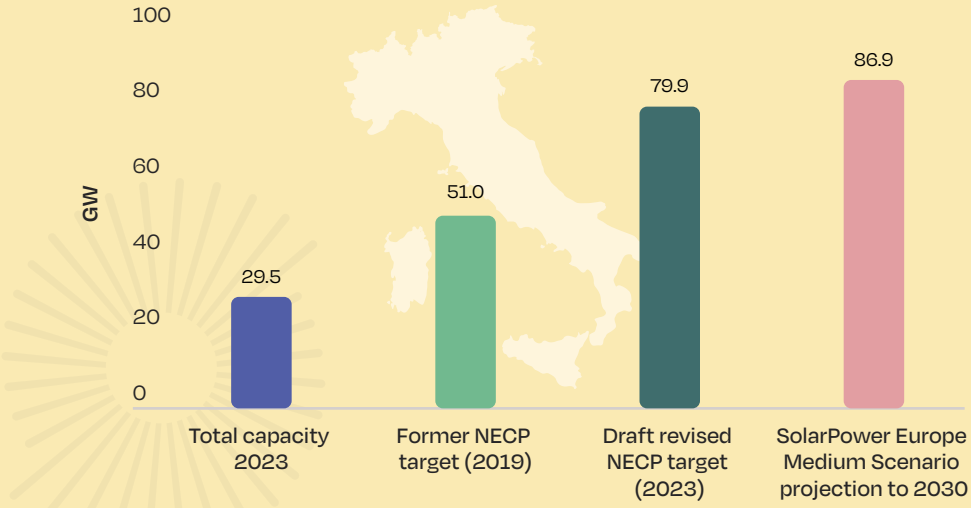
Targets

Italy sets out a renewable energy target of 40.5% for 2030, a significant increase compared with the previous NECP target of 30%, however considered still not enough to meet the REPowerEU target. This increase is also mirrored in the share of renewable energy in the electricity sector, with an increase of 10 percentage points compared with the previous NECP, to reach 65% by 2030. This value is still significantly lower than the estimated potential of about 80% by 2030.

When it comes to solar PV, the plan foresees a 55% increase from the previous 51 GW target, with a total target capacity of 79 GW. This results in a W/capita score of almost 1,400 W per inhabitant, slightly below the EU average. This increased target is overall in line with SolarPower Europe's Medium Scenario projection to 2030, whereby Italy reaches 86.9 GW by that year. The plan provides no breakdown between ground-mounted and rooftop PV. Also, the renewable target includes power dedicated to hydrogen production. Therefore, the renewable power dedicated to direct electrification is lower.

Enabling measures

- **Support schemes:** The plan mentions a comprehensive description of competitive bidding mechanisms under Decree No 199/2021. It also mentions the promotion of PPAs, with the development of a dedicated platform and guarantee schemes, and an indicative target of an additional 16 GW to be mainly covered by PPAs. While legislative Decree No 199/2021 provides for auctions for the fixed-term contract of new renewables, no information is available in the NECP regarding the volume and implementation details of these support schemes.
- **Prosumers and citizens:** Decree-Law No 162/19 (Article 42a) provides incentives for self-consumption and energy sharing. The plan clearly sets an objective of 5 additional GW for 2027 for self-consumption and energy communities. The plan also foresees enabling measures specifically targeted at energy communities, including access to information, guidelines and support measures. An extensive set of measures under Decree No 199/2021 is presented, including building standards. The plan also provides for measures related to PV in the agricultural sector. As of today, the Ministerial Decree for Energy Communities has not been published. However, without the implementation of the new incentive mechanisms, which are also aimed at plants with a capacity of up to 1 MW, and located in larger perimeters, it will not be possible to reach the target set by the NECP.
- **Flexibility and storage:** The plans provide a tool for the development of self-consumption and storage under the investment M2C2 1.1 of the NRRP, which provides for specific resources (2.2 million EUR) for the financing of renewable energy plants coupled with storage systems. An indicative amount of expected battery storage could have been useful.[8]
- **Grids:** One of the biggest challenges for Italy in terms of internal transmission grid development will be the transport of renewable electricity from the South and the islands to the Northern consumption points. In this context, the plan provides clear network planning of transmission capacities until 2030. The plan also mentions the needs to reinforce the distribution grid, with however no concrete planning, allegedly due to the decentralised nature of renewable – esp. PV – generation. The target of 15% interconnection for 2030 is likely to be missed. One of the reasons would be the increase of total inland generation capacity, mostly driven by the uptake of renewables.[9]



8 Nevertheless, an official target was set by Terna, the Italian TSO, in the "Documento di Descrizione degli Scenari 2022" (Scenarios Description Report): 95 GWh by 2030, to be accomplished mostly by utility scale storage, page 11, table 2, "Capacità installata accumuli"). This target is also confirmed in Terna's recently published (and currently subject to public consultation) TYNDP 2023, page 86.

9 Nevertheless, the scenarios developed by Terna for 2030 foresee an increase in imported electricity to 52 GWh (from the 42 GWh registered in 2022) - which should amount to 14% of the total demand of electricity - thanks to improvements in the interconnection capacity.

NECP – LITHUANIA

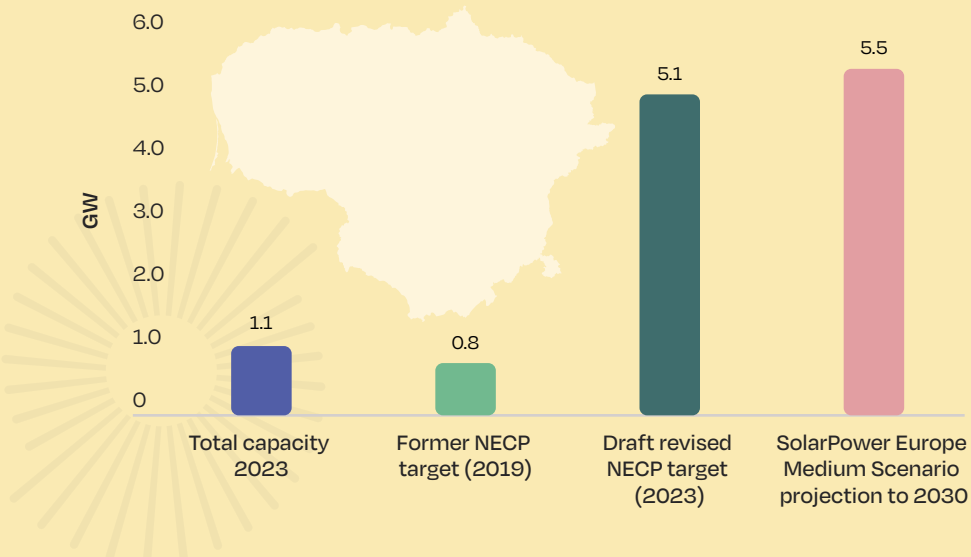
Targets

Lithuania is expected to reach 55% of renewable energy by 2030, a substantial increase compared with the 45% of the previous NECP. The increase is even more pronounced in the electricity sector, where Lithuania is expected to reach 100% of RES-E by 2030.

When it comes to solar PV, Lithuania foresees a total capacity of 5.1 GW, a spectacular increase compared with the previous NECP target, which was below 1 GW. In this new projection, presented in the PPP (Planned Policies and Measures) scenario, the lion's share of new solar PV capacities will be installed between 2023 and 2025, with an expected additional 3.6 GW in two years. The revised target places Lithuania in the top-class of W/capita countries, with almost 2,000 W per person by 2030. In SolarPower Europe's Medium Scenario projection to 2030, which has been revised upwards to match this improved level of ambition, Lithuania deploys 5.4 GW by 2030. The plan does not provide a breakdown between rooftop and ground-mounted PV.

Enabling measures

- **Support schemes:** The plan provides information on a tender for renewables in marine areas of the Baltic Sea, with the first expected delivery of electricity by 2028. The plan also details the support schemes for the commercial and industrial sector, as well as for the public sector, with the planned intervention of EU funding for total budgets of resp. 105 million EUR and 107 million EUR. However, the plan does not provide any information on the agenda, volume and expected investment pipeline for ground-mounted solar PV.
- **Prosumers and citizens:** The plan provides a clear target of 30% prosumers (compared with the total number of consumers) by 2030. It also provides a support scheme for prosumers with a premium of 234 EUR/kW up to 10 kW, and a total budget from EU funds of 160 million EUR between 2023 and 2029. Additionally, support is envisaged for investments by legal persons, farmers and renewable energy communities in onshore solar and wind power plants. In this field, the plan proposes an interesting scheme to support RES communities and fight energy poverty at the city level, with planned operating grants of 78.5 million EUR. Additionally, the plan could have provided clear milestones, volume and expected investment pipeline to support RES deployment by farmers or energy communities.
- **Flexibility and storage:** The plan provides clear objectives of storage deployment at the household level, with the intervention of the EU structural funds for a volume of 3.3 billion EUR and 20 MWh between 2023 and 2029. Lithuania also envisions a capacity mechanism to support demand response and storage. However, the plan does not provide any details on the support of demand-response, or the total expected battery capacity (including large-scale and hybrid power plants).
- **Grids:** The interconnection level of Lithuania is already meeting the EU target of 15% by 2030, with a share of above 60% today. The plan also mentions the construction of 11 internal transmission lines, with several of them coming into operation by 2025. However, the plan does not provide any details on the future investment in interconnection to meet the challenge of integrating their energy system to the European electricity market and to start synchronous operation with the European continental electricity grid by 2025.



NECP – LUXEMBOURG

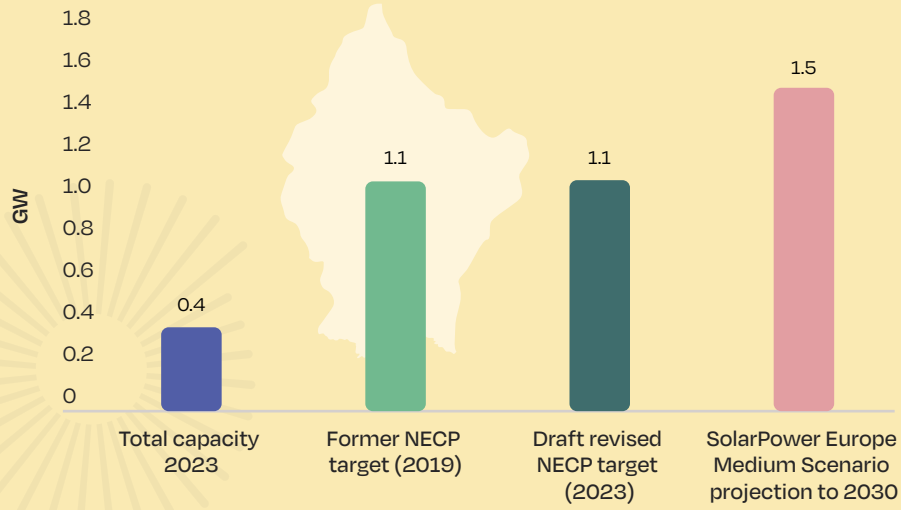
Targets

The updated National Energy and Climate Plan includes an objective of 37% of renewable energy in final consumption by 2030, a substantial increase of 12 percentage points compared to the previous NECP, due to the integration of the Fit for 55 and REPowerEU packages. The increase is even more pronounced when it comes to the share of renewables in the electricity mix, which increases from 33.6% to 60% in the updated version.

When it comes to solar PV, however, the ambition remains the same, with 1.1 GW of installed capacity by 2030.[10] This is justified in the plan by the challenge posed by the disruption of supply chains in PV installations. While the W/capita remains overall in line with the EU average, at 1,578 W/capita, this target remains below SolarPower Europe's Medium Scenario projection to 2030, whereby Luxembourg operates a 1.5 GW solar fleet by 2030. The plan provides no breakdown between ground-mounted and rooftop PV.

Enabling measures

- **Support schemes:** The plan describes 15-year support schemes for renewables and includes enlargement of support schemes for small-scale PV installations. The measures targeting buildings are well detailed, with the introduction of State support for existing buildings, including industrial and agricultural buildings. For large-scale power plants, a tender is introduced. As an interesting additional feature, the plan mentions a call for tender for Agri-PV systems. However, a clear agenda for the upcoming call for tenders up to 2030 could have added visibility to the investment pipeline.
- **Prosumers and citizens:** The plan mentions the existing call for tender for self-consumption, which will be maintained in 2023. Clear milestones and capacity allocation have been identified. On energy communities, the plan envisions accompanying these new market players in their RES projects. It also increases the fiscal threshold for selling excess electricity. It also mentions the potential inclusion of storage in large PV tenders. The plan could have mentioned the continuation of the call for tender for self-consumption and the planned allocated capacities post-2023.
- **Flexibility and storage:** Luxembourg envisions an increase of the bonus for PV self-consumption and makes battery storage eligible. It also envisions increasing the share of prosumers participating in the market, with no clear numbers, however. The plan would have benefitted from a clear timeline that describes the evolution of storage capacities, both at the centralised and decentralised levels. Regarding demand-response, only the Energy Data platform is mentioned.
- **Grids:** The level of interconnection with Germany will be increased from 230% to 400% in 2030 (as a share of maximal annual load). Additionally, the national transmission network will be reinforced esp. in the North of the Country, by replacing 65 kV lines with 110 kV lines. However, the measure 912 'Network Development Plans' lacks details. A focus could have been made on the necessary upgrade of the distribution network, which could have enabled more solar PV installations to be connected.



10 Assuming a 1020 GWh/GW conversion rate.

NECP – MALTA

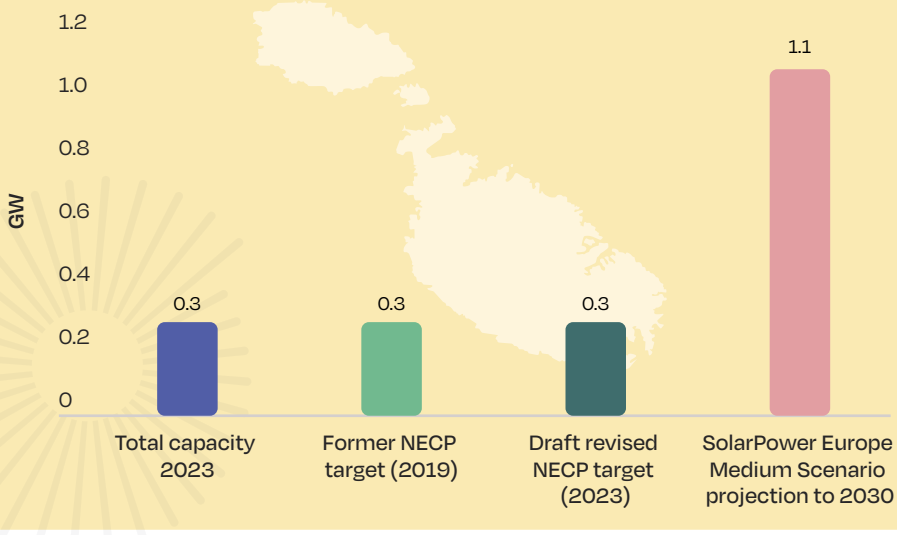
Targets

The Maltese NECP mentions an increased ambition to get beyond the national energy target of 11.5% as set in the previous NECP. It also mentions recent technology opportunities in the area of offshore renewables. It is, however, unclear what the new target would be. Given the absence of any quantitative objective, the target is considered unchanged compared with the previous NECP target of 11.5%. This applies also to the electricity sector, with a former target of 11%. These figures are extremely low in ambition, since the share of renewables in electricity was 9.7% in 2021, and the total RES-share was already exceeding the target at 12.5% in 2021. This absence of an update to the targets is extremely problematic in this NECP.

While the updated NECP provides a quite detailed analysis of the current solar PV deployment, the plan fails to provide any concrete figures on the future solar installations by 2030. The plan only mentions an ongoing assessment of technical potential for solar PV, with no specific date of delivery. If we refer to the previous NECP delivered in 2019, the solar target was 266 MW, which results in 489 W/capita, much below the EU average. This target was almost already reached in 2022, where 238 MW of total capacity were installed. In SolarPower Europe's Medium Scenario projection to 2030, Malta deploys 1.2 GW of solar capacity, much above the current NECP target. The plan does not provide a clear breakdown between rooftop PV and utility-scale.

Enabling measures

- **Support schemes:** The promotion of solar PV is ensured via a feed-in-tariff scheme. The plan provides a relatively detailed description on the design of the support schemes. For PV systems above 40 kW, a competitive bidding system is in place. While the plan provides a good overview of the existing schemes, it would have been welcome to have a better understanding of the project pipelines and dedicated budgets for future schemes until 2030.
- **Prosumers and citizens:** As described above, the plan provides an overview of the support schemes for small-scale PV. However, the plan could have detailed the expected penetration of self-consumption, and the role that prosumers would play in the future energy system.
- **Flexibility and storage:** The plan mentions the expansion of battery storage via the investment in two utility-scale battery storage systems by 2026 to facilitate RES-integration. At the distributed level, households applying for a grant for a new PV installation are also eligible to benefit from financial support towards a behind-the-meter battery storage system. The plan mentions the current behind-the-meter battery penetration with 489 installations and 3.55 MWh capacity by 2022 but fails to provide any figure regarding the future installations by 2030, both at the centralised and decentralised levels. Regarding demand-response, the plan mentions that the electricity market structure does not incentivise demand-response, therefore the assessment of demand-response and smart solutions are still at an early stage.
- **Grids:** The plan mentions the construction of the second sub-sea interconnector with Italy by 2026, to comply with the 15% interconnection target for 2030. With regards to the investment in national transmission system, there is no transmission system in Malta and the country only operates at the distribution level. As a positive point compared with most NECPs, the plan provides a relative detail of the investment at the distribution level, including voltage regulators, transformers, substations, and low voltage feeders. The plan indicates an investment of 106 million EUR between 2018 and 2022 in the network but does not provide any provisional amount between 2023 and 2030.



NECP – NETHERLANDS

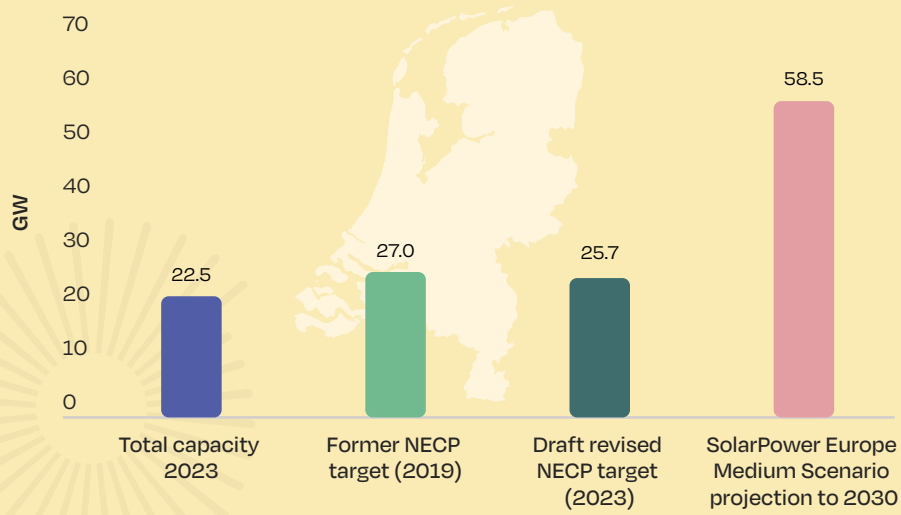
Targets

The updated National Energy and Climate Plan includes an objective of 30.5% of renewable energy in final energy consumption for 2030, an increase of 3.5 percentage points compared with the previous NECP. The transition is even faster when it comes to the share of renewables in the electricity mix, which increases from 73% to 86% in the updated version.

However, when it comes to solar PV, the ambition has not improved from the previous NECP target, and even slightly decreased, with 25.7 GW for 2030 compared to the previous 27 GW target. This is a minimal increase from the current installed capacity of 22.5 GW, and it is at odds with the Dutch national climate neutral scenario expectation of 58 GW by the same year. Considering the 25.7 GW NECP target, although the W/capita will remain somewhat in line with the EU average, at above 1,400 W/capita, the market potential is much higher. In SolarPower Europe's Medium Scenario projection to 2030, a solar fleet of 58.5 GW is deployed in the Netherlands. Furthermore, the plan doesn't provide any breakdown between utility-scale, rooftop solar and other solar technologies, which would have been helpful, especially in the context of promoting environmentally integrated solutions, as elaborated in the plan.

Enabling measures

- **Support schemes:** The scheme to support sustainable energy production and Climate Transition (SDE++) is mentioned, which will participate in the rollout of at least 35 TWh of renewable energy by 2030.[11] However, there are no details on the volume of tenders or support schemes for solar PV, nor any further information on the evolution of support schemes.[12]
- **Prosumers and citizens:** The Netherlands supports prosumers through tax exemptions and net-metering schemes. It also includes a specific support scheme for energy communities. As in the previous version, the plan doesn't provide any details on the expected size of the prosumers market and no specific targets on renewable energy communities and citizen-led initiatives.
- **Flexibility and storage:** The plan mentions the suppression of barriers to storage, and the government aims to promote storage by investing in battery innovations and making batteries mandatory in large-scale solar parks. Flexibility in the form of demand response, storage or adjustable capacity will be intertwined in the electricity market and traded through the different markets. Therefore, the plan doesn't provide any target or specific support schemes for flexibility. Residential storage is currently double-taxed and not incentivised due to the net-metering scheme.
- **Grids:** At the transmission level, the plan provides clear interconnection capacity forecast up to 2030. While grids have been rightfully identified as the major bottleneck for solar PV deployment, there is no clear vision on grid capacity increase at the distribution level.[13]



11 In the Q4 2023, a decision will be made to increase this 35TWh to 55TWh. A successor of the SDE++ will be announced early 2024 and aims to support the goal of a carbon-free electricity supply in 2035.

12 It has however been announced that a future support scheme will follow the existing one either in 2025 or 2026.

13 While this is not reflected in the NECP, this has however been announced by the Government.

NECP – PORTUGAL

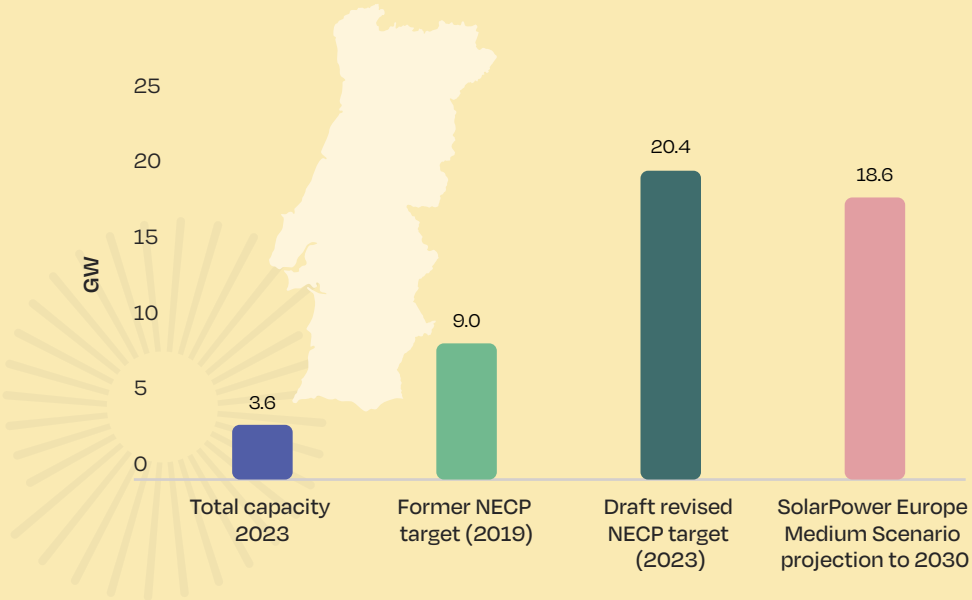
Targets

The updated National Energy and Climate Plan includes an objective of 49% of renewable energy in final energy consumption by 2030, an increase of 2 percentage points compared to the previous NECP. The increase is even more pronounced when it comes to the share of renewables in the electricity mix, which increases from 80% to 85% in the updated version.

When it comes to solar PV, the ambition jumps from 9 GW to 20.4 GW of total installed capacity for 2030, more than doubling the previous target. With such a deployment, Portugal would be able to cross 2,000 W/capita by 2030, one of the highest scores of all EU Member States. According to SolarPower Europe's Medium Scenario projection to 2030, current market hurdles pose a challenge to achieving Portugal's solar target. In this scenario, the country brings online 18.6 GW by 2030 and falls slightly short of reaching its draft NECP target, which would however be achieved shortly after, considering the annual additions expected by that year. The plan also provides a breakdown between centralised and decentralised solar power, with roughly three quarters of 2030 target coming from centralised sources.

Enabling measures

- **Support schemes:** The plan describes past auction mechanism for allocating capacity for renewables. However, the plan fails to provide a detailed volume and design of upcoming auctions.
- **Prosumers and citizens:** The plan provides a detailed analysis of the stay of play of self-consumption and includes measures to support self-consumption and energy communities. It also foresees i.a. an online platform for self-consumption and renewable energy communities, staffing and skilling, system integration of prosumers. However, the plan could have provided a quantitative assessment of the future uptake of prosumers and energy communities.
- **Flexibility and storage:** The plan foresees an increase of storage capacities, with clear targets of 3.9 GW and 1 GW, respectively centralised via pumped hydropower and decentralised via batteries. However, the plan would have benefitted from a clear roadmap on demand-response.
- **Grids:** Portugal provides a good analysis of the current energy system and sets a clear target for interconnections, corresponding to the EU objective of 15% by 2030. The plan also mentions the PDIRD-E and PDIRT-E as the programs to support the upgrade respectively of the distribution and transport grids, with no targets, however. A plan for the upgrade of distribution grids would have been welcome.[14]



14 PDIRT-E (TSO) and PDIRD-E (DSO) and extensively detailed, but the process of approval of these plans displays constraints. In the future, it will be crucial to guide the development of the transport and distribution networks in accordance with each other and the targets for installed capacity and future flexibility services.

NECP – ROMANIA

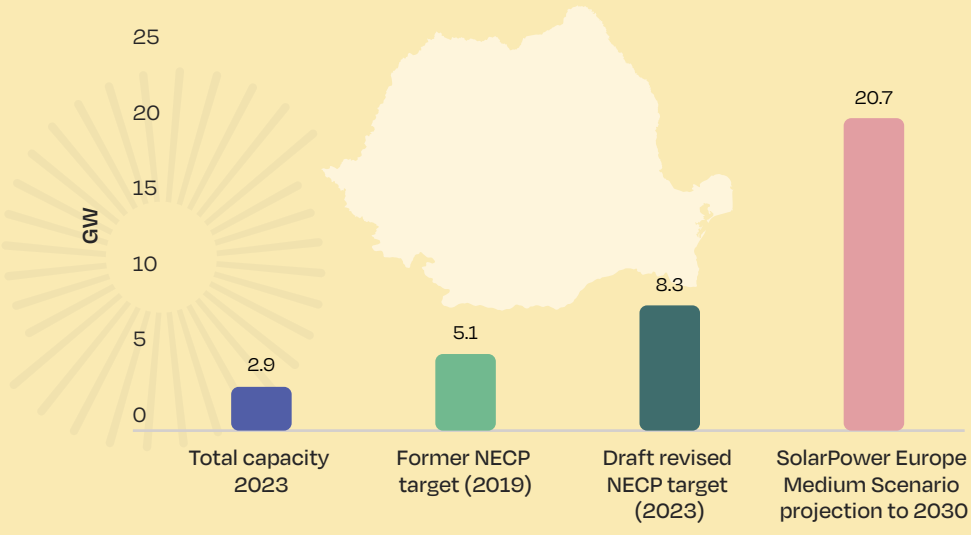
Targets

Romania has set up a renewable energy target of 36% for 2030, a 5 percentage points increase compared with the previous NECP. Biomass will remain the main renewable energy carrier, but its share will decrease from 54% in 2022, to 39% in 2030. In the electricity sector, the 36% target is translated into 55.8% for 2030, a 6 percentage points increase compared with the previous NECP. This remains below what would be needed in the context of REPowerEU. According to the industry, Romania would need a 44.4% target to fulfil its objectives.

When it comes to solar PV, Romania foresees a total capacity of 8.3 GW by 2030, with a continuous increase up to 30.5 GW by 2050. This is a 63% increase compared with the previous 5.1 GW target, and about three times higher than the 2.9 GW currently installed capacity. However, in terms of W/capita, Romania is still far below the EU average, with 436 W per person by 2030. The 8.3 GW target also remains below what would correspond to a 44.4% RES share, translating into 11.1 GW of solar power according to the solar industry association RPIA, and below SolarPower Europe's Medium Scenario projection to 2030, whereby the country installs 20.7 GW by 2030. As a positive feature, the plan does provide a trajectory for rooftop PV.

Enabling measures

- **Support schemes:** under the measure 'increase of the domestic generation capacity from PV power plants,' Romania presents a rather detailed installation plan from 2023 to 2050, with an intermediary target of 5.8 GW by 2030. It is assumed that these investments are ground-mounted only. The plan mentions State intervention but fails to provide any details on the volume or format of the intervention. The plan also includes a support programme for rooftop PV, with the aim to reach at least 2.5 GW by 2030. Here the plan provides more details on the support (up to 4,000 EUR / installation), with a total allocated budget of 500 million EUR.
- **Prosumers and citizens:** Since 2020, all market participants can have access to market individually or by aggregation. While the plan presents a target for rooftop PV, there is no specific objective for prosumers and self-consumption. Renewable energy communities are mentioned under the rooftop PV measure, but no specific recognition or support for these market players is provided.
- **Flexibility and storage:** For storage, Romania has set a specific target of installing 240 MW of battery storage capacity by 2025, with potential for storage of 480 MWh. The section on demand-response, dynamic pricing and net metering is, however, relatively limited and does not provide any quantitative target. Storage is fundamental for the country to balance the fluctuation of RES capacities. In this sense, the 240 MW is not sufficient. For Romania to align with the 2030 European targets, the country needs 4 GW of energy storage capacities to balance network demand, comprised of 2 GW battery storage capacity and 1.5 GW in electrolysers for H2 production, and the rest in hydro pumping.
- **Grids:** Romania plans to reach the 15% interconnectivity level by 2030 **through** a reinforcement of HU-RO and RO-BG capacities, with a clear multi-annual plan including respectively 720 MW and 1,490 MW. This should help the country reach a 21% interconnectivity level. The modernisation of the distribution network is also mentioned with the Measure 48. More than 1 billion EUR will be dedicated to the distribution grid. However, the focus here seems to be on reduction of losses, not on flexibility and RES integration. This is all the more problematic as grids are the main bottleneck for PV. Many TSO projects are blocked or delayed, with some completion deadlines pushed back by up to two years. The same issue also affects DSO projects. Moreover, the high cost of grid reinforcement still falls on the shoulders of investors.



NECP – SLOVAKIA

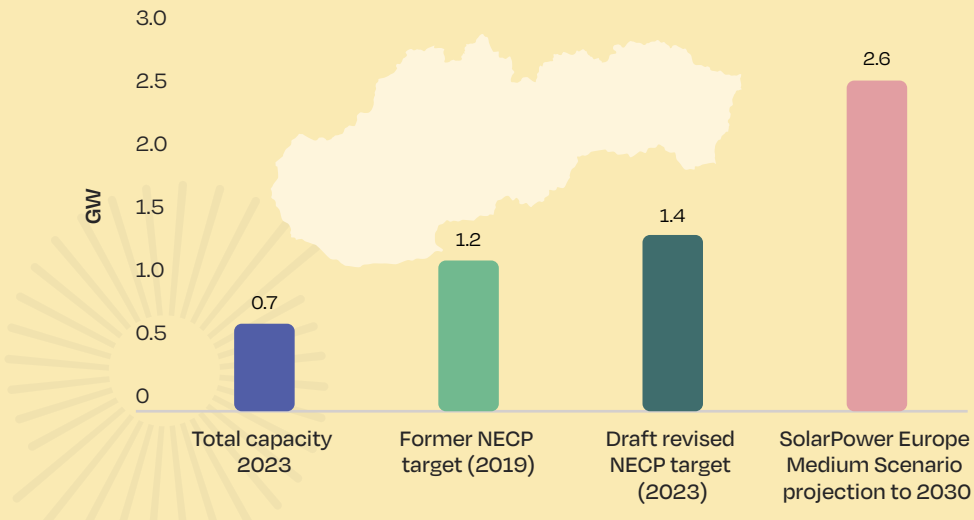
Targets

Slovakia does not mention the updated EU RES target of 42.5% by 2030. It has, however, revised upwards its target, reaching 23% RES in 2030, an increase of 3.8 percentage points compared with the previous NECP. The increase in the electricity sector is in the same order of magnitude, from 27.3% in the previous NECP to 29.5%.

When it comes to solar PV, the plan foresees a contribution to gross final energy use of 1,470 GWh, corresponding to 1.4 GW of total capacity. This constitutes a minor increase compared with the previous NECP target of 1.2 GW, especially considering that the current operating fleet has surpassed 1.2 GW in 2023. The actual potential is much higher: the Slovak PV association SAPI has established that rooftop PV alone has a maximum technical potential of approximately 37 GW. The NECP target results in 252 W/capita, among the lowest across the EU Member States. This outlook is also very low when compared to SolarPower Europe's Medium Scenario projection to 2030, whereby Slovakia operates 2.6 GW of solar PV by the end of the decade. The plan also provides no breakdown between ground-mounted and rooftop PV.

Enabling measures

- **Support schemes:** Slovakia is expected to support renewable electricity generation via feed-in tariffs for projects up to 500 kW and by auction schemes above. The support schemes will apply from 2019 to 2030, with respective amounts of electricity generated of 0.5 TWh and 1.5 TWh. The plan also mentions support for decentralised RES, RES for SMEs and households. However, the total amount of electricity generation supported is 2.5 TWh (where data is available), which is substantially below the 7.6 TWh-E presented in section 2.1.2 of Slovakia's NECP.
- **Prosumers and citizens:** The plan mentions the support to small-scale electricity generation with the aim of maximising the self-consumption ratio. However, the plan does not provide any details regarding the support of prosumers and citizens, neither in terms of capacity nor in terms of financial support volume.
- **Flexibility and storage:** By 2021, 431,433 smart meters had been installed under regional distribution system operators (DSOs) out of the final planned number of 414,388, therefore exceeding the target. The plan also mentions, under the Recovery and Resilience Plan, an investment in 52 MW of installations increasing grid flexibility, without however providing any breakdown of technologies. However, Slovakia does not have a specific objective for increasing the flexibility of the Slovak electricity system for greater integration of RES. National flexibilities and targets should be based on the assessment and quantification of flexibility needs following the transposition and implementation of new EU legislation on electricity market design reform.
- **Grids:** Slovakia is already meeting its 2030 target of 15% interconnection. The plan mentions the Danube InGrid (Danube Intelligent Grid) project, which aims for wider integration of renewables into the distribution grid through the use of smart technologies at the transmission and distribution levels, including their smart management. The plan also mentions the ACON (Again COnnected Networks) cross-border smart grid, which will include i.a. the digitisation of more than 200 kilometres of 22 kV lines. However, the plan fails to provide a clear mapping and investment pipeline for cross-border interconnections. In terms of deployment of intra-country transmission lines, the plan remains vague as of the necessary investment to absorb the highest shares of renewables. It also fails to provide details on the necessary investment at the distribution level (except from smart grids under Danube InGrid PCI).



NECP – SLOVENIA

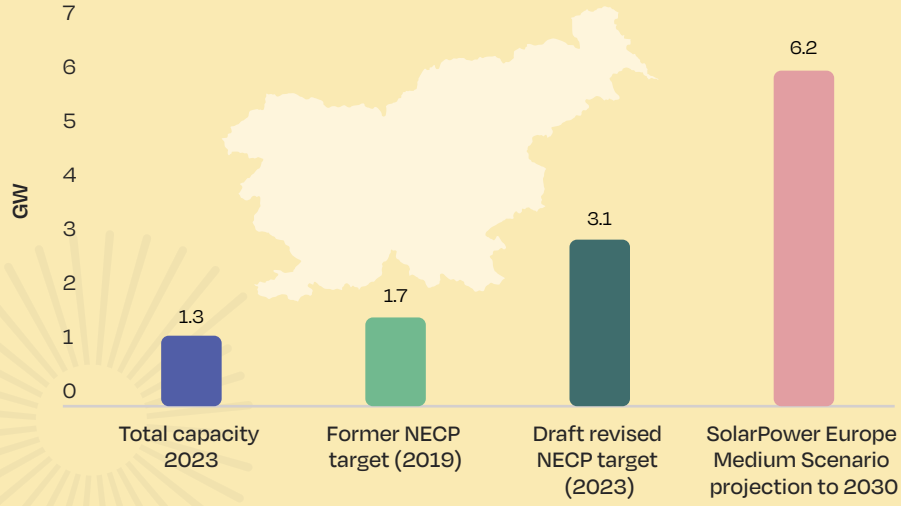
Targets

Slovenia has considered latest developments in the assessment of the renewable energy trajectory by 2030, with an objective to reach 30-35% RES by 2030, a noticeable increase compared with the previous NECP target of 27%. Slovenia, however, does not provide a clear figure beyond this range. It does provide a clear trajectory in the electricity sector with 52% RES-E by 2030, an almost 10 percentage points increase compared with the previous NECP.

When it comes to solar PV, the plan foresees a contribution to gross final energy use of 3.861 GWh. This would correspond to about 3.1 GW and an 88% growth compared to the previous target.[15] This results in 1,623 W/capita, a value in line with the EU average. While the substantial increase compared with previous NECP is welcome, it remains substantially below SolarPower Europe's Medium Scenario projection to 2030, whereby Slovenia reaches 6.2 GW of installed capacity. The plan also provides no breakdown between ground-mounted and rooftop PV.

Enabling measures

- **Support schemes:** The chapter on policies and measures is still under construction.[16]
- **Prosumers and citizens:** The chapter on policies and measures is still under construction.
- **Flexibility and storage:** The chapter on policies and measures is still under construction.
- **Grids:** Slovenia's interconnection capacity already exceeds the 15% EU target, with an 80% ratio. A very positive element is the mention of the necessary upgrade of the distribution grid and the interaction with the transmission grid. While the plan rightfully identifies the challenges of the distribution and transmission grid, it fails to provide clear investment pipeline, capacity increase and typology of support.[17]



15 Assuming 1,250 GWh/GW.

16 The Government published provisional plans for funds- only for 2024. This is a constant issue which ca obstruct the rollout of solar PV.

17 Slovenia is preparing a new 10-year grid upgrade plan next year. It should include the targets from the NECP.

NECP – SPAIN

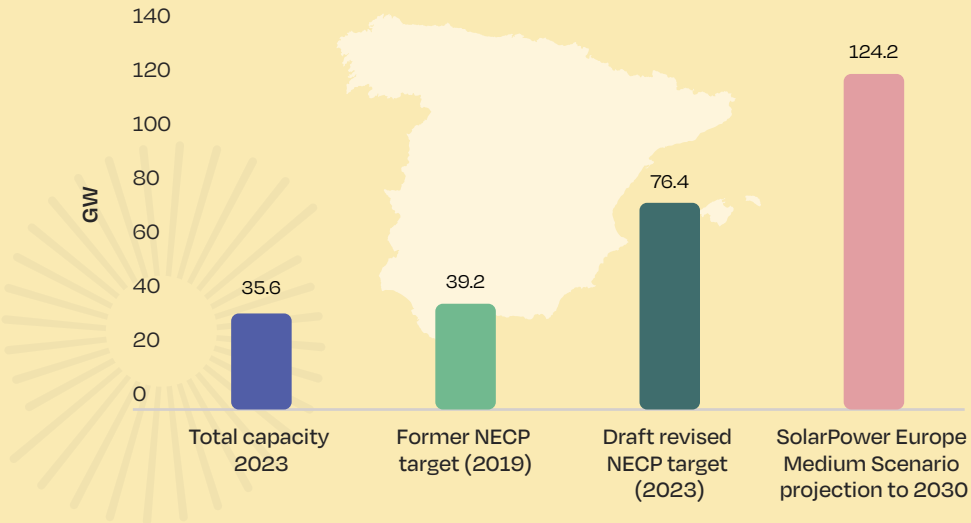
Targets

The updated National Energy and Climate Plan includes an objective of 48% of renewable energy in final energy consumption by 2030, an increase of 6 percentage points compared to the previous NECP. The pattern is similar when it comes to the share of renewables in the electricity mix, which increases from 74% to 81% in the updated version.

When it comes to solar PV, the ambition increases from 39 GW to 76 GW of total installed capacity for 2030, almost doubling the previous target. With such a deployment, Spain would be able to exceed 1,600 W/capita by 2030, which is a level in line with the EU average. While this increase in ambition better reflects the potential of the sector, it still remains below SolarPower Europe's Medium Scenario projection to 2030, whereby Spain reaches a cumulative capacity of 124 GW. On a positive note, the plan provides a breakdown between utility-scale and rooftop solar, with 19 GW for self-consumption and 57 GW for ground-mounted respectively.

Enabling measures

- **Support schemes:** The volume of auctions for renewables has been increased commensurately with the overall ambition. In the current NECP, there is a general objective to set auctions for the construction of at least 3.5 GW of RES every year, out of which more than 50% will be solar power. There is a calendar for auctions (2022 – 2026) regarding the minimum amount of MW by year and technology (1,800 MW/year for PV). Compared with previous NECPs, the information has improved. However, the plan should provide details on the design of the auctions and the criteria for capacity allocation. Also, the auctions are only designed until 2026, whereas the sector needs to have visibility at least until 2030.
- **Prosumers and citizens:** The plan introduces a quota for citizen-led renewable initiatives, which is an improvement compared with the previous plan. The plan includes details and quantified objectives in terms of prosumers' engagement. It also includes an investment volume for prosumers.[18] As in the previous version, the plan could provide a detailed agenda for prosumers' support schemes, including soft financing mechanisms.
- **Flexibility and storage:** The plan lists a series of initiatives to promote storage and an objective of 22 GW storage for 2030, a substantial increase compared to the previous plan. The investment plan on storage is clearly detailed. However, no details are available on the breakdown per technology nor on the additional vs. existing storage. On demand-response, there is the mention of specific regulation and policy support, but no clear target on the power allocated or the number of aggregators.
- **Grids:** The NECP references the network development plans, and the investment needs in the sector. However, the plan does not detail new investments on electricity grids but only points out the role of TSOs plan (plan for 2021-2026 and an upcoming one for 2024-2029). The draft mainly focusses on grid interconnections rather than reinforcing internal grids. Additionally, given the high RES-E target and the criticality of grid access, the plan could have been more detailed regarding the necessary investment until 2030, especially at the distribution level.



18 The measure was already in place through RD 960/2020.

NECP – SWEDEN

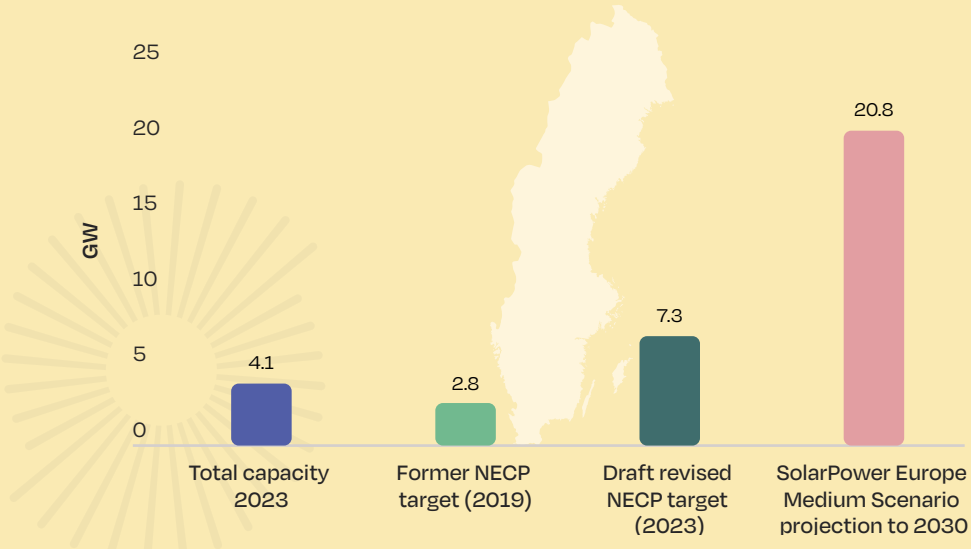
Targets

Sweden does not have a specific national renewable energy target but uses the Swedish Agency's long-term scenario which provides a share of 65% for 2030. This is similar to the previous NECP. Sweden should provide an update of the figure in its final NECP, after the adoption of the renewable energy directive. Following the same principle, the plan doesn't provide any sector-specific share but indicates that, in the 2023 energy scenario, the total capacity of renewable electricity increases from 44 GW in 2021 to 67 GW in 2030. The absence of RES and PV target is problematic.

When it comes to solar PV, the plan foresees an increase of 5 GW compared with 2020 installed capacity, therefore reaching around 7.3 GW by 2030.[19] Despite the strong growth compared to the previous indicative target of 2.8 GW, this results in a 659 W/capita score, substantially lower than the EU average. This target also remains far below SolarPower Europe's Medium Scenario projection to 2030, whereby Sweden reaches a total solar capacity of 20.8 GW. The plan also provides no breakdown between ground-mounted and rooftop PV.

Enabling measures

- **Support schemes:** An estimation of the volume of tax reduction schemes for prosumers would have been useful.
- **Prosumers and citizens:** The plan mentions the obligation for low-voltage consumers, introduced by Ordinance 1999:716, to deploy net-metering systems to facilitate the calculation and reporting of transferred electricity. Prosumers also benefit from tax reduction schemes for excess electricity injected to the grid,[20] and from tax reduction for the installation of individual solar PV systems.[21] However, the plan would have benefitted from more details on the expected uptake of prosumers, including PV and storage capacities. Also, there is no incentives for energy communities.
- **Flexibility and storage:** The plan mentions several developments around flexibility and market integration, including the Nordic Balancing Model and capacity markets. At the consumer level, a tax reduction of 50% is granted for storage. Sweden has no specific objectives in terms of demand-response and storage.[19] It relies on incentives for network operators to provide such services to end-consumers.
- **Grids:** Sweden has a Net Transfer Capacity (NTC) that has exceeded the desired level of 30% of peak load at all interconnectors, and most of the times even 100%. The plan also provides a clear description of NTC related to RES capacities, which also exceeds 30% in all cases. It also mentions the extension of the capacity of the SE-FI and SE-DE interconnectors. Regarding internal transmission capacity, the plan mentions grid reinforcement to manage congestion on the West coast and on the North-South corridor. Sweden has no explicit target for the level of electricity interconnection by 2030, but Sweden had an electricity interconnection level of 23% at the end of 2021, already higher than the EU's 2030 target of 15%. On grid reinforcement, although the plan mentions some of them, the progress is still too slow.



19 It is assumed that the 5 GW increase target is expressed in AC terms and based on a conversion factor of 1.25 AC to DC.

20 The tax reduction for excess electricity is for everyone with maximum 100 A of grid connection.

21 Maximum tax reduction of 4,200 Euro (50,000 SEK).

4 GW-scale solar markets

170 MW Klettwitz solar park, built on a former lignite mine, Brandenburg, Germany. © Trina Solar

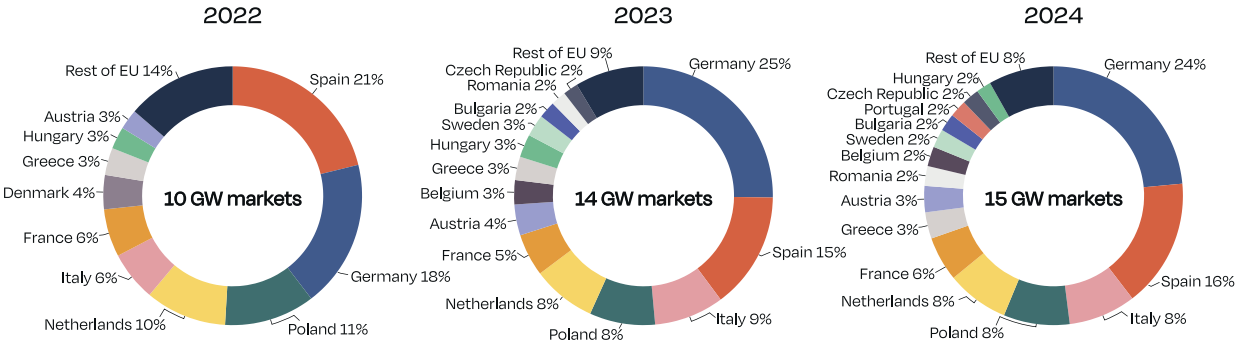
In 2023, 14 EU-27 markets installed more than 1 GW of solar in a year. According to our estimates, these markets are Germany, Spain, Italy, Poland, the Netherlands, France, Austria, Belgium, Greece, Hungary, Sweden, Bulgaria, Romania and the Czech Republic.

For the first time, more than half the markets are GW-scale, an increase of 40% compared to last year. In our 2022 edition of the EU Market Outlook , we assumed 12 markets would reach the GW-scale in 2023, but Portugal did not reach this threshold. Instead, 3 other markets grew well above GW-scale in 2023. These markets are Bulgaria, Romania, and the Czech Republic.

In the EMO 2022, Sweden and Portugal were expected to reach GW scale in 2022 but eventually failed to reach it. Instead, Austria and Hungary rose above expectations and replaced both countries in the list.

In 2023, nine out of ten GW-level markets of 2022 secured their spot in the list once again – and the 2022 newcomers Austria and Hungary are among them. At the top is Germany, being the first market ever to reach above 14 GW. In the lower ranks, some positions shifted. Denmark slowed down below the GW level in 2023, as expected, and was replaced by five newcomers. These newcomers include Belgium, Sweden, Bulgaria, Romania and the Czech Republic, of which 3 had already experienced annual GW-scale additions during the first EU solar boom phase – the Czech Republic in 2010, Belgium in 2011 and Romania in 2013. Sweden has earned its place back in the list after Hungary, but Portugal is expected to miss sightly the GW mark again. Last year, Belgium fell a little short of reaching the rankings, but today the market has even crossed the 1.5 GW mark.

FIGURE 31 EU-27 GW-SCALE SOLAR MARKETS 2022 - 2024



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The Eastern European newcomers include Bulgaria, Romania and the Czech Republic which, put together, barely summed up to 1 GW in 2022. Now, each of these Eastern European countries is expected to grow above 1 GW by the end of 2023, together representing more than 7% of the market. Italy, for the second time, broke expectations by climbing two positions and nearing the 5 GW mark this year. Two years ago, this market was still below GW-scale. The Austrian market, at the seventh place, well surpassed 2 GW in annual installations, only one year after entering the list. In total, all GW markets cover 90% of the market, which is a 6% increase compared to last year. Although Germany represents one-fourth of the market, the new entries of historically small markets shows that new clusters are forming.

In 2024, we expect each of the listed markets to keep the GW status and Portugal to confidently breach the GW threshold. The top 5 markets are expected to keep their relative positions. Germany is anticipated to continue representing one-fourth of the EU market and being the only member state installing a two-digit GW number of solar systems. However, Spain will be the only other market with a two-digit market share, at 16%. In total, we expect a share of 92% for all GW markets in 2024. Our Medium Scenario shows growth at a more stable pace in all markets, although there are a lot of variables to consider, as shown in the Low Scenario. The rest of the EU-27 is expected to retain its market share in 2024, showing the expected growth in some of the smaller markets.

Solar technology will keep growing in different parts of the EU in the coming years. Countries see solar power as the safest, most flexible, and cost-effective way to meet their climate and energy needs. By 2025, the list of GW markets is expected to expand to 18 markets, a level it will keep until 2027 (Figure 32).

In this GW chapter, we traditionally invite our members, national solar/renewables associations to provide their local expert views on their home countries (which, however, sometimes differ from our estimates that are based on several sources). For this edition, we have received contributions from national associations of all GW-markets in the EU-27 (Figure 32).

FIGURE 32 NUMBER OF SOLAR GW MARKETS IN THE EU-27

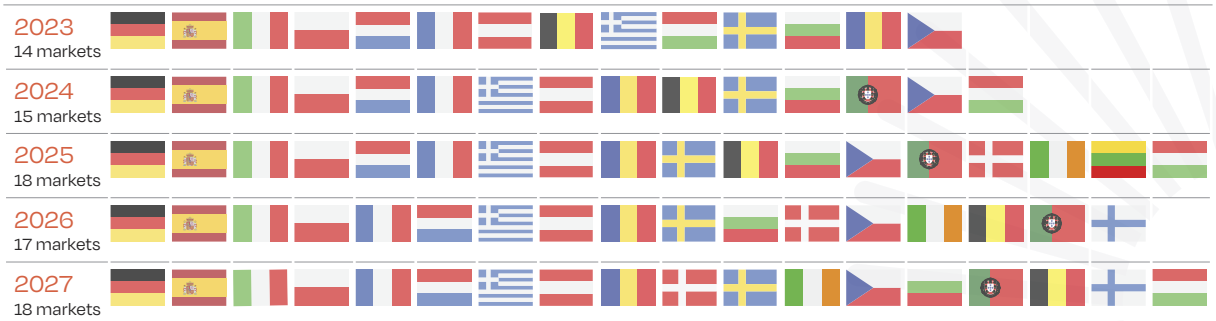

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FIGURE 33 NATIONAL ASSOCIATIONS OF ALL GW-MARKETS IN THE EU-27

1.	GERMANY (BSW)	
2.	SPAIN Unión Española Fotovoltaica (UNEF)	
3.	ITALY ANIE Rinnovabili, Elettricità Futura, Italia Solare	
4.	POLAND PSF & PV Poland	
5.	THE NETHERLANDS Holland Solar	
6.	FRANCE Syndicat des Énergies Renouvelables (SER)	
7.	AUSTRIA Bundesverband Photovoltaic Austria	
8.	BELGIUM EDORA & PV-Vlaanderen	
9.	GREECE HELAPCO	
10.	HUNGARY MANAP	
11.	SWEDEN Svensk Solenergi	
12.	BULGARIA Association for Production, Storage and Trading of Electricity (APSTE)	
13.	ROMANIA Romanian Photovoltaic Industry Association (RPIA)	
14.	CZECH REPUBLIC Czech Solar Association	

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1. Germany

Eight consecutive gigawatt-months of PV surpass expectations and break records in volatile market environment

Overview of Solar PV Developments

According to the database of the German Federal Network Agency (Bundesnetzagentur, BNetzA), a total of 11.8 GW of solar PV has been put into operation in Germany by the end of October 2023. This volume already exceeds the 7.5 GW of solar PV put into operation in 2022[22] as well as the target of 9 GW envisaged for the entire year 2023 by the government coalition. Of these projects, almost 10.7 GW benefitted from various schemes within the country's Renewable Energy Sources Act (EEG) and an overall installed capacity of roughly 13 GW can be expected by the end of the year if monthly installations follow currently observed patterns.[23] The year 2023 will therefore shatter several records such as the most annual installations (surpassing the previously leading year 2011 in installed capacity by more than 50%) and having at least 8 months in a row with more than 1 GW of confirmed capacity added from March to October 2023.

The previous year's highest monthly addition of 844 MW in March 2022 has been upstaged by the addition of 1,398 MW of solar PV in July 2023. Overall, the first ten months of 2023 showed an explosive growth in PV deployment, with 85% more installed capacity than in the first ten months of 2022, which in turn showed 34% growth compared to the same period in 2021. Moreover, the German corporate renewable Power Purchasing Agreement (PPA) market continues to mature, with rooftop PPA additions reaching roughly 150 MW by the end of October, which marks an increase of 89% compared to the same period in 2022. Ground-mounted PPA additions increased to almost 1.0 GW by the end of October compared to 0.6 GW over the same period in 2022. Meanwhile, several GW of merchant solar PV outside the EEG scheme with over 10 MW in capacity remain in the project pipeline.

Solar PV targets and drivers of growth in Germany

With roughly 79 GW of solar PV in operation at the end of October 2023, Germany's installed capacity remains the highest in Europe. Germany seeks to fulfil the commitment of its government coalition formed at the end of 2021 to reach 22 GW of yearly installed solar PV by 2026 targeting a total installed PV capacity of 215 GW for 2030. The so-called 'Easter Package' adopted in July 2022 established these progressive targets with the aim to reach close to 400 GW by 2040. With currently about 13 GW of annual installed capacity to be expected for 2023, the 9 GW previously envisaged for 2023 by the Federal Ministry for Economic Affairs and Climate Action (BMWK) would be exceeded by a significant margin. However, as demonstrated by the graph below, this only accounts for 60% of the challenging target of 22 GW from 2026 onwards.

Since June 2021, the Climate Protection Act has also set a binding path to climate neutrality in 2045, while interim GHG emission reduction targets have been raised to 65% for 2030 and to 88% for 2040. Accordingly, the target share of renewable energies has been raised from 65% to 80% of the electricity demand by 2030, with full decarbonisation by 2035. In January 2021, the former government had already introduced a national expansion to the EU-wide Emission Trading System (EU ETS) covering heating and transport fuels. Starting with a CO2 price of 25 EUR per tonne, prices will increase each year up to 55 EUR per tonne in 2025 leading to an auction system whose long-term CO2 price floor is targeted to stabilise at 60 EUR.

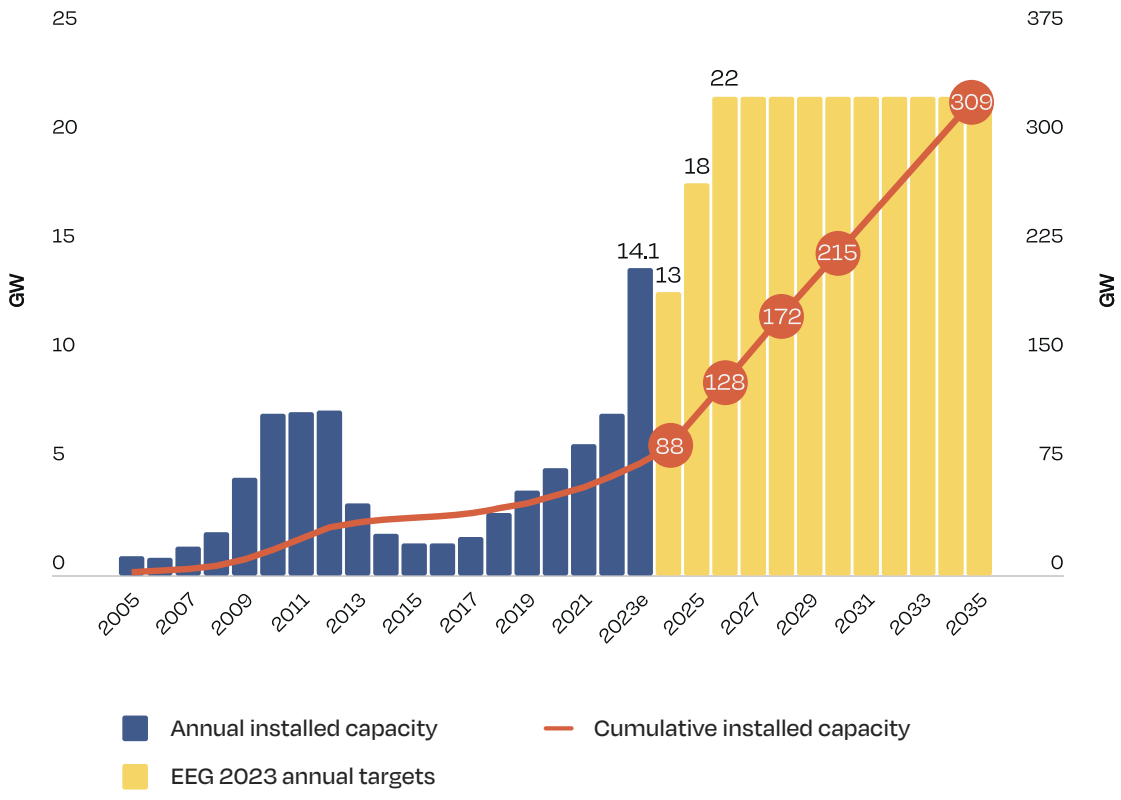
The year 2023 has seen two major policy initiatives in Germany. First of all, the encompassing Photovoltaic Strategy developed by the BMWK in cooperation with industry stakeholders and associations was announced on 5th May 2023. A significant fraction of its scope has been consolidated into the so-called 'Solarpaket I', which is currently being discussed in the German Parliament ('Bundestag') and the Federal Assembly ('Bundesrat'). This package is supposed to remove a lot of 'regulatory

22 In line with recommendations by the BNetzA and the latest revisions to their database, solar PV additions are computed based on the date of initial operation. Due to this adjustment and late registrations, minor deviations from previously calculated values may occur, especially if those were based on the reporting date.

23 The exact annual installed capacity also depends on the registration dates of large solar parks that are nearing completion. Eight consecutive months (March to October) have already been confirmed to breach the 1 GW threshold paving the way for 13 GW of total installed annual capacity.

space debris' accumulated in the past and was originally scheduled to be voted on in November or December. A pivotal decision of Germany's constitutional court, however, which declared a budget transfer to the benefit of the German 'Climate and Transformation Fund' (KTF) to be unconstitutional, has lowered the available budget by up to 60 billion EUR and will likely delay the vote on the solar package. The same holds true for the industrial policy initiative designed to reshore 10 GW of PV manufacturing capacity across the entire value chain through CAPEX support initiated by the BMWK's 'Interessenbekundungsverfahren'. This program is meant to incentivise PV lighthouse projects and has reportedly attracted numerous applications from consortia across the entire value chain interested in building 'gigafabs' in Germany. The selection of companies eligible for state aid notification to the EU Commission utilising the additional flexibility granted by the Temporary Crisis and Transition Framework (TCTF) was to be published in October, but has been postponed until further notice as of November 28th. Although both initiatives have been applauded by stakeholders, investment security is currently suffering due to the delays. A one-off program of limited size providing incentives for combined new PV and wallbox systems has sparked a short transitory surge in demand, without observable long-term effects. Last but not least, the last three nuclear plants in Germany were shut down earlier this year in April 2023, which marks Germany's complete detachment from nuclear fission technology.

FIGURE GW 1 GERMANY PV CAPACITY TARGETS 2023-2035, BY BSW-SOLAR



SOURCE: EEG 2023, BMWK.

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Connecting Strength

We connect people, products and digital technology.

- Installation on all pitched and flat roofs
- Easier design and documentation with digital tools

130
Our systems are installed in over 130 countries

29
29 GW of installed capacity worldwide

19
19 years of solar experience

Solar trends: Attention to C&I rooftops and storage

Despite volatile module prices, PV system prices remained at a high level due to increasing costs from general inflation and installation. This made system cost developments hard to predict for market participants, adding additional layers of investment uncertainty for both manufacturers and off-takers. To address the high financing costs and consequently undersubscribed auctions throughout the year 2022, maximum bids in the first segment for ground-mounted projects[24] were raised from 0.059 EUR/kWh to 0.074 EUR/kWh in January 2023, which immediately led to a 50% oversubscribed auction in March 2023 awarding 1,952 MW at an average bidding price of 0.070 EUR/kWh and a 186% oversubscribed auction in July 2023 awarding 1,611 MW at an average bidding price of 0.065 EUR/kWh. A third auction of similar volume is to take place in December 2023, whereas the weak performance of auctions in 2022 may have already had a dampening impact on this year's monthly ground-mounted PV installation figures. The entire ground-mounted capacity of 3.45 GW installed until October thus exhibits a growth of 32% compared to the first ten months in 2022. The realisation of projects with successful bids in the 2023 tenders will yield additional growth in the coming years. Likewise, rooftop tenders in 2022 were severely undersubscribed before an adjustment of the maximum bidding price from 0.089 EUR/kWh to 0.113 EUR/kWh led to an almost exhausted tender in February 2023 and two tenders in June and October that were oversubscribed by more than 75%. The combined volume of tenders including adjustments for forfeited successful bids and volumes from past auctions will therefore exceed 6 GW in 2023.

24 Germany currently has two types of large-scale auctions whose tenders are specifically designed for solar PV projects. The first segment represents a technology-specific tender for ground-mounted projects between 1 and 100 MW, and the second one comprises tenders for rooftop systems above 1 MW. Besides this, there is an auction with two rounds of approximately 400 MW for innovative systems.

Moreover, the exemption of solar PV installations below 1 MW from mandatory participation in tenders (up from 0.75 MW) has contributed to a reversal in trends in the commercial rooftop segment with an installed capacity of 2.08 GW in the first ten months, implying a growth rate of 83% over the same time period in the previous year. While the rooftop segment below 30 kW has installed 6.07 GW of capacity by October 2023 at a growth rate of +134% compared to October 2022 and the tenders appear to be on track for their combined target volume of 9 GW in 2024, the true potential of commercial rooftops remains untapped. This is mainly due to high interest rates becoming especially salient in this market segment, which needs to be addressed through feed-in tariffs that reflect the worsened financing costs to get commercial rooftops on track as well. Meanwhile, storage solutions have exhibited accelerating growth with capacity additions in residential and commercial storage already exceeding the previous year's capacity by June 2023. At the end of the year, both segments can be expected to add more than twice the preceding year's capacity, and surveys show that 80% of consumers with an interest in PV systems are prone to combine these with battery storage.[25] As large battery storage systems above 1 MWh are installed to perform grid services and are also becoming more common in combination with utility-scale PV projects, the roughly 50 large-scale BESS systems that were installed in 2022 as a whole have already been reached in July 2023. Almost 11 GWh of cumulative storage capacity have been installed in Germany by November 2023[26] and overall capacity should exceed 12 GWh by the end of the year, when accounting for late registrations.

Solar trends: 'Solarpaket I' expected to take off

Along with the increase in feed-in tariffs for small rooftop systems, VAT exemptions for PV systems below 30 kW, the liberation of self-consumption from the renewable energy surcharge ('EEG Umlage') and the increase of tender scheme volumes, which had already been passed in 2022, the upcoming 'Solarpaket I' is expected to bring about numerous improvements that will further incentivise and facilitate the deployment in both residential and utility-scale markets.

Among the expected provisions are improvements to energy sharing ('Gemeinschaftliche Gebäudeversorgung') and energy provision to commercial tenants, which constitute crucial and long overdue steps in Germany, where renting houses with multiple parties is a common phenomenon. The demand for PV systems in urban residential areas is expected to benefit in response. An accelerated approval procedure for grid-connection certificates will alleviate bottlenecks in the range between 135 to 950 kW. Furthermore, separate auction segments with adjusted maximum bids or bonuses for special PV systems ('Besondere Anlagen') comprising Agri-PV as well as floating, parking and wetland PV have been announced as part of the package demonstrating the government's willingness to invest in progressive solar PV concepts. Moreover, disadvantaged areas will be opened for subsidised ground-mounted PV, providing an option to partake in the energy transition for owners of land with low agricultural value. Since the package is currently scheduled to be voted on in December 2023 or early 2024, no complete overview is available as of yet. Nevertheless, it is expected to include countless advantageous amendments such as simplified grid connection provisions, reductions in bureaucratic burdens, improvements to the repowering of systems and additional support for 'balcony solar', which will further facilitate PV deployment in Germany. In order to ensure a successful renaissance of PV manufacturing in Germany, however, complementary measures are needed in addition to the capital expenditures (CapEx) support for lighthouse PV manufacturing projects within BMWK's 'Interessenbekundungsverfahren'. Therefore, short- to mid-term programs designed to increase the resilience of operating manufacturers and provide an immediate perspective for 'gigafab' investors are proposed by solar PV stakeholders in Germany with a sense of utmost urgency—including 'resilience programs' as late but important additions to the 'Solarpaket I'. It is widely accepted that only the timely implementation of a comprehensive industrial policy strategy can send a sufficiently strong signal to international investors that the political will to support domestic 'solar valleys' and European PV manufacturing remains unbroken.

25 According to YouGov surveys commissioned by the Bundesverband Solarwirtschaft e.V. in summer 2023.

26 According to the Battery Charts of the RWTH Aachen as of November 28th.

Challenges

While the much anticipated 'Solarpaket I' will undoubtedly improve PV deployment in many areas and has been applauded for its integrative approach and stakeholder involvement, the decision of the constitutional court from 15th November to void a significant fraction of the KTF's budget will have far-reaching implications. With the government coalition racing to secure funds for political projects nearing implementation, projects possessing a support notification are supposed to remain unaffected. Unfortunately, the latter may not necessarily be the case for the more recently discussed PV industrial policy schemes. Furthermore, the government can be expected to apply additional scrutiny to proposals benefitting solar PV deployment through government expenditures going forth.

At the same time, grid congestion, the untapped potential of the C&I rooftop segment, incentivising private investments and consumer markets despite soaring interest rates, nourishing the PPA market and securing solar power jobs for all parts of the value chain remain crucial tasks. The government coalition has demonstrated its unwavering support for the energy transition and its willingness to readjust regulations when deployment targets are in danger. However, the upcoming elections in 2025 have already begun to cast their shadow, as recent federal state election results have put additional pressure on the coalition partners. The urge to sharpen political profiles in combination with the unforeseen budget restrictions and geopolitical uncertainty may reduce the political capital available for transformative policies. One gauge of the remaining capacity for decisive action will be the continuation of PV industrial policy along with a smart digitalisation of renewable energy systems, support for grid expansion and flexibilisation as well as the consultations for the 'Solarpaket II', which was announced alongside its counterpart to address technical and building code related aspects before the end of the legislature period. A cold winter with ongoing armed conflicts may also revitalise discussions around energy security and solar integrated heating solutions, which suffered a heavy blow earlier this year due to a controversy-laden debate surrounding amendments to the Buildings Energy Act (GEG). Last but not least, German solar PV stakeholders and policymakers follow EU legislative procedures with anticipation as several initiatives such as the Net-Zero Industry Act and the PV Ecodesign consultations are scheduled to culminate in early 2024 and expected to set impactful framework conditions for future political initiatives and market developments at the national level.

Authors: *Alexander Rohlf,* Bundesverband Solarwirtschaft e.V. (BSW-Solar).

21.14 MW PV power plant, Bad Liebenwerda, Brandenburg, Deutschland.

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2. Spain

The challenges to our future

Overview of solar PV developments

In 2022, Spain's solar power energy sector achieved a significant milestone, with the annual installation of approximately 8.4 GW in capacity, including both ground-mounted systems and self-consumption units. This marked the country's most successful year to date in solar PV deployment, establishing Spain as the foremost PV market in Europe. Until november 2023, Spain has augmented its capacity with over 4.5 GW of ground-mounted installations, a figure anticipated to rise in the ensuing months.

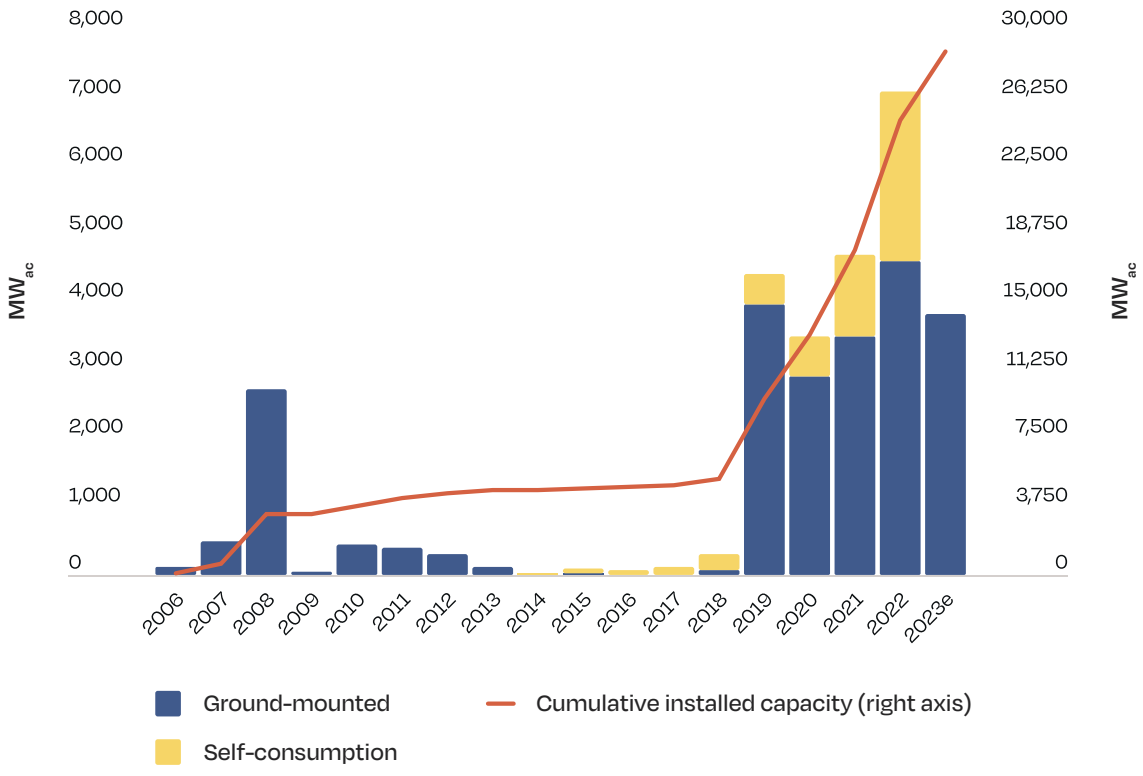
Within the MIBEL electricity market zone, encompassing Spain and Portugal, the contribution of photovoltaic energy to the energy mix has seen a substantial increase. The photovoltaic production proportion grew by 10.6%, reaching 38.3% in 2023, a notable rise from 27.7% during the same period in the previous year. On a national level, the share of PV within Spain's energy mix escalated from 10.1% in 2022 to 14.6% in 2023.

From January to October 2023, Power Purchase Agreements (PPAs) achieved a total of 99.4 TWh, marking a decrease of 11.6 TWh compared to the same period last year. These figures encompass all RES technologies, not solely photovoltaic. Despite these variations, Spain maintains a leading position in the EU's PPA market.

Drivers for solar growth

The latest **draft of the National Energy and Climate Plan (NECP)**, pending ratification in the coming year, outlines ambitious goals for photovoltaics, **aiming for an installed capacity of 76 GW by 2030—57 GW from**

FIGURE GW 2 SOLAR PV CUMULATIVE MARKET IN SPAIN, 2020-2022 & NECP TARGETS, BY UNEF



SOURCE: UNEF & TSO.

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ground-mounted facilities and 19 GW from self-consumption units. Additionally, the draft sets targets for energy storage and hydrogen production at 22 GW and 11 GW, respectively. These bold objectives are expected to significantly propel industry development in the near future.

Spain's solar sector growth is underpinned by its **competitiveness** in both ground-mounted and self-consumption installations. For ground-mounted plants, the economic viability - spurred by scale economies, favourable terrain, and abundant solar irradiation levels averaging over 1,600-1,800 kWh/kW annually-coupled with regulatory stability since 2018, has created a conducive environment that appeals to a diverse array of market participants. This includes national and European utilities, oil & gas corporations, independent power producers, solar developers, and investment funds, among others.

PPAs have been instrumental in the recent evolution of the sector. All large-scale solar capacities commissioned in 2020 (3.5 GW), 2021 (4.3 GW), and 2022 (5.3 GW) were realised independently of public subsidies or regulatory frameworks, solely through PPAs or merchant projects. The reliability proffered by PPAs is increasingly prized.

The legislative landscape for **self-consumption** has also evolved. The rooftop PV market expanded rapidly in 2022, due to the confluence of high electricity prices in 2022 and tax incentives from numerous local governments that motivated a wide spectrum of households and businesses to embrace self-consumption. Currently, we estimate a deceleration in 2023, suggesting a maturation of the market. This slowdown can be attributed to the public's perception of lower energy costs, grid connection challenges with distributors, and prolonged waits for funding and subsidies, sometimes exceeding a year. The draft **NECP** has set a target of 19 GW for self-consumption by 2030, guiding the development of a supportive framework with ambitious goals.

Economically, the impetus behind rooftop PV has been amplified by soaring wholesale electricity prices, leading various sectors to consider solar power as a viable, eco-friendly solution for reducing energy costs. During this year (January to October), wholesale prices reached 90.96 EUR/MWh, considerably less than in 2022 (179,86 EUR/MWh) but still high compared to previous years. This fact fostered a general perception of low energy prices, which slowed down the installation of self-consumption systems. Nevertheless, compared to previous years, they are still relatively high. Compared to pre-energy crisis times in 2020 at around 51 EUR/MWh, they are today at about 78 EUR/MWh.

The geopolitical implications of Russia's invasion of Ukraine in April 2022 spurred the Spanish government to implement measures aimed at reducing fossil fuel dependency, moderating energy prices, and expediting renewable energy deployment. These measures included the establishment of a regulatory framework for floating PV, expedited processes for PV parks under 150 MW, enhancement of the distribution grid to support 7 GW of self-consumption, and regulations concerning the infrastructure for renewable gases, such as renewable hydrogen.

Looking ahead, the prognosis for Spain's solar sector remains optimistic. So far, the ground-mounted segment has seen an installation of 4.5 GW in 2023. Numerous new projects, having secured environmental permits, are poised for installation in the forthcoming years, contingent upon meeting administrative requirements. To achieve the targets proposed in the new NECP draft for ground-mounted installations, an average of 6 GW per year must be installed, presenting a significant challenge linked to the design of renewable auctions, inflation rates, and market prices.

In the **rooftop PV market,** projections for 2023 indicate a deceleration, particularly within the residential sector. To fulfil the NECP's ambition of 19 GW by 2030, Spain will need to consistently add approximately 1.9 GW_{AC} annually over the next seven years.

Challenges

The Spanish solar sector, particularly regarding ground-mounted plants, faces a crucial juncture due to stringent deadlines imposed on development projects. With the mandate that **all projects holding current network access permits must secure their construction permits by end of December 2023,** there is a risk of dismissal for a significant number of projects, which could lead to the forfeiture of permits and associated economic fees. Currently, approximately 40 GW of photovoltaic projects are queued in the administrative process.

This situation poses two substantial challenges: firstly, administrative authorities are under intense pressure to process a massive backlog of applications to prevent a cascade of project cancellations. Secondly, should a large volume of projects concurrently receive administrative approval, it could lead to logistical bottlenecks in the construction and installation phases, potentially hindering the timely and efficient rollout of these solar projects.

Multiple elections at the local and national levels have produced political paralysis this year. Spain did not develop any new significant framework to push forward the solar industry. **2023 ended with no new tender calls** (Contracts-for-Difference). The upcoming tenders are expected in 2024, and the auction design needs to improve to attract interest from developers.

On the local communities' side, the sheer volume of projects going through local permitting (amounting to 2-3 times the NECP targets), is generating a **NIMBY effect**, i.e. a 'not in my backyard' mentality. Certain local associations are opposing utility-scale renewable plants, requiring a significant communication effort from companies and UNEF, about the benefits of solar power on land use and biodiversity.

For rooftop PV, the main challenge is the **length of permitting times** (both at the administrative and network level), due to diverging processes across municipalities, and reduced permit exemptions for network access for rooftop PV. In addition, delays in implementing the national recovery plan's support programs are slowing down consumers' and developers' decision-making processes, who are now waiting for the funds to be available in their region.

Another important challenge for PV development, both ground-mounted plants and rooftop PV, is the lack of a **skilled labour force** which is driving an increase in costs for developers. Government professional training programs must adapt to these new market developments.

Increasing **inflation rates** are also impacting prices for developers, affecting projects' profitability. Furthermore, Spain is experiencing with an increase in curtailment during solar peak hours mainly due to the network physical restrictions. Spain must increase investments in its networks and accelerate its regulatory framework related to storage incentives as proposed by UNEF.

40 MW attached to a 3 MW / 9 MWh battery, Campo Arañuelo III in Almaraz, Caceres.

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Conclusions

Spain's high NECP targets, and the success of the national solar power market call for **excellence from all parties: companies, the public administration, and policymakers. In other words, our ambition is to overcome our challenges to maintain the supportive solar ecosystem** that has placed Spain as one of the top two markets not only in Europe but also among the world´s top 10 largest markets.

On the policy side, it is key to ensure regulatory stability and to eliminate remaining barriers by streamlining administrative procedures, and network access, especially for smaller PV plants and self-consumption projects. On the sector side, companies need to respond to the growing NIMBY effect, and present projects with the highest standards in terms of environmental sustainability, positive social impacts, and transparency.

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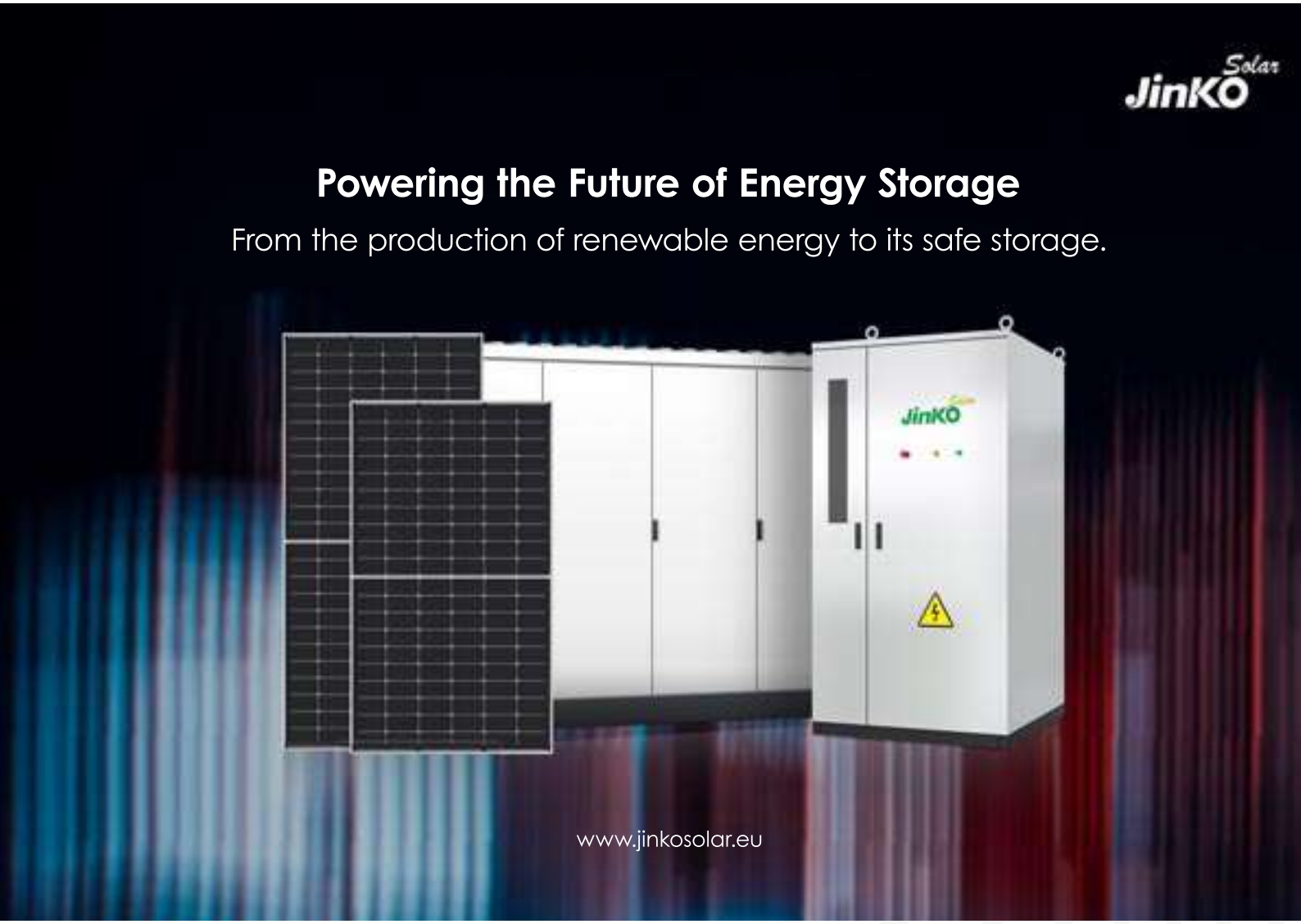


3. Italy

Eight consecutive gigawatt-months of PV surpass

Overview of the solar market

The Italian solar market experienced sluggish growth between 2014 and 2021, with an average of 500 MW of capacity installed per year. After an improved performance in 2021, when 936 MW of solar PV was added, 2022 represented a record year for the sector. That year, Italy installed nearly 2.5 GW of solar capacity, bringing the country's solar fleet to a cumulative capacity of over 25 GW, with a total of over 1.2 million PV systems. Most of these new installations were residential systems (1.1 GW), mostly benefitting from the Superbonus 110% incentive scheme.

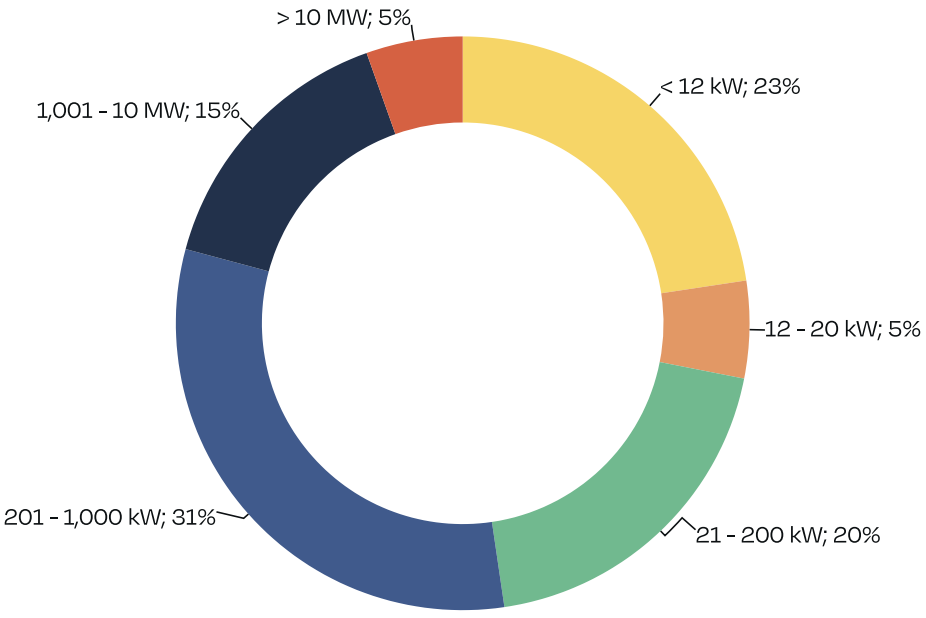
At the end of September 2023, Italy's solar fleet totalled 28.6 GW, with more than 1.5 million PV systems. As can be observed in Fig. GW 3, medium-size PV systems between 200 kW and 999 kW make up most of Italy's installed solar PV capacity, with just above 9 GW (31%). The utility-scale segment (above 1 MW) represents 20% of the solar PV market, while smaller PV systems (less than 200 kW) capture a 48% market share.

The regions with the highest installed capacity are Lombardy (3.8 GW), Apulia (3.2 GW), and Veneto (3 GW), while those with the lowest installed capacity are Molise (204 MW), Liguria (176 MW), and Aosta Valley (33 MW).

Public solar PV targets

The updated draft National Energy and Climate Plan (NECP), sent to the European Commission in July 2023, sets a target of 57 GW new PV power capacity in the 2022-2030 period (out of the total 73 GW new renewable power capacity). This would lead to a total solar capacity of 79 GW by the end of the decade. The NECP will have to be finalised by June 2024.

FIGURE GW 3 ITALY'S CUMULATIVE SOLAR PV CAPACITY BY SEGMENTATION IN Q3/2023, BY TERNA



SOURCE: TERNA.

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The Italian associations ANIE Rinnovabili, Elettricità Futura, and Italia Solare agree that Italy must install at least 85 GW of new renewable power in the 2022-2030 period to achieve its REPowerEU targets. Solar PV should represent 68% of that renewable capacity. It will be critical that the vast majority of the deployed capacity is comprised by utility-scale plants to minimise costs, whilst ensuring security for the energy system. This new capacity will bring the overall renewable installed power in Italy to 143 GW. Considering that 8 GW of existing renewable power will become obsolete by 2030, the country will need to install 12 GW of new renewable power per year in the 2024-2030 period, at least 8 GW of which being PV. The associations also believe that Italy must install 80 GWh of new large-scale storage capacity to effectively integrate new power into the grid. Reaching the 2030 targets will mobilise 320 billion EUR of overall investments in the electricity sector and associated supply chain in the 2022-2030 period. It will also lead to 360 billion EUR of overall economic benefits in terms of added value along the electricity sector supply chain, and an increase in domestic spending. This deployment of solar capacity, together with the other RES technologies needed, will also lead to a reduction of 270 million tons of CO_2equivalent emissions, and up to 540,000 new jobs by 2030.

Key drivers and challenges for the solar market

To reach the 58 GW solar target in the 2022-2030 period, it is necessary to overcome some key obstacles. In particular, 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.

The following actions should be urgently undertaken to cultivate further solar growth:

- Finalise the new NECP and the "Opportunity Sharing" planning between the regions (DM Aree Idonee);
- Define "go-to areas" for PV project development;
- Continue simplifying the authorisation procedures of new plants and repowering projects;
- Implement a mechanism to allow RES auction bases to be adjusted according to the LCOE value (DM FER X);
- Facilitate the transfer of the energy produced from PV and other RES plants to consumers;

130 kW, Porto Mantovano, Mantua, Italy.

© Oltre

- Implement support measures for energy communities and self-consumption (DM Energia Condivisa);
- Encourage the development of PPAs, especially long-term renewable energy purchase contracts;
- Increase support schemes for storage systems in all market segments (Implementation art. 18 Dlgs 210/2021);
- Avoid regulatory disruptions or sudden law changes which destabilise the market operators' plans; long-term planning is needed (see Ministerial Decree "FER" 1 bis, Ministerial Decree "FER 2" tax deductions for the residential segment, tax credit for businesses);
- Ensure a correct implementation of the revenue cap that excludes PPAs, including cross-bidding zone PPAs, and that it is not retroactive;
- Finalise the legislation for the development of Agri-PV systems;
- Review the connection regulations (TICA) to speed up process timing;
- Strengthen the European PV and BESS technological supply chain for improved energy resilience and decreased dependency from non-EU countries;
- Accelerate the reform of the electricity market rules to enable a greater penetration of RES, storage, and demand-side response.

Solar market prospects 2023-2027

Considering that the Italian PV market in 2023 will ramp up to around 4.5-5 GW according to current estimates, a significant further growth in annual additions is needed, starting from 2024. Considering that the total Italian PV fleet will get close to 30 GW by the end of 2023, an average of 7-8 GW of solar should be installed annually in the 2024-2030 period to achieve the 2030 target of 80 GW.

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4. Poland

Overview of the solar market

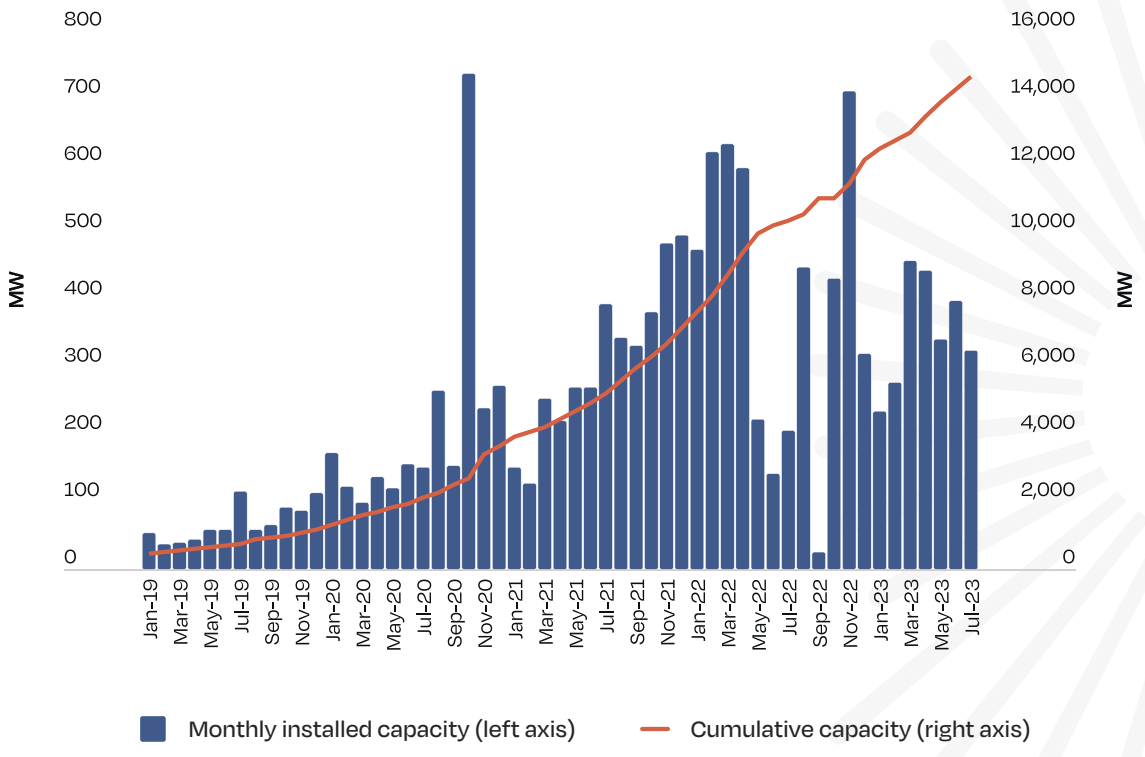
At the end of August 2023, over 26.4 GW of renewable energy was installed in Poland, of which 14.7 GW came from solar PV systems, which is more than 50% of the country's total RES capacity.

The success of solar energy in Poland is mostly due to the popularity of residential prosumer installations. According to the data of the Energy Market Agency, by the end of September 2023, Poland already had more than 1.3 million PV micro-installations under 50 kW, with a total grid-connected power of 10.4 GW (see Fig. GW 4). Such prevalence of household installations is mainly the result of very favourable financial conditions for prosumers, which were in force until recently. Specifically, the country's net-metering scheme allowed prosumers with systems up to 10 kW to feed 1 kWh into the grid and receive 0.8 kWh in return. For larger installations above 10 kW, this ratio was 1 to 0.7. Moreover, prosumers did not pay the distribution fees for using the grid.

The large growth in the number of micro-installations in Poland turned out to be challenging for distribution networks and led to changes in the policy framework. In April 2022, the net-metering system was replaced by a net-billing system, whereby the amount of electricity injected and retrieved from the grid is balanced in an hourly settlement using a metering system. Under the new scheme, prosumers are rewarded for surplus energy fed into the grid at the wholesale price, and they pay for the consumed energy just like other electricity consumers. After this change, the popularity of micro-installations somewhat decreased, although solar PV remains an attractive investment for households considering current electricity prices.

A public opinion survey carried out in May 2022, commissioned by the Polish Photovoltaic Association, shows the continued elevated support and social acceptance for solar energy. The survey highlights that

FIGURE GW 4 EVOLUTION OF PV INSTALLATIONS IN POLAND, JANUARY 2019 – JULY 2023, BY ENERGY MARKET AGENCY



SOURCE: Energy Market Agency.

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renewable energy sources (RES) rank best in all aspects when compared to any other energy source. Among renewable sources, solar PV obtains the best results and is the technology that Poles are the most willing to have in their neighbourhood (51% of responses). Nearly 2 in 5 respondents also think that the requirement to install PV systems on all new buildings is a very good idea.

Public solar PV targets

The regulation on the maximum quantities and values of electricity from RES assumes that, between the years 2022 and 2027, there will be 9 GW of new solar capacity stemming from public RES auctions. Auctions are carried out at least once a year by the National Energy Regulatory Office (URE), and projects below 1 MW and above 1 MW are placed in different baskets. The plan seems easily attainable, and the potential of PV in Poland is actually much larger. The URE anticipates 50 GW of RES capacity in 2030, half of which is set to be provided by solar.

Key drivers for the solar market

In addition to the favourable legal framework, the global energy context is providing a boost to solar deployment. The significant increase in energy prices and the lack of raw materials resulting from Russia's aggression against Ukraine is driving local governments and enterprises to prioritise energy self-sufficiency, resulting in new investments in photovoltaics. The country is also observing an increasing interest in the direct sale of market-based RES energy in the form of corporate Power Purchase Agreements (cPPAs).

In August 2023, the Polish Parliament implemented amendments to the RES Act that support the long-term development of the RES sector, and thus increase the share of RES in national energy consumption. The changes introduced are intended to improve the country's energy security and to help implement the EU RED II Directive (2018/2001) on the promotion of renewable sources into the Polish system. The Act introduces changes, among others, in the field of hybrid RES installations, energy clusters, modernisation and operational support for RES installations. It also contains provisions for the development of offshore wind energy. The Act also includes new solutions for increasing the connection potential of new renewable energy sources - the so-called cable pooling.

Winogrady, Poland.

© IBC Solar

In the small-scale segment, in addition to the change from the previous net-metering framework to the new net-billing scheme, the popular Mój Prąd (My Electricity) scheme was also revised. From mid-December until the end of March 2023, the subsidies towards residential solar were increased by 50% from 4,000 PLN (852 EUR) to 6,000 PLN (1,282 EUR) per system, while the rebates on battery installations were more than doubled to 16,000 PLN (3,409 EUR). Eligible installations range from 2 to 10 kW and grid connection is necessary. The war in Ukraine is regarded as the main reason for providing additional funding. Since the beginning of the scheme in 2019, over 1.7 billion PLN (360 million EUR) have been allocated to over 410,000 projects. With the termination of the subsidy boost, the attractiveness of the scheme has now decreased.

Key challenges for the solar market

The biggest barrier is still the limited capacity to connect new energy generation sources. Where the grid develops, photovoltaics will rapidly compensate for power shortages. The grid requires modernisation not only due to the energy transformation, but also due to its age - most of its components are over 25 years old, and a significant part is over 40 years old.

The act limiting electricity prices recently adopted by the Parliament is very relevant for the PV sector – and the entire Polish energy market. The act implements the European Council Regulation No. 2022/1854 and aims to protect the most vulnerable consumers against uncontrolled price increases. It contains a mechanism that limits the market income of energy producers and energy companies to the amount specified in a separate regulation. While physical PPAs are exempted, virtual PPAs are negatively affected by the cap. The reduction in energy prices is applied until the end of 2023.

The government adopted the Spatial Planning and Development Act, which is also worrying for the PV industry, and RES in general. Some of the legal solutions proposed in the draft will block further development of renewable energy sources in Poland. The proposed legislation aims to make it more challenging and prolong the time it takes to invest in class IV agricultural land. Typically, this refers to medium-quality land that is often unsuitable for agricultural production.

Prospects for the solar market 2023-2027

Despite these challenges, we anticipate further stable development of solar energy. The self-consumption segment is expected to grow, whereas the development of large-scale PV has been greatly affected by the capped electricity price situation. In the coming year, most PV systems will be developed under the auction system, both up to 1 MW and ground-mounted systems above 1 MW. The number of PV parks built commercially under PPA agreements for the sale of green energy to industry will increase even faster. We will observe a slower rate of increase in new residential micro-installations.

Large investments in power grids will be necessary. Recently, a draft amendment to the Act on the Transmission Grid has been published, aiming to accelerate the construction of power grids. Poland is already experiencing a shortage in energy production capacity, and this trend is set to become even stronger. Against this background, PV is currently the only technology that can deliver new energy production capacity within a short timeframe.

According to the latest forecast, the solar fleet in Poland will continue to grow, although at a slower pace than in the past few years. However, at the end of 2023, the capacity of all installed photovoltaic sources may exceed 17 GW. It is estimated that the year-to-year increase in power may even exceed 6 GW, which will be another record. The increase in new power in 2023 may be largely due to micro-installations added by the business prosumer segment. The new formula of the Mój Prąd programme, together with additional measures, will support a calm and stable increase in new power and will be a form of security for the transitional period before dynamic prices for prosumers are implemented in 2024.

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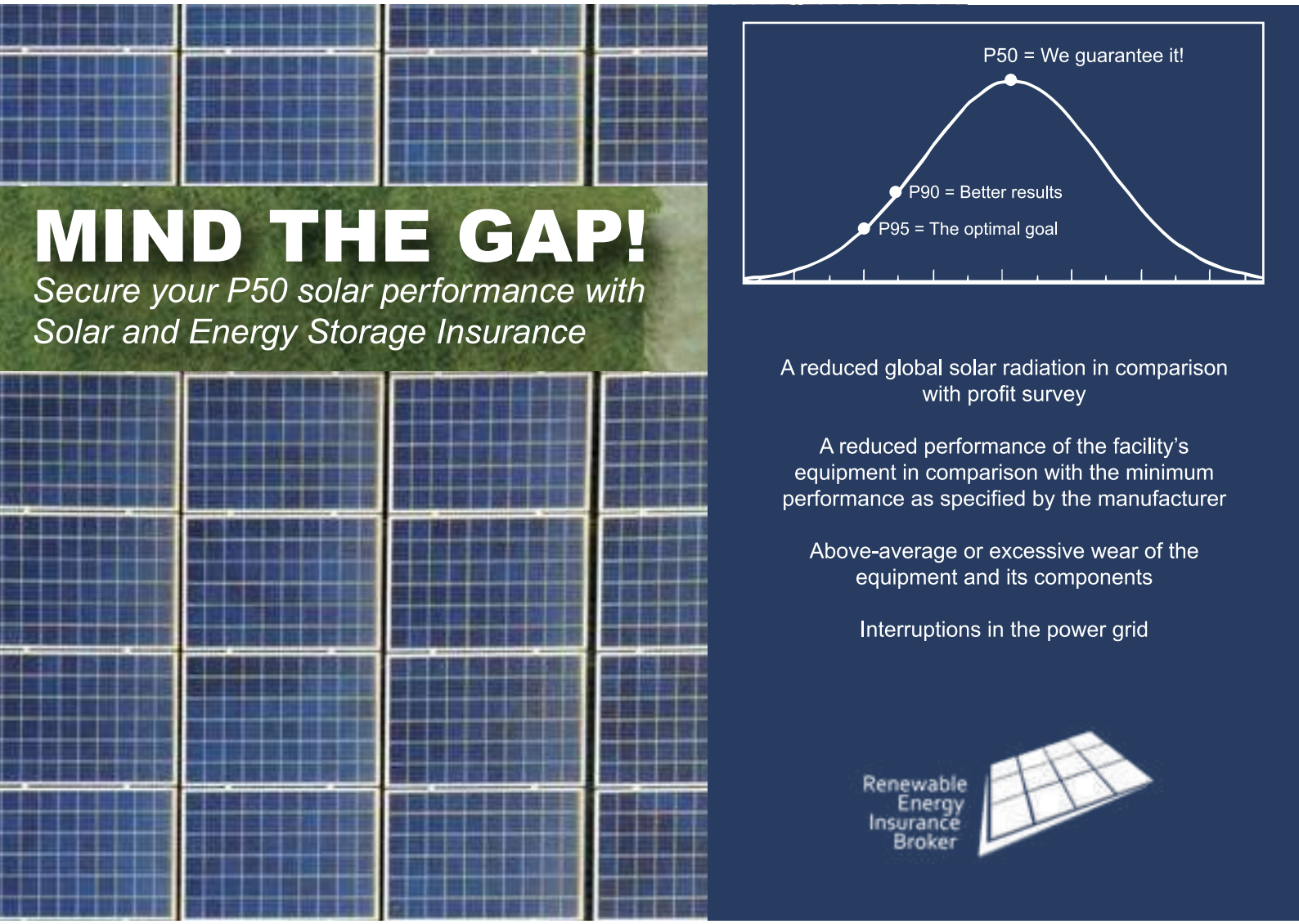
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P90 = Better results
P95 = The optimal goal
A reduced global solar radiation in comparison with profit survey
A reduced performance of the facility's equipment in comparison with the minimum performance as specified by the manufacturer
Above-average or excessive wear of the equipment and its components
Interruptions in the power grid
Renewable Energy Insurance Broker

5. The Netherlands

11 GW project pipeline, the game towards 75% clean electricity in 2030 is on

Overview of the solar PV market

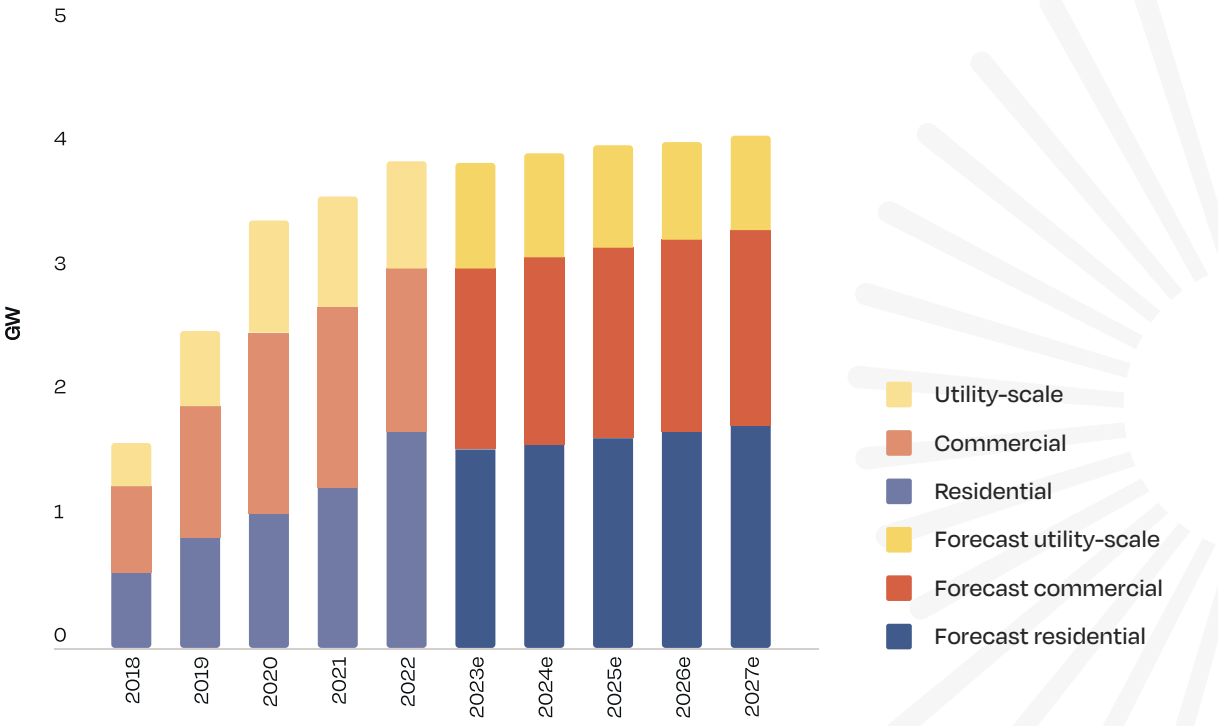
The market in the Netherlands experienced strong development in 2022, with an added solar PV capacity of 3.9 GW. This brought the total Dutch PV fleet to 18.2 GW, including a surprisingly high growth from the residential sector, which added 1.8 GW in 2022. The Netherlands also holds a project pipeline of about 11 GW from its Sustainable Energy Transition subsidy scheme (SDE++) awarded projects, with even shares of commercial rooftop and ground-mounted projects. Looking at the capacity connected so far throughout 2023, it is expected that the total market will stay just under 4 GW this year and will pass the 4 GW in 2025.

The main challenge in the Netherlands is to ensure that all these projects in the pipeline will be built. Currently, around 65% of proposed solar projects reach completion, including a timely grid connection. This completion rate will most probably decrease in the coming years, mainly due to the increase in project costs, such as material, labour, and financing costs. We expect that commercial rooftop projects will face an expected completion rate of only 40% or less in the coming years. For ground-mounted solar, project completion will most probably fall from 90% to 80%.

The Dutch government has introduced the option to revoke previous SDE++ bids (2019-2022) and to take part in the SDE++ round of 2023. This year's round accounted for the new financial conditions for the industry, which provided the opportunity to preserve a large portion of the 11 GW pipeline that was at risk. More than 2.1 billion EUR worth of projects have reapplied to the subsidy scheme.

Due to new congestion management tools, extra grid capacity, and peak shaving requirements, an increase

FIGURE GW 5 SOLAR PV MARKET IN THE NETHERLANDS 2018-2027, BY HOLLAND SOLAR



SOURCE: Holland Solar.

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in solar connection capacity was seen in some areas in the Netherlands. Clearly, net capacity issues are still challenging for production and demand projects. Despite this challenge and the decreasing interest in the residential sector observed in the second half of 2023, it is expected that the Dutch solar energy market will stabilise around 4 GW (see Figure GW 5).

New size records in 2022

In 2022, the biggest market segment in the Netherlands was the residential rooftop market, with a share of 46% (approx. 1.8 GW) of the total market. The commercial rooftop market had a share of 33% (approx. 1.3 GW) while the market for ground-mounted and floating solar PV accounted for 23% (approx. 0.9 GW). The residential market has had an impressive year-on-year growth of 38% (from 1.3 GW to 1.8 GW) and 10% points market share increase mainly due to a strong increase in electricity consumer price levels. This segment is expected to decrease to 1.6 GW in 2023, and slowly grow back up to 1.8 GW in 2027. Residential and commercial rooftop solar is considered an important market segment for the Netherlands and is the most favourable option when it comes to policy, as well as social acceptance.

In 2022, the largest project with an SDE subsidy grant was a solar park in Slochteren developed by LC Energy, in which 12 hectares of new nature were created, including water areas where a protected dragonfly species can breed. The total capacity of the park will be 64.8 MW.

Dutch policy and RES targets

The Netherlands still has a significant pipeline of over 11 GW of large-scale solar PV projects. With this pipeline and the successful completion of several wind projects, the government believes that the 2030 National Climate Agreement target of 35 TWh/year of renewable electricity production on land will be met in time. The Dutch National Climate Agreement was agreed upon in 2019 and does not yet consider the higher national targets – 55% but targeting 60% – related to the EU ambition of 55% greenhouse gas emissions reduction by 2030, or the impact of the Russian invasion in Ukraine. However, with the fall of the Dutch government in July 2023, setting new national climate targets is dependent on the results of the elections in November. A significant number of political parties have expressed their ambition to create a carbon-free electricity supply by 2035. With the expected increase in the demand for electricity, this will be an ambitious goal. Government studies show that the demand for green electricity will grow by around 50 TWh by 2030. The national climate

Location of the LC Energy project Woudbloem in Slochteren, Groningen.

© LC Energy

neutral scenario expects 58 GW solar PV to be installed by 2030. To facilitate this growth, it is foreseen that the tender scheme SDE++, or a successor, will stay open for solar and wind projects in 2023-2025, and later into this decade.

Improving the quality of residential installations

The massive growth in the number of residential installations in 2022 and 2023 highlighted the importance of new industry rules on, among others, worker and installation safety and transparent customer contact. Additionally, the Dutch solar industry requested a comprehensive mapping of the environmental impact of the production of solar panels. With the new results, it will be possible to install more panels per newly developed housing project. In line with the ambition of 1 million additional houses to be built by 2030, residential rooftop solar is expected to grow in parallel to the housing stock.

Drivers of solar growth

The growth in the Dutch residential solar market has been driven largely by net metering, and lately by the insecurity concerning the future of electricity prices. There is no limitation or charge for net delivery. A proposal supported by the Dutch solar sector to gradually phase out the net-metering scheme, with a 9% decrease every year until 2031, is still pending a vote in the Senate, after the parliament narrowly supported its adoption in early 2023. This degressive path is based on a seven-year payback time for the prosumer, assuming 30% self-consumption and optimal system conditions. Nevertheless, even with the proposed phase-out, this segment is and will remain an important driver for continuous growth in the Dutch solar sector, especially in the current context of high electricity prices.

The growth of the commercial and utility-scale solar PV market in the Netherlands has been driven entirely by the SDE++ tendering scheme, whereby solar energy projects compete with other renewable energy projects and other CO_2-reducing technologies such as CCS. In this tendering scheme, different maximum capacities are awarded, depending on the technology (wind, biomass, solar), size, and application (ground-mounted, rooftop, floating). The ranking in the scheme is based on EUR per $ktCO_2$ avoided. In 2023, for the first time ever, the Dutch solar PV sector achieved average negative subsidy levels. This means that the government does not expect to pay out any grants during the time that the installations are operational.

The maximum SDE++ contribution decreases every year, but for the 2023 round, it has been increased by about 17%. This increase can be attributed to worsened finance conditions and higher project prices. The 2023 round had a budget of 8 billion EUR. Unlike previous years, it will be allowed to revoke a bid from the period 2019-2022 and rebid in 2023. A total of 2.1 billion EUR worth of projects reapplied for subsidy. A total of 3.3 GW of solar PV projects have requested subsidies — 1.6 GW for rooftop solar, 1.7 GW ground-mounted solar, and 49 MW floating projects.

Challenges

The main challenges for the solar energy sector in the Netherlands are changed regulations for ground-mounted systems, a timely grid connection, the business case for large rooftop projects, and a stable pipeline in the residential segment. Because of these reasons, the sector expects to face serious delays, and possibly a higher project non-realisation in the coming years. Additional reserve capacity will be put into general use by the grid operators in 2023. With the obligation for all large solar PV installations to participate in congestion management programmes, we expect significant progress in acquiring timely grid connections. Additionally, from 2022 onwards, new projects applying for SDE subsidies must comply with a grid connection of a maximum of 50% of the system's peak capacity to be eligible for applying to a grid connection and to the subsidy scheme. The yearly loss is compensated in the subsidy level per kWh.

For the first time, grid operators in the Netherlands have recognised the significant growth of the solar sector and estimate that between 42 GW and 76 GW of solar capacity will be installed in the Netherlands by 2030. Former legal limitations to cable pooling, which combines solar and wind projects in co-location with batteries, will likely be resolved in 2023. A new subsidy scheme that co-locates batteries to solar PV systems (ground-mounted and rooftop) worth 416 million EUR has also been announced.

New regulations on the installation of ground-mounted solar panels

Another challenge the Dutch solar energy sector faces is the availability of land, especially for utility-scale projects, as well as social acceptance when it comes to using agricultural land for solar energy projects. In October 2023, the national government announced that they are planning to restrict how solar PV parks are being built on land. From the first of January 2024, agricultural land will not be considered a development zone for solar-PV projects. There are three exceptions to this new regulation: solar PV parks that are installed in 'transformation zones', solar PV projects with a low grid dependency, and Agri-PV projects. However, there is an urgent need for clarification of this regulation as specific projects are still unclear whether they will be able to successfully receive a permit.

A good example of avant-garde dual use of land is GroenLeven's Agri-PV project in Sint-Oedenrode, which will be the largest Agri-PV installation above raspberries in Europe. 24,206 solar panels are to be installed (about 8.7 MW of installed capacity).

The Dutch government has shown a good level of ambition regarding fighting climate change. New actions are being announced to support solar developments but are not yet in place. Examples include deploying additional support for solar on "unsuitable" rooftops, defining solar-prepared building standards and outlining obligations for solar carports. Increasingly in the last few years, solar carports have been developed in the Netherlands. Recently, at the local level, authorities have been encouraging rooftop owners to use their roofs for the energy transition. From 2024 onwards, municipalities will have the authority to demand solar panels to be installed on large utility roofs (>250 m^2).

However, the most important step will be to create, as soon as possible, 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,* Manager Public Affairs; and *Marinthe Bos,* Communications Officer, Holland Solar.

Agri-PV project for Van Hoof Zachtfruit en Asperges in Sint-Oedenrode by GroenLeven. 8.7 MW.

© Groenleven

6. France

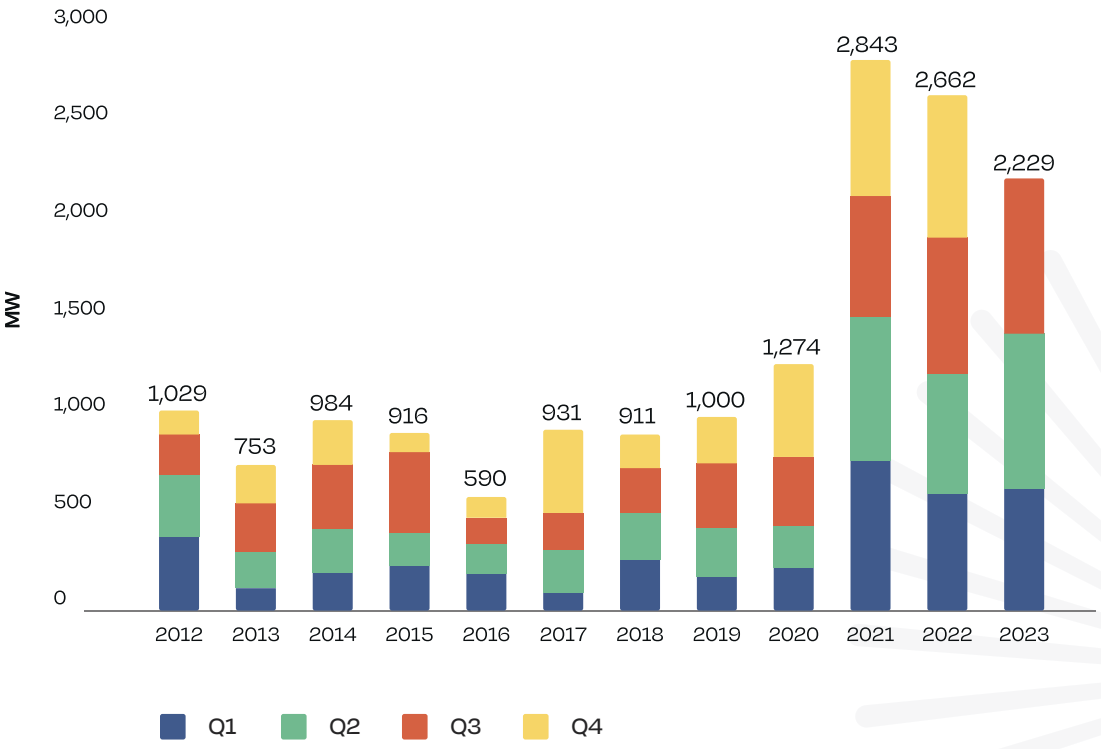
Overview of solar PV developments

The French solar fleet reached 18 GW at the end of the first semester of 2023. An additional 1.4 GW was connected, compared with 1.2 GW in the first half of 2022. Solar power generated 11.2 TWh during the first six months of 2023, recording an increase of 18% relative to the same period in 2022. This generated solar power represented 4.7% of French total electricity consumption in that period.

Solar PV targets in France

The solar target set in the Multi-Annual Energy Programme (MAEP) requires an operating solar PV fleet of 20.1 GW at the end of 2023. At the start of July 2023, the completion rate of this objective stood at 89%. A law on energy production is expected over the next few months with new objectives. The French Renewable Association (SER) also updated its roadmap with 65 GW to be installed for 2030 and 115 GW for 2035 as the new targets for the country. This is slightly above the new draft NECP published in November 2023, which aims at reaching 54 to 60 GW by 2030 and 75 to 100 GW by 2035. The new draft

FIGURE GW 6.1 FRANCE SOLAR PV MARKET INSTALLATIONS PER YEAR 2012-2023, BY MTE



SOURCE: French Ministry of Ecological Transition.

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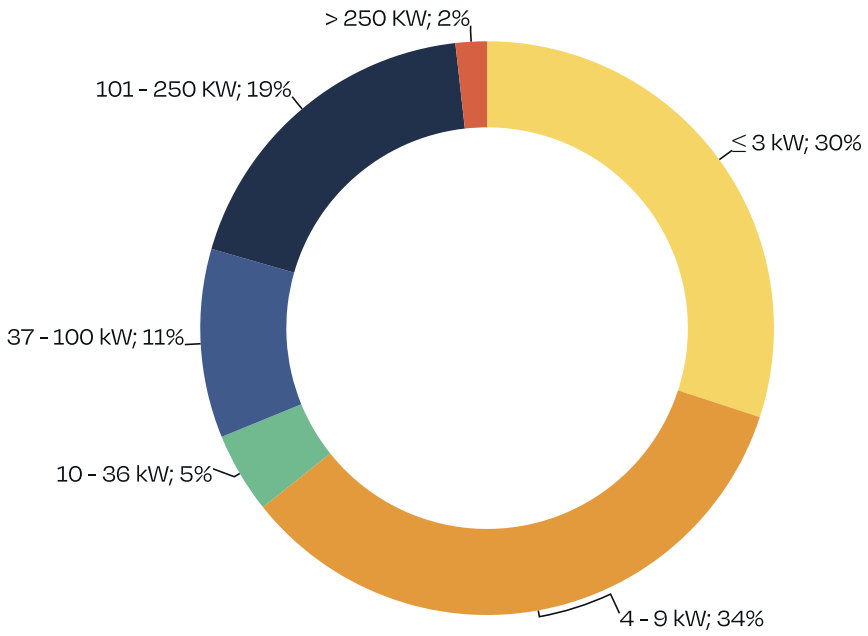
FIGURE GW 6.2 FRANCE CUMULATIVE SOLAR PV GRID-CONNECTED CAPACITY Q3 2023, BY ENEDIS



SOURCE: ENEDIS.

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NECP is significantly upping the previous solar targets of 35-44 GW by 2028 and 100 GW by 2050. Local objectives are also to be introduced to allow an orderly deployment of installations on a regional level.

Drivers for solar growth

Calls for tenders remain the main contributor for achieving solar growth targets, with 3.2 GW scheduled every year. After a series of undersubscribed tenders in 2022, the last tender call for ground-mounted PV power plants in September 2023 set an all-time record. 129 projects were selected, and a total capacity of 1.5 GW was allocated. This is the largest capacity since the Commission of Energy Regulation (CRE) started issuing calls for tenders. In August 2023, the French authorities concluded a procurement exercise for C&I rooftop PV projects, allocating 378 MW of solar capacity to 60 developers, marking another successful tender scheme.

The economic framework is becoming more closely aligned with current economic realities: the feed-in tariff "S21" now reflects the inflation level and has been increased to 131 EUR/MWh. In addition, a tariff for ground-mounted projects of less than 1 MW is expected to be introduced shortly, as well as a dedicated tariff for non-interconnected zones.

The "self-consumption without injection" segment is growing very strongly; it represents 11% of the total volume connected in the first quarter of 2023 and totals 316 MW. Between 2022 and 2023, the number of installations for individual self-consumption rose 77%, reaching 325,000 installations, which amount to 1.6 GW of installed capacity. Today, 11% of France's PV capacity is used for individual self-consumption.

Among the measures to accelerate solar development, the decrees for the "acceleration of renewable energy" adopted in March 2023 are currently under discussion. The decrees cover, in particular, obligations to install PV on carports, the creation of an Agri-PV framework and value sharing.

In line with the Green Industry Act adopted in October 2023, a Solar Pact is being discussed between the industry and the government to speed up the reshoring of the solar industry. This pact represents a mutual commitment to support the development of the PV solar industrial base in France across the entire value chain and developing state-of-the-art projects from a technological, social and environmental point of view.

Challenges

There is still a long road ahead to achieve the national targets set by the MAEP (44 GW by 2028) and the most recent 2030 NECP target of 54-60 GW. At the local level, the delay in publishing the acceleration act decrees means that projects cannot be examined quickly.. Besides, more restrictive local legislation is being implemented for Agri-PV projects, hindering the much-needed expansion of the segment.

Supporting mechanisms, and especially tender conditions, would greatly benefit from a more stable regulatory framework: law amendments are at times implemented too quickly, preventing project developers from adapting their projects to the new rules.

Furthermore, the current market dynamics affecting the PV manufacturing industry is making it difficult for French solar companies to remain competitive. In this regard, the Solar Pact currently under discussion should provide greater support for domestic manufacturing.

Finally, the shortage of solar workforce is still a pressing issue that hampers the acceleration of deployment. This is particularly true for installers, and therefore for the self-consumption segment, even though this segment is still growing.

Author: *Salomé Durand*, Head of Solar Power & Solar Heat, Syndicat des Energies Renouvelables (SER).

Solar park in Lavernose, 5 MW, located in a former gravel quarry.

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7. Austria

Overview of solar PV developments

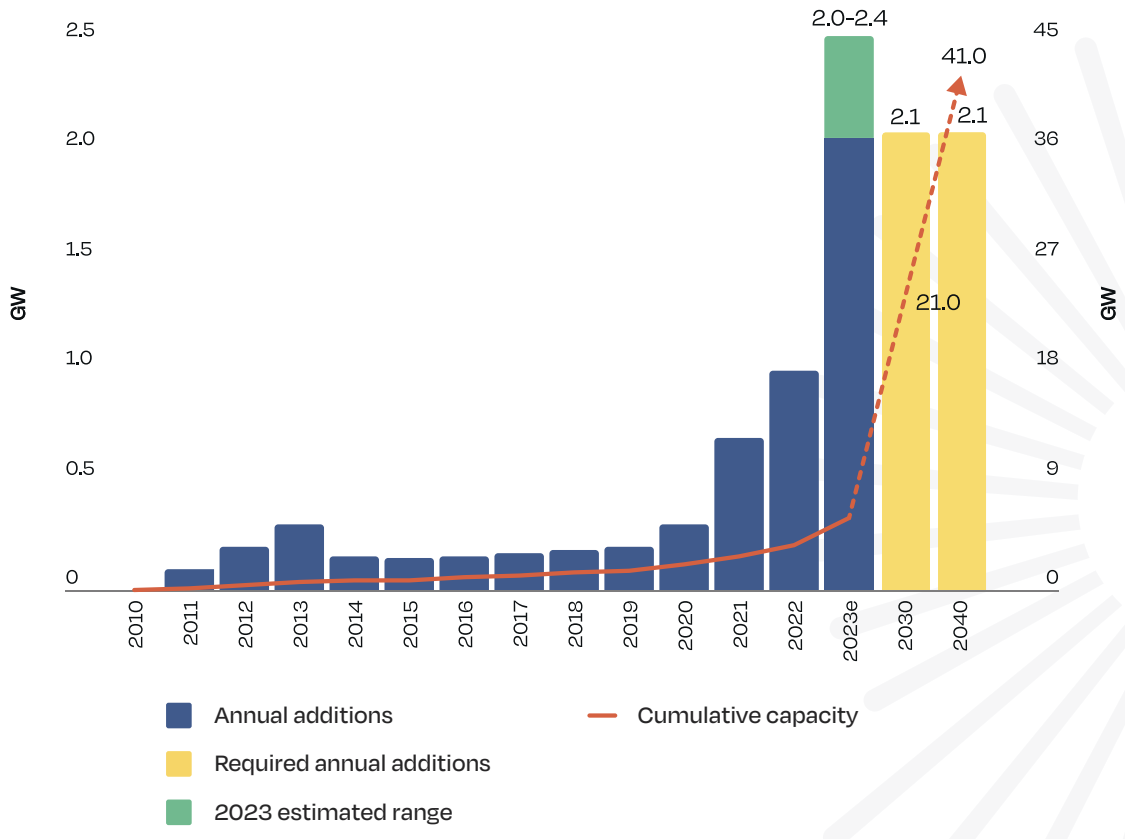
Another year – another record. After Austria exceeded the threshold of 1 GW of newly installed PV systems for the first time in 2022 (see Figure GW 7), it will probably even break the 2 GW barrier in 2023. Although the official data will not be published until mid-2024, preliminary forecasts assume that Austria will reach between 2.0 and 2.4 GW of new photovoltaic capacity in 2023, which represents a doubling compared to the previous year. Including all recent data, a total fleet of around 5.8-6.2 GW of PV systems will be in operation at the end of 2023.

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, in 2023, the majority of PV systems installed were rooftop PV systems, with utility-scale and Agri-PV systems covering a minor share. Residential systems below 20 kW are expected to contribute 1 GW of new installations in 2023. A shift towards larger ground-mounted and Agri-PV systems is expected in the future.

National PV Targets

As a contribution to achieving the European Union's 2030 renewable energy target of overall energy consumption – earlier at least 32% oe and just raised to at least 42.5% – Austria has defined binding national

FIGURE GW 7 AUSTRIA ANNUAL INSTALLED CAPACITY 2010-2022 AND REQUIRED CAPACITY BY 2040



SOURCE: PV Austria.

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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 was presented in 2023 but has not come into force at the publication date of this report – 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. The draft 2023 revision of the Austian NECP has not been published by early December.

Drivers for solar growth

The major driver in the past two years was Russia's invasion of Ukraine and the resulting energy crisis, which created high electricity prices and attractive feed-in tariffs. However, the PV boom in Austria started before. Falling system prices and public subsidies for PV, combined with the growing desire of households and companies for energy autonomy, boosted demand for decentralised generation systems. In particular, PV subsidies were considerably increased by the government with the publication of the EAG, rising from around 110 million EUR in 2021 to 300 million EUR in 2022, and have grown further to 600 million EUR in 2023. In addition, as part of the EAG, a market premium for PV systems (CfD scheme) has been created to deploy 700 MW per year. In summary, the combination of governmental support, Russia's invasion and the energy crisis resulted in a rush for subsidies in the past two years.

Challenges for the market

The greatest drawbacks of the ongoing PV boom in Austria are the slow national power grid expansion and the severe worker shortage. The high demand for PV systems in the past two years l has resulted in strong demand for trained specialists in the industry. While there were around 6,100 full-time jobs in the Austrian PV industry in 2022, forecasts for 2030 estimate that 30,000 jobs will be required. Regarding grid expansion, simpler connection procedures are needed to achieve the specified national targets, especially for small systems.

© Bundesverband Photovoltaic Austria

Significant delivery bottlenecks for important system components, resulting from the crises of the last few years, have led to a re-examination of material availability. In 2022, the share of Austrian-manufactured modules in residential PV systems was only 9.5% (2021: 14%). Today, most PV system components are produced by and delivered from Asian countries. The PV manufacturing industry must be strengthened at the European level in the coming years. Austria would also benefit from this and of course will make its contribution to the reconstruction of the PV industry in the EU.

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 (only one more than 2022) have provided acceleration areas. However, with RED III, which recently came into force, this topic will hopefully soon be a challenge of the past.

Outlook

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. We, therefore, hope to be able to maintain this year's installation record, as there is still a long way to go. The Austrian government is also aware of this and plans to reduce the VAT on PV systems (including all necessary components) for private individuals from 20% to 0% for the years 2024-2026. This step comes at the right time, as the PV industry is already experiencing a slight decline in demand from the private sector. In addition, the rapid implementation of RED III is necessary. Complementary to the EAG, an additional law, the Renewable Energy Expansion Acceleration Act (EABG), was planned for 2023. This law is aimed at assisting the expansion of renewables by simplifying administrative procedures, especially for PV systems. Thanks to RED III, we can now hopefully expect the EABG to enter into force in the first half of 2024.

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

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8. Belgium

2023 is a record year, reaching nearly 1.7 GW for the first time ever

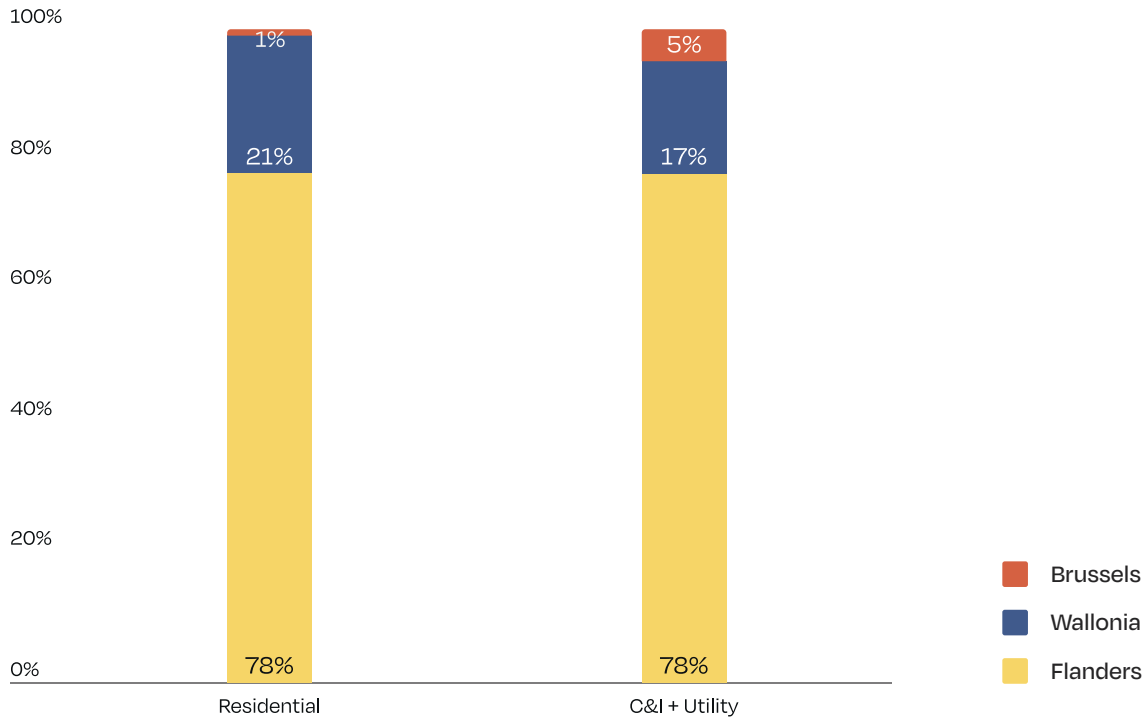
In 2023, the Belgian solar market has grown to levels well above a GW for the third time. In 2011 and 2020, installation levels peaked slightly above 1 GW. Today, a mature and stable market above 1.5 GW has developed. In Belgium, energy policy is a regional responsibility, resulting in different support schemes and legal frameworks in the regions of Brussels, Flanders and Wallonia. We will highlight the market data and the most important developments in each region, and then address some national trends.

Preliminary data shows that the Belgian market will reach a total of about 1.7 GW newly installed PV capacity in 2023, a 72% annual growth compared to last year. The residential segment accounted for 69% of all installed capacity, 25% was installed in the commercial and industrial segment and only 6% is attributed to utility-scale systems. Regionally, Flanders accounted for nearly 80% of all installations, both large and small scale (Figure GW 8. 1). Part of this division can be explained by the population share of the regions. Roughly 58% of the population resides in Flanders, 31% in Wallonia and 11% in the Brussels region.

Flanders

The Flemish market will be nearly subsidy-free from 2024 onwards. This is the result of a bumpy process including the shift away from a net-metering scheme towards simple installation subsidies in 2021. As shown in Figure GW 8.2, this shift caused a rush in installations over 2019-2020. Today, the market has completely recovered from the resulting installation dip in 2021. By the end of September 2023, preliminary data shows that installations have already surpassed those for the full year of 2022. This data is prone to underestimation and actual figures should be even higher.

FIGURE GW 8.1 PERCENTAGE OF INSTALLED CAPACITY PER REGION AND SEGMENT 2023, VEKA



SOURCE: VEKA.

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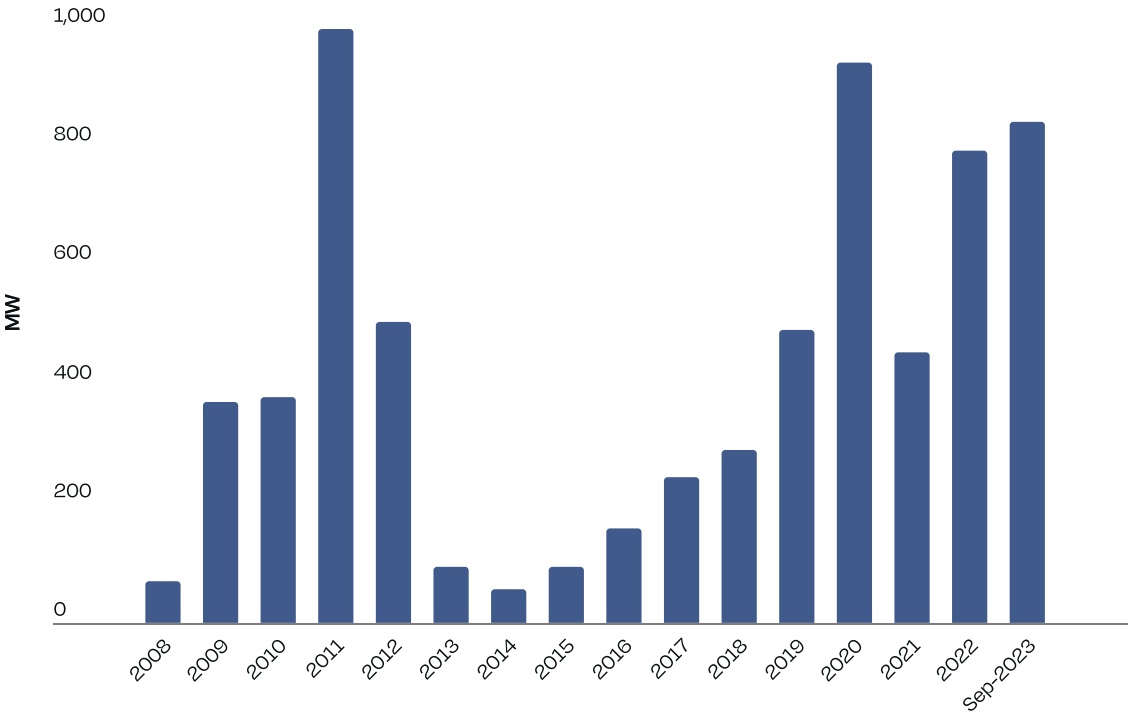
FIGURE GW 8.2 ANNUAL INSTALLED CAPACITY IN FLANDERS (IN MW_{AC}) 2008-09/2023, BY VEKA



SOURCE: VEKA.

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19.9 MW, Brugelette, Belgium.

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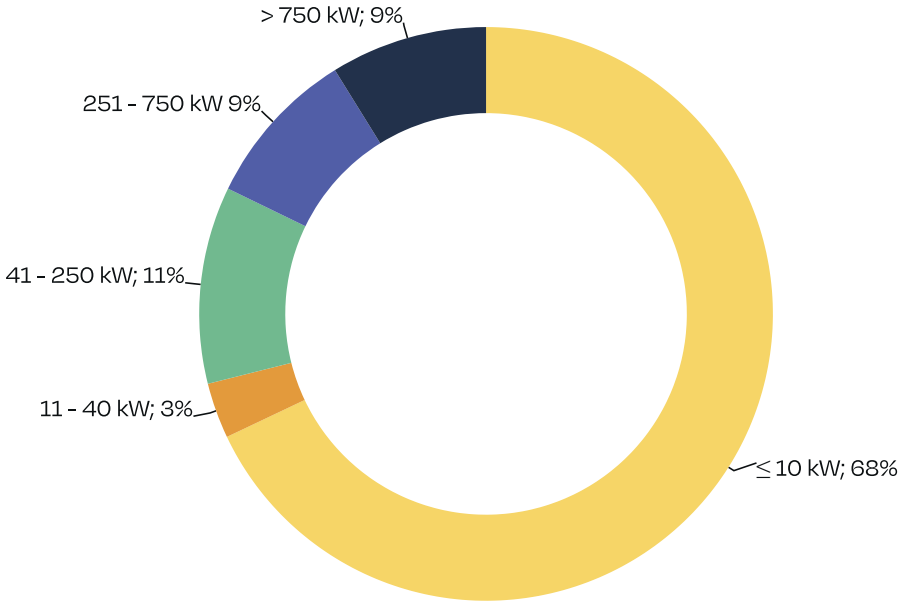
FIGURE GW 8.3 FLANDERS INSTALLED CAPACITY SEGMENTATION, JANUARY TO SEPTEMBER 2023, BY VEKA



*All system sizes are expressed in AC terms

SOURCE: VEKA.

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By September, more than two-thirds of the installed capacity came from systems smaller than 10 kW_{AC} (Figure GW 8.3). Noticeably, this is divided over nearly 100,000 systems, meaning that the average system size is almost 5 kW_{AC}. Out of the remaining systems, over 200 MW_{AC} is captured by systems larger than 40 kW_{AC}. These systems could obtain support through a tendering mechanism which regularly allocates funding to a diverse range of PV systems (including, for example, floating PV). Most of the Flemish installed capacity can be found on rooftops. Still, in 2022, only 8% of the rooftop capacity was used for solar energy production. Latest estimates show that over 52 GW_{AC} of rooftop potential remains largely untapped.

There are multiple drivers that are expected to push stable market growth for residential solar. First, an end-of-year boost in the residential market is expected because of the subsidy stop on installations in 2024. Given the current maximum support of 750 EUR, however, the installation rush is not expected to be major. Additionally, a change in the VAT rate (6% to 21%, based on the invoicing date) on PV systems for new buildings will likely lead to additional installations in this segment. This changing VAT rate is applied to the invoice. Therefore, additional connections can be expected in Q1 2024. Furthermore, there is a segment of prosumers that still benefit from the net-metering scheme. For these small-scale installations, the scheme will end in either 2024 or 2025 depending on the installation date. The prosumers could see it as an opportunity to do two things: (i) enlarge the PV installation without risking the loss of the net-metering benefit, and (ii) adjust consumption patterns in line with the PV system.

In parallel to residential PV, the C&I segment is set to grow significantly over 2024-2025 following a government mandate. Companies with over 1 GWh offtake from the grid will be required to cover part of it with solar PV electricity by 2025. Therefore, over 2,500 companies will have to invest in solar PV over the next two years. For public organisations, this requirement is even higher. This mandate is strengthened again in 2030 and 2035, so some companies might choose to install larger systems already.

Finally, electrification will be a major driver over all segments in the longer term, while energy efficiency obligations will drive stable growth of small-scale solar PV installations. By the end of 2025 there should then be over 1 million installations (858,000 plus whatever gets added in rest of 2023, 2024 and 2025) without net metering, which should make Flanders an interesting market for home energy management, flexibility & storage.

Wallonia

In Wallonia, the net-metering scheme will end in 2023. Therefore, a rush on the residential market is expected. Since no follow-up scheme is planned, a drop similar to the one seen in Flanders in 2021 can be expected in early 2024 in Wallonia. The net-metering scheme was active for installations up to 10 kW. Now, digital meter rollout should speedup and a stable, subsidy-free market might develop in the longer term. So far, utility-scale installations have struggled to gain pace in Wallonia. The region adopted ambitious 2030 targets aiming to reach a PV-production of 5,100 GWh/year by 2030. However, Wallonia has not developed any strategy to reach this target yet and still needs to adopt adequate measures. The sector demands specific rules to support PV integration in buildings and PV development for carports and in open fields. Developers face grid access and land availability hurdles. Nonetheless, the potential of large-scale systems is immense with the most recent example of a 20 MW carport installation for a local amusement park.

Brussels

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 produced electricity. The latest average prices of these certificates were over 70 EUR per MWh of electricity produced. For a typical residential system, this can lead to over 700 EUR in annual revenue. Since these certificates can be earned for 10 years, this drastically reduces the payback term of solar PV installations. 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 connection tariffs.

Outlook

Unlike in 2020, when the market surge did not result in a stable GW-size market in the following two years, we expect Belgium to remain steadily part of the GW club in the upcoming years. The end-of-year rush taking place in Flanders at the end of 2023 is anticipated to have only a minor impact on the overall market performance in 2024. In the longer run, growth is expected to continue, reflecting the prevailing trend across the continent.

Belgium's total solar installations, expected to cross 11 GW by the end of 2023, have surpassed the country's NECP target of 8 GW already in the course of last year. After months of delay, the Government announced a provisional agreement on its revised NECP in November 2023. At the time of writing, however, no formal document has been submitted to the European Commission.

Authors: *Jonathan Gorremans, Christophe Lits, Raffaele Rossi,* and *Michael Schmela*, SolarPower Europe; *Wannes Demarcke,* Policy Expert, PV-Vlaanderen; *Dr. Ir. Fawaz Al Bitar*, General Manager, EDORA.

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Solar API

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The Google Maps Platform Solar API empowers solar professionals with the data needed to accelerate solar deployment and enjoy a wide range of benefits including:

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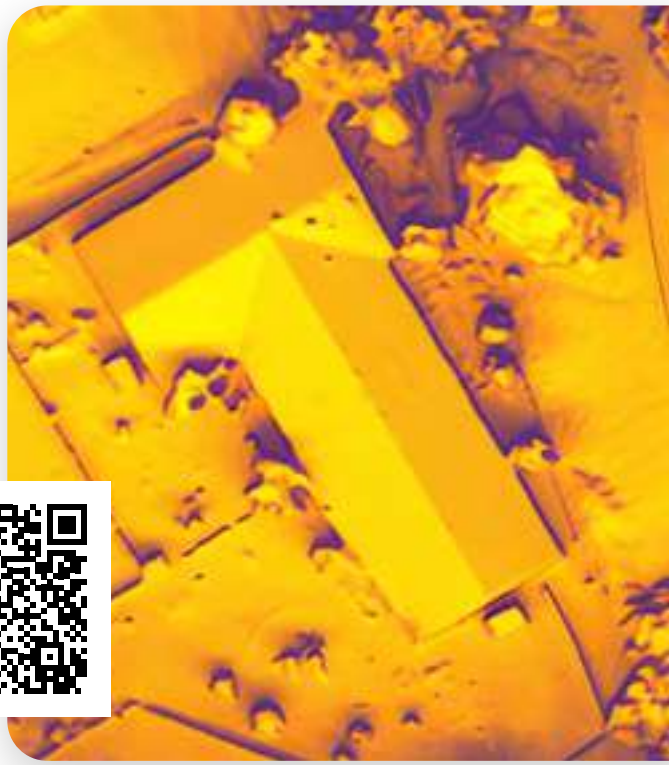


Solar API offers two specific service endpoints

Building Insights:
This service endpoint returns insights about the location, dimensions, and solar potential of a building

Data Layers:
This service endpoint returns detailed raw solar information for an area surrounding a location

https://mapsplatform.google.com/maps-products/solar

9. Greece

Another record-breaking year

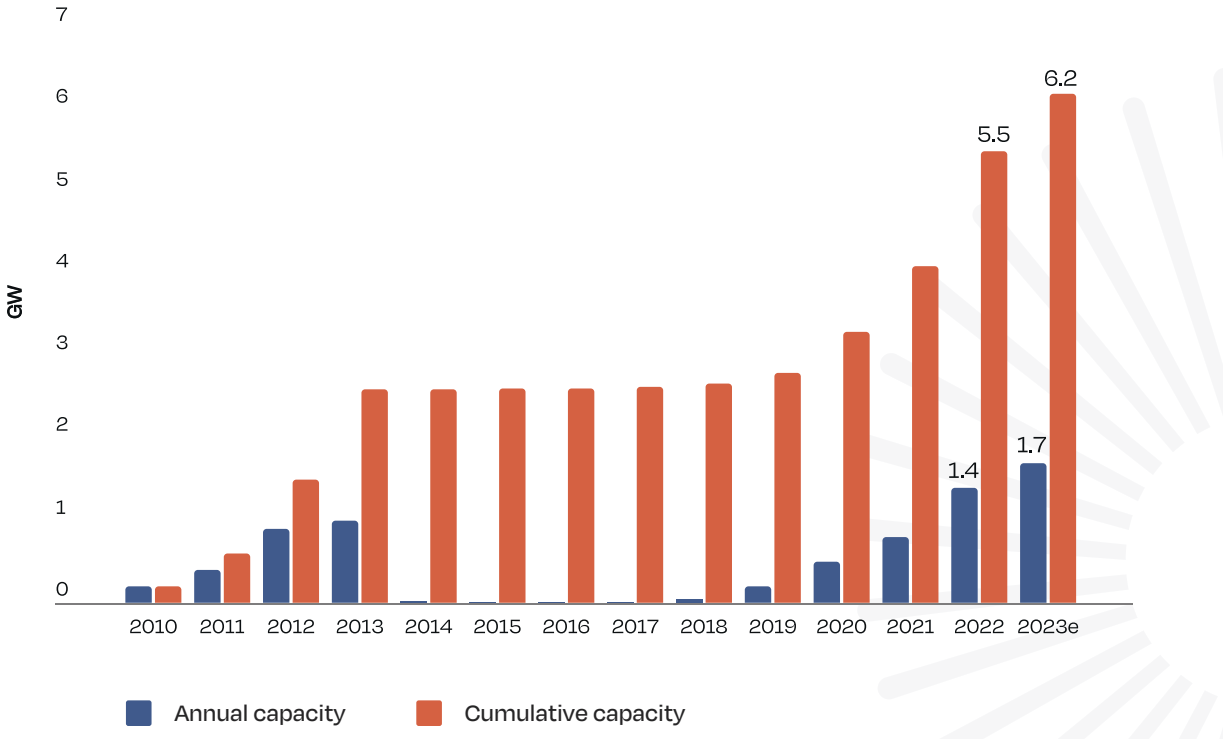
Overview of solar PV developments

The Greek solar PV market has gained tremendous momentum, which is expected to continue for the next few years. In 2022, 1.4 GW of new PV projects were connected to the grid, bringing the cumulative capacity to 5.5 GW (see Figure GW 9.1). This was the best performance ever for the Greek solar sector. Still, it looks modest if compared with the expected performance of the market in 2023, which should bring online around 1.6-1.7 GW of solar capacity.

As can be observed in Figure GW 9.1, the market is still dominated by medium-size projects between 10 kW and 1,000 kW (71% market penetration). However, the utility-scale (22%) and especially the residential self-consumption (7%) segment are experiencing noteworthy growth. For the first time, annual installations in the household self-consumption segment in 2022 exceeded the 100 MW milestone, with 116 MW connected that year. Going further, 2023 is expected to be another record year for self-consumption systems, with the market expected to more than double its size.

In terms of energy generation, the bright weather across the country helped solar PV to contribute about 13.6% of total Greek electricity production in 2022. This share is expected to be over 18% in 2023.

FIGURE GW 9.1 GREECE SOLAR PV MARKET DEVELOPMENT 2010-2023, BY HELAPCO



SOURCE: HELAPCO.

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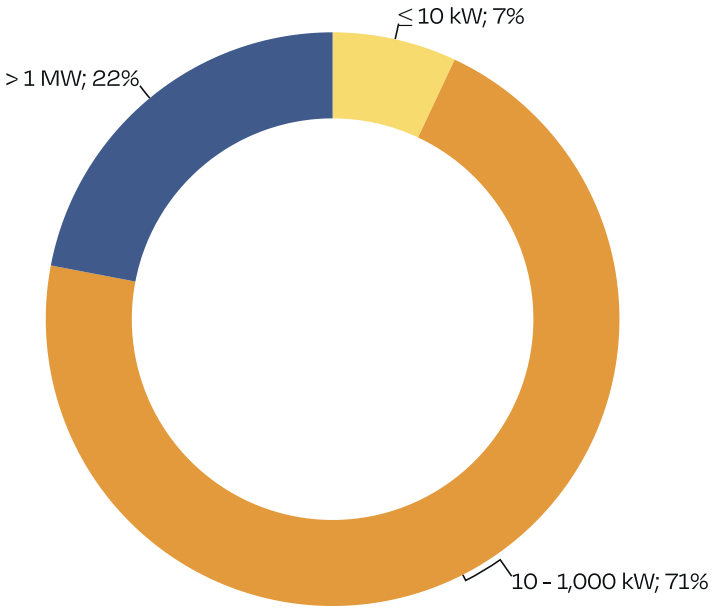
FIGURE GW 9.2 GREEK CUMULATIVE SOLAR PV SEGMENTATION 2022, BY HELAPCO



SOURCE: HELAPCO.

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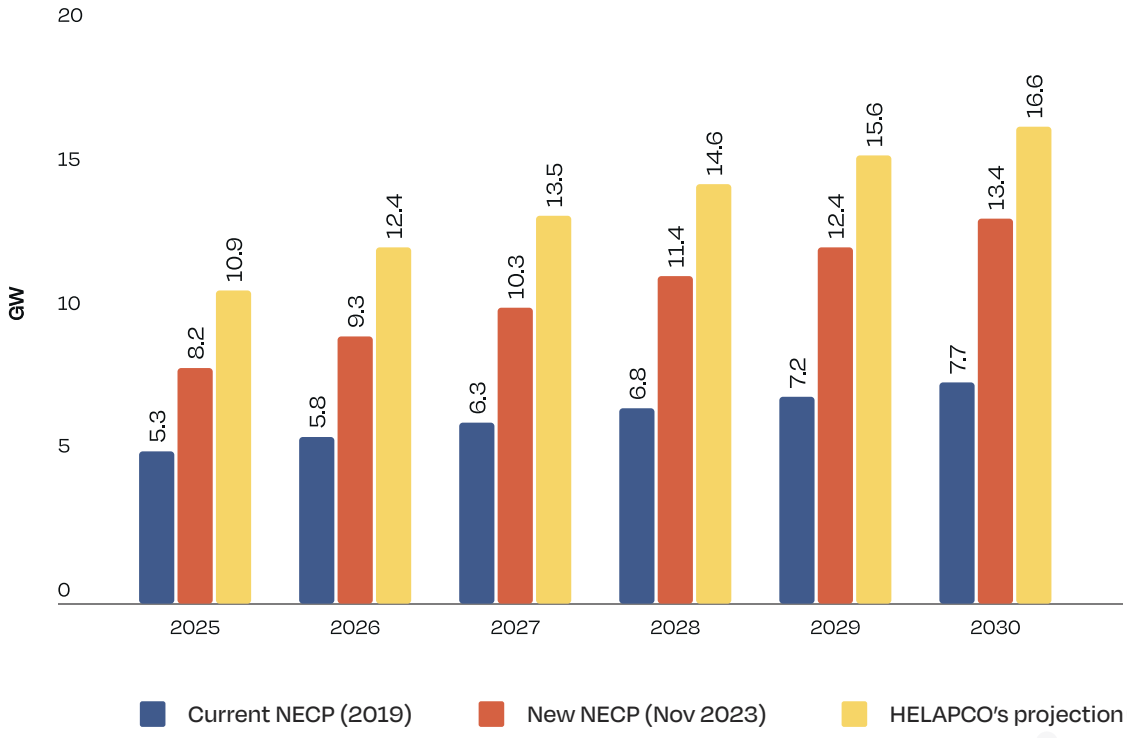
204 MW, Kozani, northern Greece.

© JUWI Hellas

FIGURE GW 9.3 GREEK SOLAR PV MARKET OUTLOOK CUMULATIVE INSTALLED CAPACITIES 2025-2023, BY HELAPCO



SOURCE: HELAPCO.

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Solar PV targets in Greece and market outlook

Considering current trends, Greece is revising its 2030 national solar target: the new draft target is 13.4 GW by the end of the decade, almost doubling the one previously set. However, as depicted in Figure GW 9.3, the new NECP targets are still considerably below HELAPCO's market projections.

Challenges

The major bottleneck 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 January 2023, 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.

Drivers for solar and storage growth

Regarding support schemes, some 4.1 GW of RES projects will be auctioned in Greece between 2023 and 2025, with PV expected to get around 3 GW.

In 2022, the Greek Parliament also passed a thorough regulatory framework for storage. Large-scale storage is selected through a bidding process, with a total tendered power capacity of 1 GW and at least 2.6 GWh of storage capacity. The allocation of the contracts to selected projects should take place before Q1 2024, and storage facilities should be completed by the end of 2025. A support scheme for self-consumption PV systems (<10.8 kW) coupled with storage in the residential and small agricultural sectors commenced in May 2023. This programme covers the full cost of batteries, to facilitate the development of a new market segment. Some 25,000 small batteries (<10.8 kWh) are expected to be deployed by the end of 2024.

Author: *Stelios Psomas*, Policy Advisor, HELAPCO.

10. Hungary

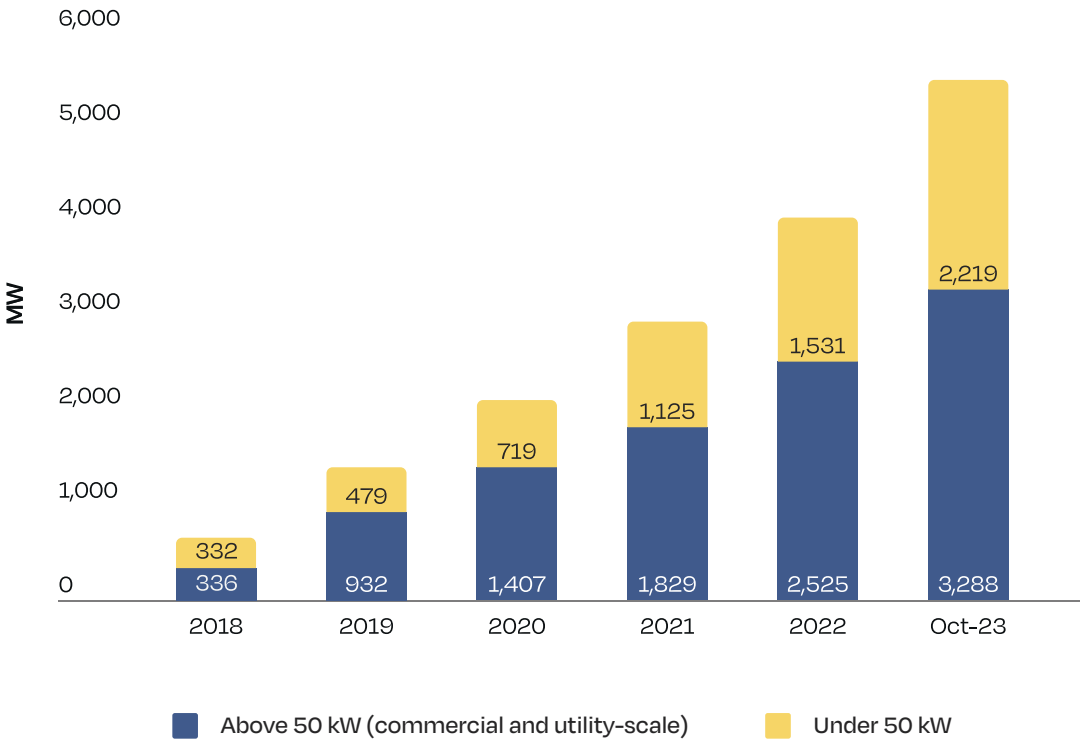
2023, possibly the last really strong year

Overview of solar PV developments

2022 set a new record for solar PV in Hungary, with 1.1 GW of annual installed capacity and allowing the country to reach the GW-scale for the first time. Last year, Hungary's cumulative capacity exceeded 4 GW. This year, we are even breaking 2022's record. As of the end of October, Hungary has installed more than 1.4 GW of solar capacity. This brings the country's solar fleet to a total of 5.5 GW. The country's 2030 NECP target in the proposed revision has been almost doubled from 6.5 GW to 12 GW.

The Hungarian PV market can be divided into two main segments: PV systems below and above 50 kW. However, there is no detailed breakdown currently available to determine the size of commercial installations. The segment below 50 kW has steadily expanded in the rooftop market for years, reaching 406 MW of newly added PV systems in 2022 with a cumulative capacity of 1.5 GW. By the end of October 2023, nearly 690 MW have been deployed in the small-scale segment, already marking a 45% yearly growth relative to the entire year of 2022. Although the large-scale segment has historically deployed more capacity than smaller installations, there seems to be an ongoing shift towards the latter, as the installation gap has shortened in 2023.

FIGURE GW 10 HUNGARY CUMULATIVE SOLAR PV CAPACITY FROM 2018 UNTIL END OF OCTOBER 2023, BY MANAP



SOURCE: MAVIR.

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Drivers for solar growth

The high installation numbers recorded in 2021 stemmed from the fear of a potential phase-out of the net metering that year. In 2022, two demand shocks led to similar installation levels.

Firstly, Hungary has a regulated electricity price that is artificially kept low. Despite this, due to record-high energy prices, electricity prices doubled for residential consumers in mid-2022. In addition, the regulated price was removed for SMEs. The impact of the regulated price changes catalysed a rush to invest in small rooftop PV systems.

Secondly, in October 2022, the government announced a feed-in ban for new rooftop installations and set a 2-week deadline to apply for grid connection. As expected, an overwhelming number of requests were registered that grid operators could not deal with. This brought the rooftop PV segment to a standstill. It also led to a huge demand for PV installers. As a result, 2023 is a strong year for the small-scale segment, with 688 MW of newly installed capacity by the end of October. However, order books of residential PV systems have significantly decreased during autumn, which has negatively affected developers and installers.

Until the 7th September 2023, Hungary had a net-metering scheme, in which self-generated electricity can be deducted from consumed electricity on a yearly basis. We believe this was the most favourable scheme in the EU. The end of the feed-in ban is approaching, as the government announced the new "gross-metering" scheme, but new installations of residential customers will get only around 1.3 cents per kWh for electricity fed into the grid. The government also announced a support scheme for PV + storage for the residential segment; however, the details are yet to be worked out. These two measures have not helped the market recover so far.

Installations above 50 kW, mainly ground-mounted systems, jumped to 696 MW in 2022, setting a new record in Hungary. This record will be surpassed in 2023, given the 763 MW new capacity added by the end of October 2023. These systems now total 3.3 GW. The dynamics are interesting, as the largest part of these systems were still built under the old feed-in tariff system (KÁT) that ended in 2016. After the ending of the KÁT scheme, Hungary started a new auction-based Contract for Difference (CfD) support scheme, called METÁR, in 2019. With five rounds, the programme has allocated 933 MW. However, by the end of 2022, only 60 MW were operating under the METÁR scheme. The main reason behind this was the record-high electricity market prices. Developers were reluctant to enter the METÁR scheme. Many also abandoned or temporarily stepped out of the old KÁT scheme to sell electricity on the Hungarian Electricity Exchange. PV power plants are also seeing good opportunities in longer-term Power Purchase Agreements (PPAs) with consumers. However, apart from a few milestone contracts, this has not yet become mainstream.

Unfortunately, commercial installations have been sidelined due to grid connection problems, despite high demand.

Challenges

Grid connection is the main challenge for PV development in Hungary. While the national target for 2030 is 12 GW, the operating capacity has now exceeded 5.5 GW, and the Hungarian grid has nearly reached its limits. Since April 2021, it has not been possible to obtain a new grid connection for systems over 50 kW. The Hungarian TSO points to the fact that connection rights were already issued, and the sizable growth of rooftop PV systems, for which already more than 5 GW have been reserved for the next 4 years. As the Hungarian grid load averages 6 GW and no balancing capacities were developed in the past 10 years, the grid will likely be congested already in the coming year if no measures are put in place by the government. A more regulated and transparent system for grid connection applications was set to begin in May 2022. The results of these applications only came in summer 2023, which resulted in approximately 3.9 GW applications, but only 1.5 GW were ultimately confirmed by the applicants. These grid-connection permits were mainly granted for the 2028-2029 period. The remaining applications were rejected due to high connection costs and late potential connection dates.

However, as many grid capacities have already been allocated, the utility segment is expected to remain strong even in 2024 with around 600-700 MW capacity additions. Beyond 2025, the situation is difficult to predict and will depend on grid connection possibilities. In a positive scenario, new installation capacities might remain above 500 MW; but in a negative scenario, they may drop back to a few hundred MW.

For rooftop systems, the feed-in ban, and the end of net metering already slowed down progress. While 2023 is another record year, numbers will decline in the future and ultimately depend on the PV+storage support scheme under the new "gross-metering" scheme. In a positive scenario, new rooftop installations will only halve to 300-400 MW levels, but in a negative scenario, they may drop back to 150-200 MW.

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

11. Sweden

GW-scale solar market for the first time

Overview of solar PV developments

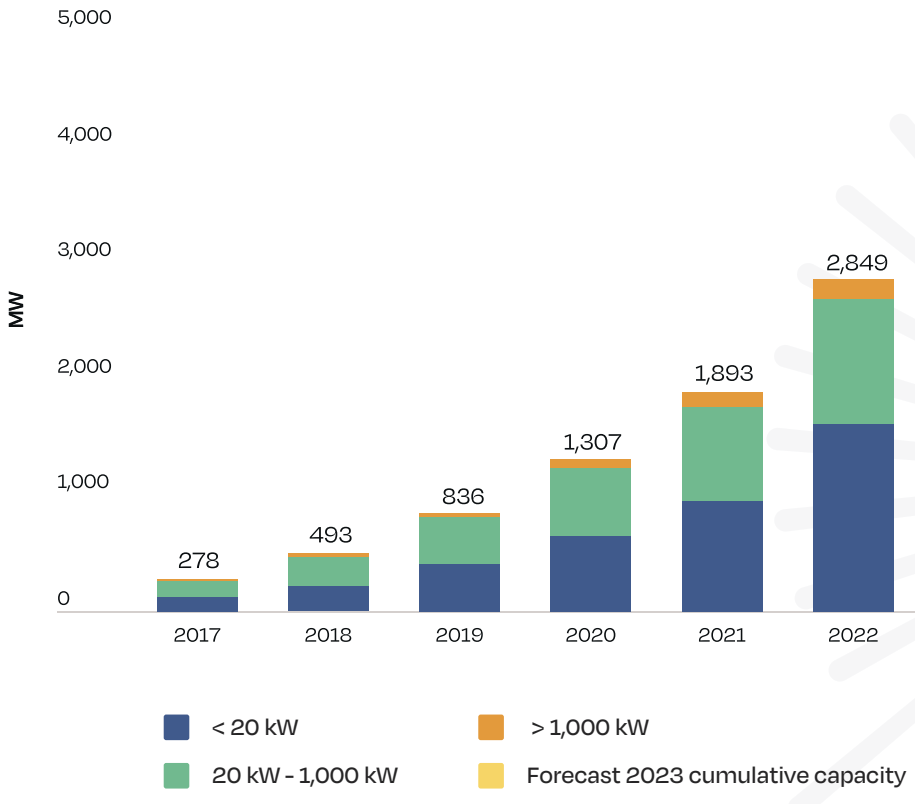
In 2023, Sweden finally reaches beyond 1 GW annual installed capacity, after falling on the finish line in the previous year, with around 960 MW. The expected installed capacity in 2023 is about 1.6 GW, which will result in a cumulative installed capacity of close to 4.5 GW.[27]

The Swedish market has grown steadily every year, from a very low level in the first half of last decade. It reached over 100 MW annually for the first time in 2017, and the total installed capacity at the end of 2022 was roughly 2.8 GW. However, the share of solar power in the electricity mix is still very low, only expected to reach 2% in 2023. As can be seen in Figure GW 11, small PV systems below 20 kW comprise the largest market in Sweden with more than 1.6 GW of cumulative capacity. The segment represented nearly 60% of the total solar fleet by the end of 2022. PV installations between 20 kW and 1,000 kW have experienced a decrease in market share from 52% in 2017 to 38% at the beginning of 2023. The total installed capacity stood at just over 1 GW. The utility-scale segment was on the rise in terms of annual additions, but receded in 2022, when around 21 MW were installed, 64% less than in 2021. The utility-scale segment captured a market share of 6% in 2022.

Public target and demand

There is not a specific public goal for solar power in Sweden, as the use of fossil fuels in the country's electrical production is minimal. Nevertheless, there is a need to increase electricity production capacity

FIGURE GW 11 SWEDEN CUMULATIVE SOLAR PV CAPACITY 2017-2022, BY ENERGIMYNDIGHETEN



SOURCE: Energimyndigheten.

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27 All capacity values in this article are expressed in DC. A 1.2 AC to DC conversion rate is assumed.

due to the impending electrification of the industry and transport sector. Additionally, Sweden is witnessing the establishment of energy-intensive industries. The Swedish Transmission System Operator (TSO) foresees a potential doubling of electricity consumption by 2045. Concurrently, Sweden serves as a significant net exporter of electricity to Baltic Sea countries, offering a green alternative to fossil fuels. In 2022, Sweden was the largest net exporter of electricity in Europe.

Swedes are more optimistic about solar power compared to other energy sources. 80% of the Swedes want more investments in solar. Also, the politicians at the local level are just as positive about solar. In 2008, the Swedish right-wing government set a target for wind power capacity, which was a key for the strong expansion of the wind industry. In the latest months, two out of three parties in the government coalition have announced that they want to develop a national solar strategy and target. We are still waiting on the third party, which is led by the Minister of Energy, and the government to set a target for solar power expansion; it is an integral part of the expansion of electricity production.

Main drivers

The energy crisis in Europe and Russia's invasion of Ukraine drastically increased the demand for solar and batteries in 2022 and beginning of 2023. However, the market has slightly decreased during the second half of 2023 and is now at the same level as at the beginning of 2022. Yet, the market growth is still at a historically high level.

The solar market in Sweden is driven by the residential market, which constituted about 57% of the cumulative capacity by the end of 2022, followed by the C&I segment, with about 37%, and the utility-scale market (about 6%).

The subsidies for solar energy in Sweden are mainly directed to the residential sector. There has been a tax deduction for green technologies for private homeowners since January 2021. The investment cost for installation and materials was reduced by 15% for PV installations (and the reduction was raised by the new government to 20% from January 2023), and by 50% for energy storage connected to PV and EV chargers. For small prosumers with grid connections of maximum 100 A, there is a tax deduction of 60 öre/kWh (5.5 EUR cents/kWh) for exported electricity, as a light version of net-metering, for the first 30,000 kWh exported.

From July 1, 2022, a change of the law allows micro-producers to generate more electricity than they consume per year without getting charged by the grid operator for overproduction. This made it more profitable for micro-producers to install larger PV systems. But on March 20, 2023, the authority inspecting grid companies declared that the reduction in grid fee in Swedish law to

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encourage small-scale electricity production is not compatible with European law and, thus, must not be followed by the DSOs. Therefore, all electricity producers with plants smaller than 1.5 MW might face higher grid fees soon, especially if they feed in at a higher power to the grid than what they use.

Key challenges

The interest in building utility-scale plants in Sweden is very high, as indicated by recent announcements of several large PV projects on the multi-hundred MW scale. Yet, so far, there is no solar system larger than 22 MW, and there is only a handful of PV plants larger than 10 MW. One reason for this is the legal uncertainty. In many counties, the local administrative board (*Länsstyrelsen*) rejected larger installations, and rulings have been appealed. In November 2022, the highest Swedish court concerning land and environment legislation issued its first ruling, which clarified some of the cryptic legal aspects. In December 2023, another ruling from the highest court will be announced, which hopefully will clarify how extensive an investigation of alternative locations needs to be. However, Sweden – the fifth largest country in Europe – has vast land availability and low population density. Only Finland has a lower population density in the EU. There are promising opportunities for ground-mount PV in Sweden. Depending on future legal interpretations, political initiatives may have to be introduced to facilitate the permitting of utility-scale projects.

In September 2022, there were parliamentary general elections; a pro-nuclear right-wing government was elected, supported by a climate-sceptic party. Within the solar industry, there was some concern that the new government would negatively impact the deployment of solar power. However, so far, no proposal impeding solar energy deployment has been presented. On the contrary, the government has implemented an increase in the tax reduction for private individuals on PV installations from 15% to 20%.

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. The government has still not indicated whether it will review this rule, which strongly inhibits the expansion of large rooftop PV installations.

We are also waiting for the government to introduce a proposal to benefit energy communities in Sweden. There is currently no regulatory framework for energy communities and there are no incentives for the creation of energy communities.

Authors: *Oskar Öhrman*, Technical Affairs; *Anna Werner*, Director, Svensk Solenergi.

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12. Bulgaria

Bulgaria joins the GW club of new solar capacity in 2023

Overview of solar PV developments

Bulgaria will close 2023 with over 1 GW of new solar power capacity on the grid, bringing the total PV fleet close to 3 GW and poising the country to achieve its 3.2 GW NECP target for 2030 about seven years in advance.

The feat is even more impressive if we take into account the fact that Bulgaria has practically tripled its installed solar capacity in about three years, going from a bit more than 1 GW in total at the end of 2020 to close to 3 GW at the end of 2023, according to estimates of the Association for production, storage and trading of electricity (APSTE).

On sunny days in the summer of 2023, photovoltaic energy made up 41% of the energy supply mix, even if for a few hours only. This trend looks set to continue over the coming years.

Drivers of growth

In terms of **solar irradiation levels**, Bulgaria, a country of southeastern Europe that extends from 41 to 44 degrees north latitude, rivals the northern regions of Spain. With a yearly average of between 2,000 and 2,600 hours of sunshine in different regions, the PV sector in the country looks primed for success from the very start.

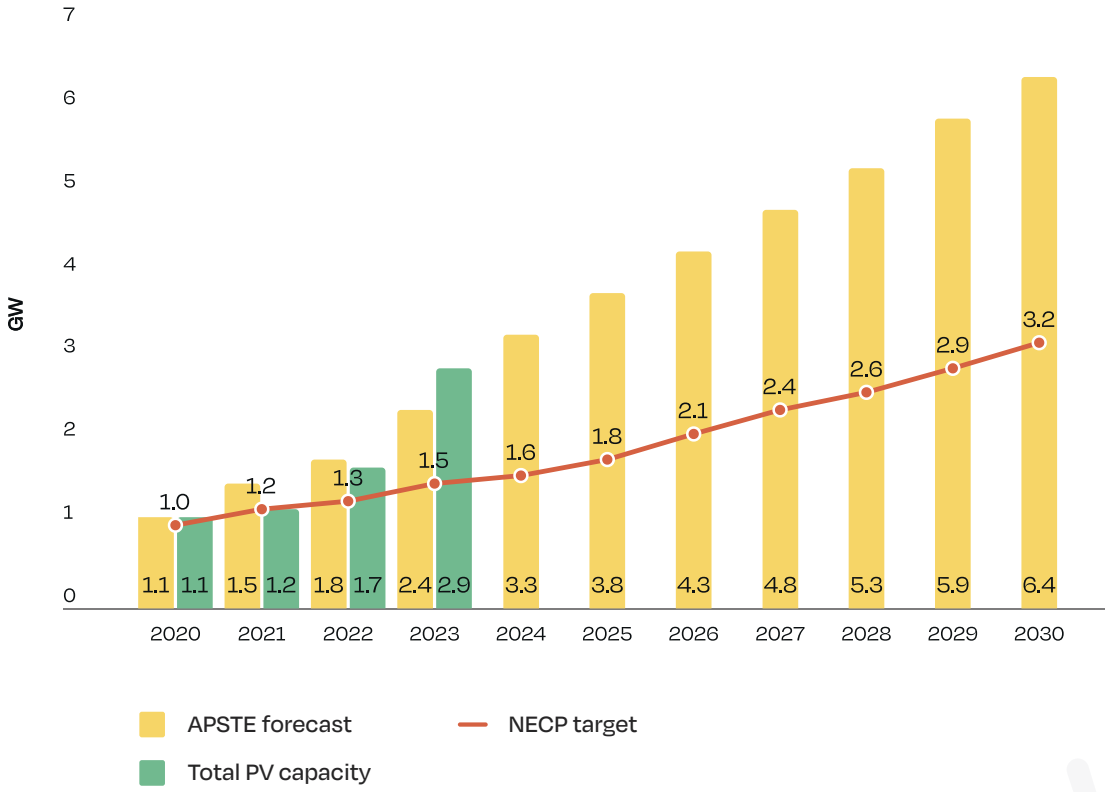
Continued **advances in technology** over the last years, combined with **lower prices of PV modules**, make the market economics work well for solar. In the absence of sizable incentives promoting small-scale residential systems, the development of the sector is strongly tilted towards utility-scale development where **economies of scale** can drive the levelised cost of energy (LCOE) further down.

Solar is currently the **cheapest source of power** available on the market and energy-intensive businesses are beginning to take notice. Three corporate PPAs for solar assets were announced in 2023, signalling that high energy prices in 2022 served as a wake-up call for the stable and predictable prices renewable energy assets can offer.

82 MW PV park installed in 2023 at a site of a former dump of opencast lignite mine, near the village of Mednikarovo, Bulgaria. © Sunotec

Mednikarovo, Bulgaria © Sunotec

FIGURE GW 12 SOLAR PV DEVELOPMENTS IN BULGARIA, BY APSTE, SEDA



SOURCE: APSTE, SEDA.

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Challenges

Aiming to provide renewable energy at the lowest cost for customers at the same time as transitioning the grid to handle an increasing share of renewables with variable output, such as wind and solar, is no simple task. This transition requires integral planning around electricity networks and new market rules to incentivise investments in **grid congestion management and distributed flexibility**. The continued sustainable development of the solar sector in Bulgaria will depend on the speed of grid upgrades and the uptake of electricity storage technologies.

Outlook 2024-2028

Under its **National Recovery and Resilience Plan** (NRRP), Bulgaria will launch its first renewable energy auction by the end of 2023. The auction will allocate CapEx support for 1,995 MW of renewable energy projects co-located with at least 350 MW / 700 MWh of storage. Successful applicants will have to build the projects by the end of 2026.

As it can be seen in Figure GW 12, APSTE expects to see sustained growth of 450 to 750 MW of new solar capacity added per year over the next three to four years. Concerns over grid-connection capacity or low capture prices for solar production profiles are expected to tighten the requirements of financing institutions for future projects and drive investment in energy storage.

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

13. Romania

Overview of solar PV developments

Following a period of lull, Romania has achieved in 2023 a significant milestone in its renewable energy journey – over 1 GW of new solar capacity installed in one year between distributed generation and utility-scale projects. The new solar installations, equating to a 308% increase compared to the capacity deployed the previous year, have set a new record high since the early 2010s' surge in renewable energy. Solar PV is now the fastest-growing power source in the country. By the end of 2023, the cumulative PV capacity – distributed and utility-scale – reached 2.85 GW, generating over 2.5 TWh, which accounted for approximately 5% of the total electricity produced.

With the addition of 297 MW in utility-scale projects installed between Q1 and Q3 2023, the centralised PV capacity reached 1.7 GW, accounting for 28% of the total solar installed capacity this year (see Fig. GW 13).

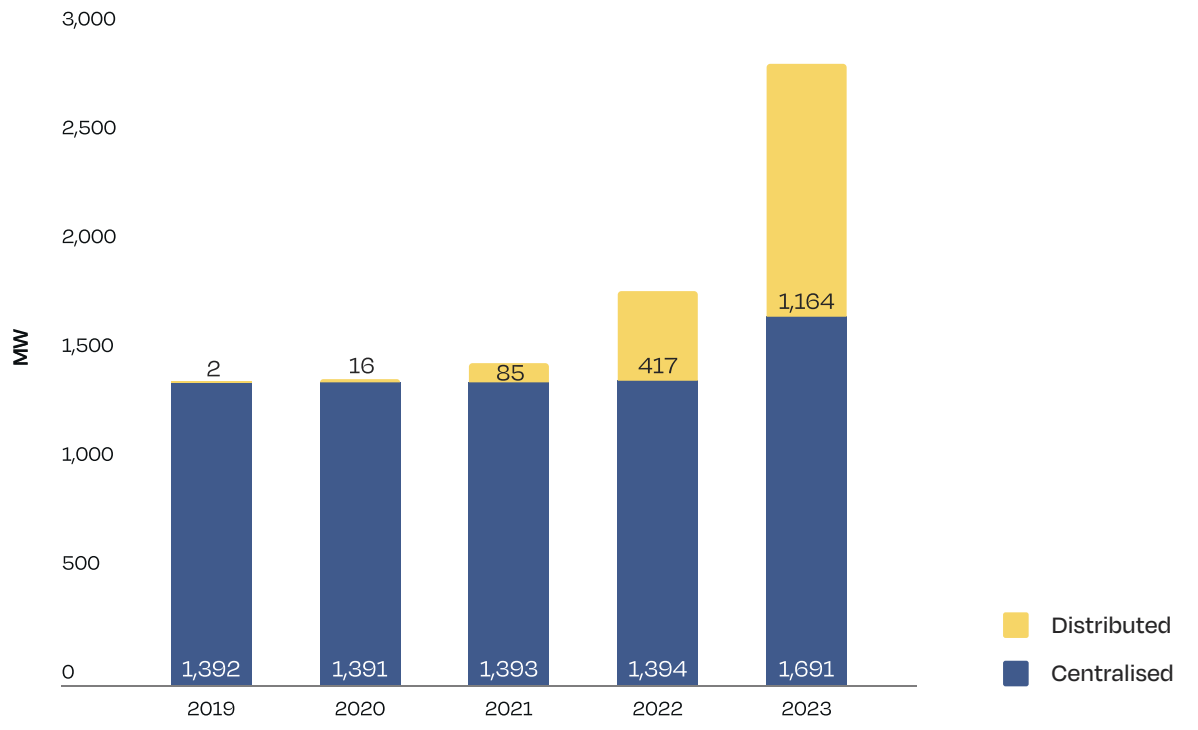
While this annual figure represents a significant quantitative leap relative to the capacity deployed in past years, which averaged 1 MW, the main driver of the impressive developments in the Romanian PV sector is the distributed generation segment.

During the fourth quarter of 2023, the number of prosumer households, firms and institutions exceeded 80,000, totalling an installed power capacity of nearly 1.2 GW, with the residential sector accounting for over 85% of the total installations.

National targets for solar PV

With an average of 1,900 to 2,400 annual sunlight hours, Romania has significant natural potential for solar PV development. Yet, the country has not set ambitious targets for renewable energy sources, aiming for only 30.7% of its final energy consumption to come from RES by 2030. For solar, this translates into an objective of 5.05 GW, which would entail the addition of 2.2 GW to the existing capacity. The draft

FIGURE GW 13 ROMANIA CUMULATIVE SOLAR PV CAPACITY, 2019-2023, BY ANRE



SOURCE: ANRE.

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National Energy and Climate Plan (NECP) submitted in November 2023 increases the RES target to 36%, which for solar would mean an increase to 8.3 GW – 5.8 GW for utility-scale projects and 2.5 GW for rooftop PV. While this is a positive step, it is not enough to align with the EU's binding objective of 42.5% RES by 2030. In the context of the European ambitions, Romania would need to aim for 44.4% RES, meaning 11.1 GW of solar - 6.1 GW for utility-scale and 5 GW for rooftop PV.[28]

Drivers for solar growth

The last two years have been marked by significant legislative changes that underpinned the development of the Romanian PV sector. For utility-scale projects under 50 ha (approx. 42 MW), the permitting process was simplified in January 2023, following the 2022 removal of the requirement for prior planning documentation, which reduced the time for acquiring the necessary permits to from an average of 18 months to 6-12 months. This measure has led to a competitive timeframe, compared with similar procedures in the region. For the prosumer sector, the modification of the legislative framework has also been one of the main drivers of its impressive development.[29] To that end, the grid connection procedures for distributed solar systems generating under 400 kW per place of consumption were streamlined in 2022, allowing all necessary documentation and permits to be obtained within a month. Another significant factor that drove the growth of the prosumers segment in Romania was the subsidy programme and the fourfold increase in the funding to 610 million EUR, coupled with the possibility for prosumers with an installed capacity of up to 400 kW per consumption point to sell the excess electricity directly to their electricity supplier.

Romania still has some gaps and inconsistencies in its legal framework for renewable electricity production. However, the country is making significant progress in simplifying and improving the process.

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28 Deloitte&E3M – Renewable Energy in Romania – Roadmap to 2030 – report for RWEA&RPIA..

29 Code of Good Practice for Renewable Energy in Romania, no. 2 - https://goodpractice.rpia.ro/2023-2/

Challenges

While Romania has the necessary preconditions – climate, land availability, and relatively streamlined permitting processes – for RES project development, the industry faces several legislative and structural challenges. Whereas the 2022 modification of the Land Law (254/2022) streamlined the permitting procedure for projects under 50 ha, an artificial blockage was created for larger capacities above the 50-ha threshold, as the Ministry of Agriculture and Rural Development (MARD) does not issue the necessary permits. In this sense, while it is relatively easy to develop PV plants below the 50-ha threshold, bigger projects face a more arduous process in obtaining the necessary documentation. The second significant challenge pertains to grid connection, which tends to be cumbersome due to the limited availabilities in specific areas – such as Dobrogea and Banat. Additionally, the high costs of grid reinforcement and expansion are still falling on the shoulders of investors, and some construction deadlines have been pushed back by the TSO and DSO up to 2 years.

Outlook for 2023-2027

The Romanian PV market has entered a new boom phase, driven by the current security context, the imperative of green transition, and the favourable permitting framework. As the country moves towards decarbonisation and the large-scale adoption of clean technologies, the outlook for the future of PV points to sustained development. It will be supported by the availability of European funds and the emergence of new business models against the backdrop of a more mature market. However, some challenges remain, such as regulatory uncertainty, administrative barriers, market fragmentation, and grid integration issues. Therefore, for Romania to tap into its full solar potential, the market will require a stable and supportive framework that can foster innovation, investment, and competitiveness in the long term.

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

14. Czech Republic

Czech Republic returns as a gigawatt-scale market after 13 years

Return after a 13-year absence

Czechia is currently experiencing a second solar boom. In 2023, the Czech Solar Association expects that the total added PV capacity will exceed 1 GW of new PV installations. This would mean Czechia's return to the GW-market stage for the first time in 13 years. Czechia has already experienced one solar boom in the past and was one of the first significant PV markets in Europe. In 2009 and 2010, driven by a feed-in-tariff scheme, thousands of investors, from households to multinational investment funds, built more than 20,000 PV installations totalling more than 2 GW. Approximately 1.5 GW was installed in 2010 alone. The growth, however, was much faster than the government anticipated and caused a significant hike in energy prices for end consumers, who – as in other countries – were financing RES growth through a surcharge in their energy bills. This in turn led to a negative perception of solar energy from voters and politicians. The government responded by firstly halting subsidies for large-scale solar and then for all solar systems for several years. Retroactive cuts were introduced, causing severe damage to the sector. Companies left the market; others shifted their activities to other sectors.

Until recently PV demand in Czechia was kept barely alive by modest subsidy schemes. Households and companies were plagued by administrative burdens, restrictions in size and other factors that made investments in PV unattractive to consumers. In 2017, for example, only 4.7 MW were installed in the entire country. The original National Climate and Energy Plan targeted only 1.9 GW of new PV additions until 2030. The Climate Plan had no effect on the market and the total goal for 2030 will already be surpassed in 2024.

Effective subsidy schemes and the energy crisis as drivers for solar growth

In 2021, the subsidy system for residential PV was relaunched after lobbying from the Czech Solar Association. Barriers, restrictions, and administrative hurdles were removed. The changes to the subsidy scheme coincided with the beginning of the energy crisis, which in Czechia started in the autumn of 2021 when one of the largest energy suppliers with a million customers went bankrupt bust. This sparked an upswing in residential installations, which was later accelerated by the Russian invasion of Ukraine and the subsequent chaotic situation in energy markets.

The business-to-business (B2B) sector too was delighted to see a subsidy programme launched in 2022, financed through the Recovery and Resilience Fund (RRF). This much-simpler subsidy scheme attracted a total of 6,000 companies that applied for solar rooftop PV projects. At the same time, the EU Modernisation fund, of which Czechia is one of the recipients, launched its first calls for projects for utility-scale solar. Until 2030, at least 150 billion CZK (6 billion EUR) will be allocated for projects aimed at reducing the impact of the decarbonisation of industry in Czechia and facilitate the shift towards renewable energy. It is however widely expected that the total sum will increase, since the total budget of the Modernisation Fund is linked to the price of CO2 emission certificates. Almost 39% of the funds from the Modernisation Fund will be dedicated to new renewable energy projects. As a result, in 2022, a total of 298 MW were installed, leaving behind the cloudy years when the Czech PV sector was languishing in the lower leagues.

In 2023, the expansion continues and in the first six months alone a total of 487 MW of new PV was added, with many more projects being commissioned in the second half of 2023. For the first time since 2010, Czechia will once again be a GW-scale market.

Market segmentation: when will business-to-consumers (B2C) be replaced as the main force?

However, in stark comparison to 2010, the market is currently driven not by a FIT scheme, but by upfront investment subsidies. While in 2010 almost all of the added capacity was comprised of utility-scale installations, the current boom phase is driven by residential rooftops. During the first half of 2023, almost 45,000 new projects were commissioned; 95% of them are below 10 kW. There are currently no signs of the residential sector slowing down. The potential for B2C installations remains high. The three Czech DSOs are receiving a large number of applications for new grid connections and do not

expect this trend to change anytime soon. In 2023, a subsidy scheme for low-income households was added, which is further powering growth. Currently, the subsidy scheme for residential rooftops applies only to already existing buildings, not to planned houses. With stricter building guidelines, it is expected that after 2025 new family homes will be built with solar already installed.

The B2B segment, in contrast, is expected to pick up in late 2023 and 2024. Of the approximately 6,000 applications for subsidies from the RRF, most are not processed yet and construction has not started. As a result, only 2,350 projects (worth 93 MW) between 10 kW and 1 MW were added between January and June 2023. The large bulk of projects, which will be connected in the second half of 2023 and 2024, will cement Czechia's place as a GW-market in the coming years. In addition to that, B2B subsidies should in the future not be administered by the Ministry for Industry and Trade, which is not equipped to deal with such large numbers of applications but by the State Fund for the Environment. This organisation has offices spread across the country and is used to handling tens of thousands of applications given that it administers the residential solar subsidy schemes.

There is one big segment not participating in the current boom phase: the utility-scale sector. In the first half of 2023, only 13 projects above 1 MW were installed in Czechia; half of them were built on rooftops. However, these 13 projects already make up 10% of the newly installed capacity, and many more large-scale rooftops are being planned, or already in the installation phase. The first ground-mounted projects since 2011 are being constructed, with many more in the pipeline. There are currently grid capacity reservations for almost 20 GW with the Czech DSOs. And while a fair amount of these reservations will not materialise, the Czech Solar Association expects that more than 10 GW of new solar should be added in Czechia by 2030.

Challenges and outlook 2023-2027

Despite the positive trend, Czechia is still lagging when it comes to the speed of the PV rollout. During the first half of 2023, the market growth was 114 W per inhabitant, significantly slower than more advanced EU peers such as the Netherlands or Austria. Yet there are several reasons to be optimistic when it comes to the future of the Czech solar market, as all segments are mostly untapped, and there is an urgent need to decarbonise the energy system. There are millions of people living in apartment buildings, many of them in tower blocks built during the Soviet Union era which are yet to be utilised to produce solar power. This should change over the coming years as Czechia builds the legislative framework for energy communities and energy sharing.

PV + hydrogen project launched in November 2023.

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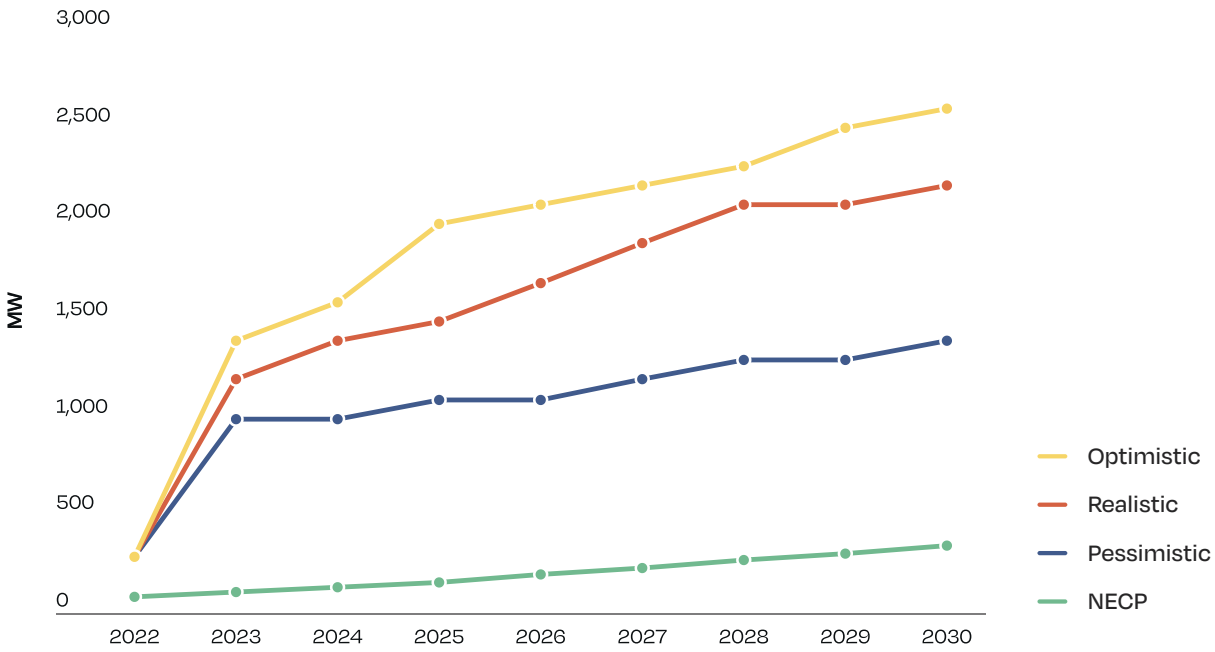
FIGURE GW 14 SCENARIOS FOR ANNUAL SOLAR PV INSTALLATIONS IN CZECH REPUBLIC, 2022-2030



SOURCE: CZECH SOLAR ASSOCIATION..

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The main demand driver will be the Czech industry, which is the backbone of the national economy. With heavy industries, such as automotive, steel works, chemical plants etc. needing to decarbonise, the stage is set for large utility-scale solar. Similarly, the Czech energy sector, currently relying on coal and nuclear, will be in dire need of new renewable capacity soon. The ageing Czech nuclear plants will be expanded, but new reactors are not expected before 2038. Additionally, according to the Czech coal commission, coal power plants will probably cease to be profitable before 2033. The gap will need to be filled soon, and renewables are ready to step up. Whether the energy transition succeeds will, as always, not be up to the market, but to policy makers. Permitting needs to be streamlined, and the grid strengthened. Additionally, Czechia needs to quickly pave the way for large-scale energy storage to be legalised, something that has so far been blocked by some fossil fuel companies.

According to the models by the Czech Solar Association, Czechia will experience the following growth scenarios until 2030 (see Fig. GW 14):

- Pessimistic scenario (mostly rooftops, little utility-scale): annual growth between 1 GW and 1.4 GW;
- Realistic growth (utility-scale picking up steadily): annual growth between 1.2 GW and 2.2 GW;
- Optimistic growth (barriers removed): annual growth between 1.4 GW and 2.6 GW.

The stakes are high, given that companies need and want to decarbonise, hit climate targets and tick ESG boxes. The alternative is to rely on importing energy from countries that will themselves be facing shortages and potentially seeing companies move abroad to countries where the energy they offtake is cleaner.

Author: *Jan Krčmář,* Executive Director, Czech Solar Association.

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