EU Market Outlook

For Solar Power

2021 - 2025

SolarPower Europe


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Foreword

Welcome to our EU Market Outlook for Solar Power 2021-2025,

Despite its numerous success stories, solar PV's near-term potential is often still underestimated in both public discourse and policy targets. It is only natural that analysts regularly adapt market deployment numbers to changing business environments. But when it comes to solar, the direction is usually the same: year-on-year assumptions about solar market developments must be revised significantly upwards, as reality hugely outshines expectations. Restrained forecasts were understandable at the outset of solar technology, when its capacity was not fully grasped many years ago. In the present day, however, setting limited expectations for solar is unjustifiable: Solar is the world's lowest cost power technology, the most job intensive power generation source, and the only true versatile power technology that can be applied from small distributed to large utility-scale applications.

Solar power is our daily business – as the sector's European representation in Brussels we are looking very closely at any developments with the mission 'to ensure that more energy is generated by solar than any other energy source by 2030' in Europe.

Our short-term forecasts for the sector have been often too conservative as well. We also did not predict that solar would maneuver so safely through the pandemic, growing by nearly 20% in 2020. While we learned from our experience during the first year of the COVID-19 pandemic to show more optimism for the solar sector in 2021, our forecast was still below the estimated 34% growth rate we are seeing now. With newly installed 25.9 GW, 2021 is not only the best year ever for solar in the European Union, it also broke the decade old installation record from 2011. In fact, solar would have grown even faster in the EU in 2021, if severe material supply shortages, logistic issues, and consequent product price hikes had not resulted in project implementation delays across the member states.

The learning: All stakeholders need to be more realistic about solar!

Member states' targets for solar in their National Energy Climate Plans (NECPCs) add up to 335 GW by 2030, but it is already clear that Europe will exceed that level much earlier. The most-likely Medium Scenario of our new market outlook predicts 328 GW of installed solar capacity to be reached in the EU already in 2025. The Europe Commission anticipates 479 GW of solar by 2030 in its impact assessment for a 40% renewables share by 2030, but our modelling of the Medium Scenario shows a much higher solar volume of 672 GW operating in the EU by that time even without further ambitions.

What the EU needs to succeed on its path towards 1.5°C Paris in the most cost-efficient way, according to scientists, is to boost solar capacity to a total of 870 GW in 2030. In other words, solar has only nine more years to grow by about 700 GW more than today. The crucial tool to get there is a renewables target of at least 45% for 2030 in the updated Renewable Energy Directive. The success of solar means that to be more realistic is to be more ambitious!

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Table of contents

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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.

Executive summary

Solar power in the Europe Union has again demonstrated a stellar performance in 2021 despite adverse market conditions on various fronts – from the continued negative effects of COVID-19 on our daily lives, to PV product supply shortages and consequent solar module price hikes.

As forecasted, demand for solar power in the European Union has grown significantly in 2021. The 27 member states of the European Union saw around 25.9 GW of new solar PV capacity connected to their grids in 2021, an increase of 34% over the 19.3 GW installed the year before. This growth makes 2021 not only another record year for solar in the EU, it was also the best year in history, taking place exactly one decade after the former record was set at 21.4 GW in 2011.

The new record number is 16% higher than our forecast for 2021 in the previous EU Market Outlook, but 5% lower than indicated by our research for the latest Global Market Outlook in mid 2021, when the supply shortage-related project delays were already evident but not the extent of its effects on solar deployments in the Europe Union.

Like in the previous year, Germany is again Europe's major solar market in 2021 with 5.3 GW of newly installed capacity, followed by Spain (3.8 GW), the Netherlands (3.3 GW), Poland (3.2 GW) and France (2.5 GW).

In 2021, the Top 5 markets in the European Union have stayed the same, and among the Top 10, there are only 2 newcomers that are from northern Europe (Denmark and Sweden), replacing two established PV markets, one in central Europe (Belgium), the other in the south (Portugal). In 2021, 25 of 27 EU member states deployed more solar than the year before.

The EU's solar power generation fleet increased by 19% to 164.9 GW, from 139 GW in 2020, when growth was also in the two-digit level, but at 16% a little lower. The European Union's solar power plant portfolio is still dominated by two countries – Germany (59.9 GW) and Italy (22 GW) operate around 50% of solar power generation assets today, although the share is declining – in 2020, its combined share was 55%.

As impressive as Germany's newly installed annual capacity and its operating power fleet at the end of 2021 is, when it comes to solar power per capita, the EU's most populated member state is no longer No. 1 – that honour now goes to the Netherlands.

Analysis of the solar developments in the context of the EU member states' solar National Energy Climate Plans (NECPs) shows that two countries have already met their 2030 NECP targets in 2021, and over half of EU member states will meet their 2030 targets within the scope of this outlook period, by the end of 2025.

For most member states, we again expect more power additions in our 4-year installation forecasts than in last year's outlook. Backed by the ambitious announcement from Germany's new government to double its solar 2030 target to 200 GW, Europe's leading market will become even more central to the continent's solar sector. Germany is expected to install 47.7 GW by 2025, almost as much as we estimate for the three following solar markets together – Spain, the Netherlands, and France.

This year's EU Market Outlook's PV market scenarios 2022 to 2025 show continuous, two-digit annual growth rates that are all slightly higher than in our previous edition. The Medium Scenario now forecasts 18-20% growth rates compared to 16-17% levels last year, adding around 162.7 GW, and reaching 327.6 GW by the end of 2025. According to our modelling of the Medium Scenario up to 2030, the total solar fleet in the EU will continue its strong growth to 672 GW in that year, with the annual installation rate reaching over 85 GW.

However, as outlined in our policy recommendations (see, p. 6), we ask for the European Commission and the Member States for much more ambition for the solar sector. By 2030, the EU needs to operate 870 GW of solar capacity across its territory to enable the most cost-efficient trajectory towards climate neutrality in 2050 and meet the 1.5°C Paris target. The crucial foundation for this path is a EU renewables target of at least 45% for 2030.

Policy recommendations

Fit for a Solar Future

The European Union is moving ahead to deliver on the Paris Agreement. In 2021, the European Commission proposed a new regulatory framework to take the continent to a 55% reduction of GHG in 2030, and achieve climate neutrality in 2050.

With its 'Fit for 55' legislative package, the European Commission is mandating the comprehensive decarbonisation of the economy, delivering on the EU Green Deal. The package is a far-reaching set of new legislation and revamped existing legislation issued in two parts over the year 2021. Political negotiations on the proposed measures are expected to be concluded by the end of 2022.The Fit for 55 package is on the cusp of delivering the necessary level of ambition that will create the unprecedented opportunity to accelerate renewables-based electrification for all end use sectors.

The proposals should maximise the potential of a truly European solar value chain, redeveloping critical manufacturing capacity of solar PV components Europe, while creating over 1 million green EU jobs by 2030.Some of the drivers for this growth include the proposed 40% renewable energy use target for 2030, which is set to be translated into national measures. Binding targets for green hydrogen use in industry and transport will also kickstart the creation of a renewable hydrogen market in Europe.

Notably, the Fit for 55 package is set to be complemented by a European Solar Strategy in 2022. This reflects the wider move to incentivise European countries and companies to step up ambition on solar energy at national level and to tackle remaining barriers to solar deployment. Following the pattern, already we can see the new German government raising their solar targets.

So what is in for the solar sector and what is still needed to maximise the impact:

1. **Climate urgency needs bolder ambitions.**

   A key pillar to sustain a 55% reduction of GHG emissions in 2030 is the Renewable Energy Directive, amendments have been proposed to increase the overall renewable energy target from the current 32% to 40% in gross final energy demand by 2030.

   According to SolarPower Europe and LUT modelling, this increased target is still insufficient to set the EU on the right track to deliver on the 1.5°C goal. By 2030 we need to deploy 870 GW of solar across the EU to set the most cost-efficient trajectory towards climate neutrality in 2050. Considering the current market growth of solar, which is expected to reach 50 GW of annual capacity additions across the EU by 2025, a higher target is well within reach.

   SolarPower Europe together with leading scientists and eight other energy and city associations in the renewable sector, has published an open letter calling for the EU's 2030 renewable energy target to be increased to at least 45% renewables in the EU's final energy demand.

2. **Faster permitting times and permitting best practices to support more solar projects.**

   Increasing solar deployment ambitions requires granting more permits for solar projects, and doing so more efficiently. Solar projects currently face significant burdens through permitting and land-access for new projects. Permitting procedures must be simplified, standardised, and digitalised, with authorities ensuring appropriate staffing levels to tackle bottlenecks. The already applicable Renewable Energy Directive has defined new rules, but in practice, it still takes between three to five years to develop a ground mounted solar project in Europe, depending on the country. While the sector welcomes the European Commission's proposal to publish guidance on permitting by summer 2022, we must urgently pursue comprehensive

implementation of permitting rules to facilitate the development of projects. In parallel, best practice for the implementation of permitting rules, or for increasing public acceptance of projects should be identified and disseminated.

3. **On-site solar coupled with storage to decarbonise the EU building stock.**

Buildings represent about 36% of the EU's energy consumption and produce around 40% of the bloc's greenhouse gas (GHG) emissions. Decarbonising existing buildings, which represent between 75% and 90% of the building stock, remains a significant challenge. On-site solar should be mobilised as a key solution.

The potential of on-site solar is yet to be fully maximised – with only 111 GW deployed today. The **Recast Renewable Energy Directive (RED III)** sets a useful indicative benchmark on EU buildings to use at least 49% of renewable energy by 2030. It must be complemented by the explicit exemption of construction permits for solar rooftop systems, a key barrier in several member states.

In addition to this, the **implementation of the Renovation Wave must focus on the deployment of on-site solar and demand-side flexibility solutions.**

The recast **Energy Performance of Buildings Directive (EPBDII)** is a further opportunity to mainstream solar and storage in all building renovations. It should, at a minimum, ensure that all buildings are 'solar-ready' by requiring a GHG emission reduction component in Energy Performance Certificates (EPCs) to promote integrated energy renovation, and include minimum requirements to deploy on-site solar and storage (Mandatory Performance Standards).

4. **Boosting a Renewable Hydrogen economy for the climate transition of hard to abate sectors.**

Priority must be given to renewable hydrogen when and where direct electrification is not cost-efficient or not technically viable, for example for the maritime sector or aviation.

It will be essential to implement the recast Renewable Energy Directive (RED III) proposal for 50% of the hydrogen intended for end-use in industry to be from renewable electricity by 2030. Additionally, Renewable Fuels of Non-Biological Origin (RFNBOs) will need to account for 2.6% of the energy used in transport. Another very important step taken in this endeavour is the update of the definition of RFNBOs, as well as of the methodology to calculate its emission savings, which need to be robust enough to guarantee that the electricity used for its production comes from renewable sources.

As a second step in the Fit-for-55 package, in December 2021 the European Commission will publish the Hydrogen and Gas Decarbonisation package. Those texts must integrate the hydrogen sector into the natural gas legislative framework, and allow for the replacement of fossil gases with hydrogen in a cost-effective manner. Similarly, it will be paramount that this legislation focuses on the scale-up of renewable hydrogen in the hard-to-abate sectors by establishing a fair, open market with strong certification schemes.

5. **Leverage corporate procurement of renewables to accelerate private sector investments towards European Green Deal objectives.**

Private procurement of solar energy must be more actively promoted across all Member States. Record breaking low costs have meant that European market for solar and hybrid solar-and-wind PPAs have reached 1.9 GW in 2021 at the time of writing.[1] However, administrative and market barriers still hinder the growth of private procurement of renewable energy in several member states.

1 RE-Source (2021) https://resource-platform.eu/buyers-toolkit/

Policy recommendations

The European Commission has correctly identified the issue and has made corporate sourcing a key priority for the revision of the renewable energy directive. Specifically, it has proposed requirements on member states to actively promote the uptake of renewable energy Power Purchase Agreements in their market, including through de-risking them via credit guarantees. PPA requirements must be complemented by guidance for member states on how to develop frameworks to promote PPAs, currently slated for 2024. In addition to this, the European Commission has also introduced proposals to ensure that all renewable energy producers are able to receive Guarantees of Origin (GOs).

To ensure the corporate sourcing framework is fully fit for purpose, **SolarPower Europe is also proposing to improve the temporal granularity and transparency of GOs,** calling for member states to time-stamp GOs at more regular intervals, rather than annually.

6. Provide the basis for solar manufacturing to flourish again in Europe.

An industry can develop sustainably only with a comprehensive vision of its supply chain. The growth of the EU Solar market, coupled with the sustained EU leadership in future solar cells technologies, opens an opportunity to reinvest into a sizeable solar PV manufacturing capacity. This will be critical to ensure a diversification of supply for EU project developers, to increase the sustainability of supply chains, while creating added value and highly qualified jobs contributing to the European Green Deal.

We need to re-establish 20 GW of solar PV manufacturing in the EU by 2025, from polysilicon to module assembly. **This is the vision set by the European Solar Initiative (www.europeansolarinitiative.eu), the industrial alliance launched by SolarPower Europe and EIT InnoEnergy in 2021 with the support of the European Commission.**

Reaching that objective will require adopting a coherent strategy, aiming at de-risking investments into new manufacturing capacities while ensuring a level-playing field with global producers. The upcoming EU Solar Strategy, to be proposed in summer 2021, and further planned EU actions to support the resilience of our continent's economy next year, will be excellent opportunities to set the course towards that objective.

7 Factoring sustainability into business decisions.

The solar PV industry is constantly looking at means to improve its sustainability performance under different perspectives beyond what is required by law. **SolarPower Europe's recent publications such as *Solar Sustainability Best Practices Benchmark*[2] and *Agrisolar Best Practice Guidelines*[3] show the effort from the sector to lead by example**, taking into account social and environmental dimensions, including biodiversity preservation, local acceptance, circularity and supply chain transparency.

As part of the Green Deal sustainable product policy agenda, the EU Commission is currently preparing regulatory measures aimed at supporting the PV sector's sustainability credentials, notably with the Ecodesign Directive and the Energy Labelling Regulation. The proposed regulatory measures will improve the environmental sustainability of PV products by increasing their environmental performance and energy yield and reducing the overall environmental footprint of the products placed on the EU market. The policy measures are planned to be adopted at the beginning of 2023.

2 SolarPower Europe (2021): Solar Sustainability Best Practices Benchmark.

3 SolarPower Europe (2021): Agrisolar Best Practice Guidelines.

8. **Address grid bottlenecks & the flexibility potential of solar prosumers.**

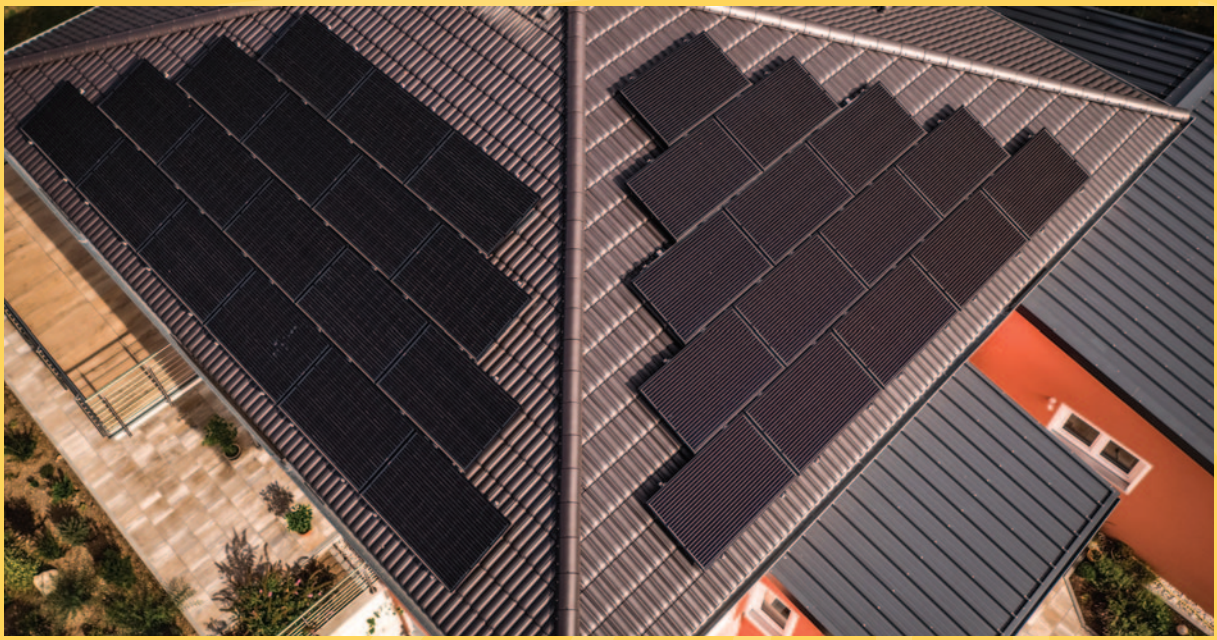
The availability of sufficient grid capacity to connect new projects, in particular in the low voltage grid, can limit more solar deployment.

To mitigate this risk, important investments are needed in power networks, estimated at 59 billion euros annually by 2030 according to the European Commission Long-Term Decarbonisation Strategy, which is three times the amount invested during the previous decade.

SolarPower Europe is putting forward best practices in grid planning and grid connection practices as member states implement the Clean Energy Package rules. SolarPower Europe has worked to reflect this approach in the TEN-E Regulation, which regulates the use of the EU funding for energy infrastructure (CEF-E).

System operators must be incentivised to deploy smart technologies or use flexibility sources that can alleviate the need for grid reinforcements. Deploying the right framework to unlock flexibility resources, through standards for local flexibility markets and an updated approach to network tariffs are solutions to these challenges.

Solar prosumers also represent an untapped flexibility potential to compensate for supply and demand imbalances or congestions in the distribution grid. They can optimise local solar generation by synchronising it with energy consumption patterns and avoiding transmission losses. Tailoring the energy system of the future to them is therefore key to support the integration of solar, while creating future-proof right investment conditions for rooftop solar.



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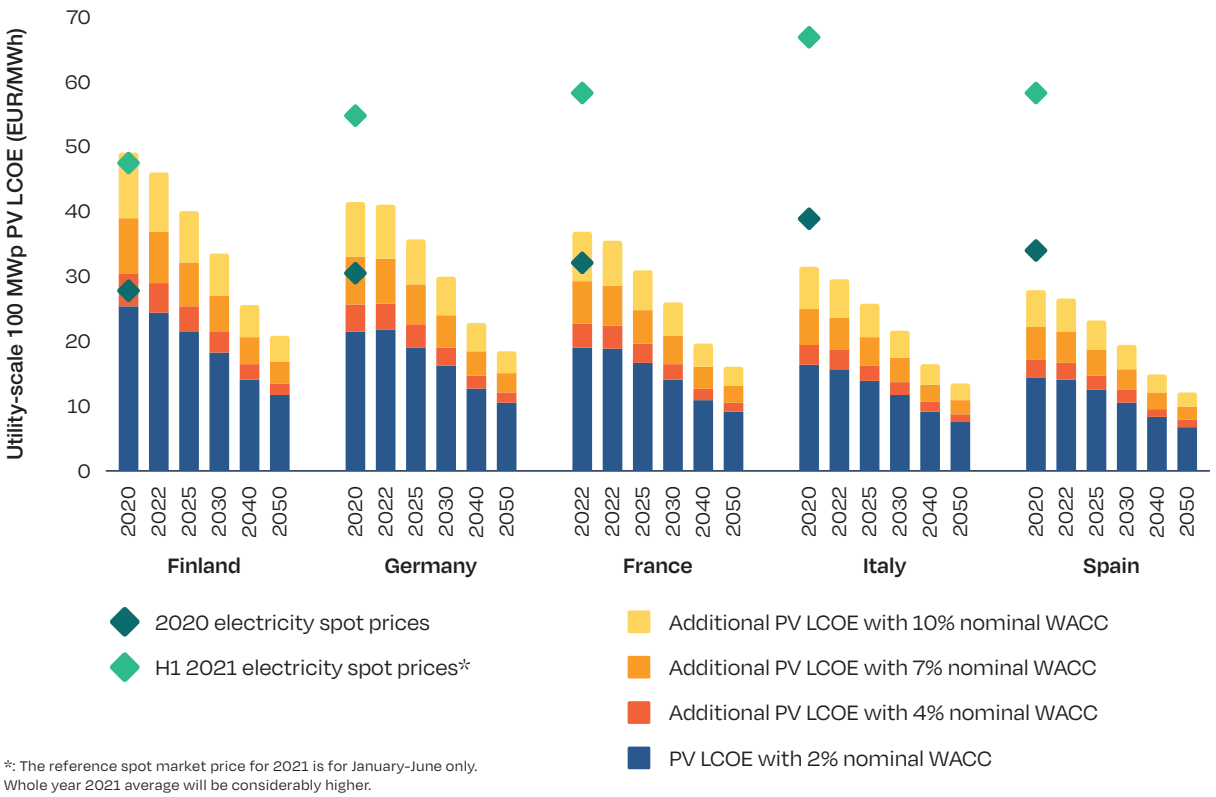
Solar power in the Europe Union has again demonstrated a stellar performance in 2021 despite adverse market conditions on various fronts – from the continued negative effects of COVID-19 on our daily lives to PV product supply shortages and consequent solar module price hikes. Unlike in 2020, when electricity prices had dropped in the first half of the year due to lower economic activities during the first EU COVID-19 lockdowns, in 2021 electricity spot prices had jumped to new heights, improving solar power's very attractive business case. Now, even in a northern country like Finland, solar investments make sense also in a very high interest rate environment (see Fig. 1).

FIGURE 1 PV LEVELISED COST OF ELECTRICITY (LCOE) IN FIVE EU LOCATIONS, 2020-2050

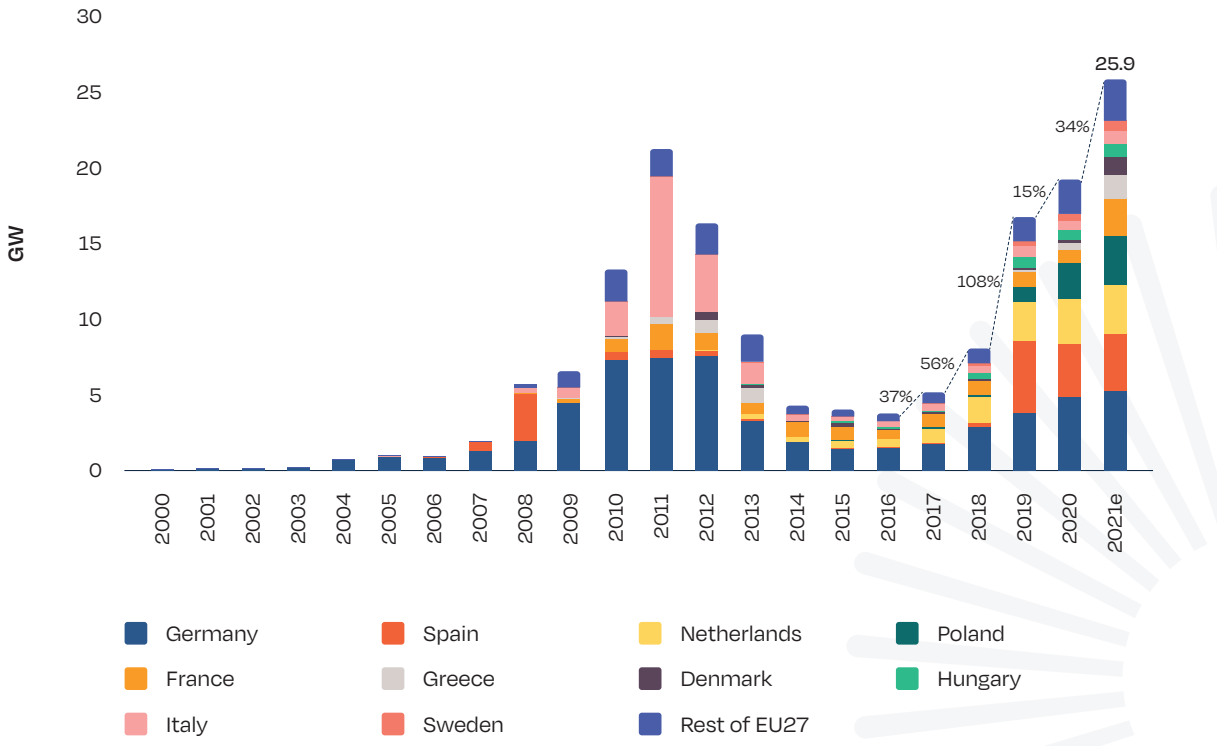


*: The reference spot market price for 2021 is for January-June only. Whole year 2021 average will be considerably higher.
SOURCE: Vartiainen et al. (2021).

As forecasted, demand for solar power in the European Union has grown significantly in 2021. The 27 member states of the European Union saw around 25.9 GW of new solar PV capacity connected to their grids in 2021, an increase of 34% over the 19.3 GW installed the year before (see Fig. 2). This growth makes 2021 not only another record year for solar in the EU, it was also the best year in history, taking place exactly one decade after the former record was set at 21.4 GW in 2011. While the former peak ended the first European solar boom phase, marking the start of a several year-long market slump in the context of a solar energy market transition phase away from traditional feed-in tariffs to new incentives and market models, the new record is considered only another milestone towards much higher annual installation levels in the coming years.

The new record number is 16% higher than our forecast for 2021 in the previous EU Market Outlook, but 5% lower than indicated by our research for the latest Global Market Outlook from July 2021, when the supply shortage-related project delays were already evident but not the extent of its effects on solar deployments in the Europe Union (see Box 1, p. 12).

FIGURE 2 EU27 ANNUAL SOLAR PV INSTALLED CAPACITY 2000-2021

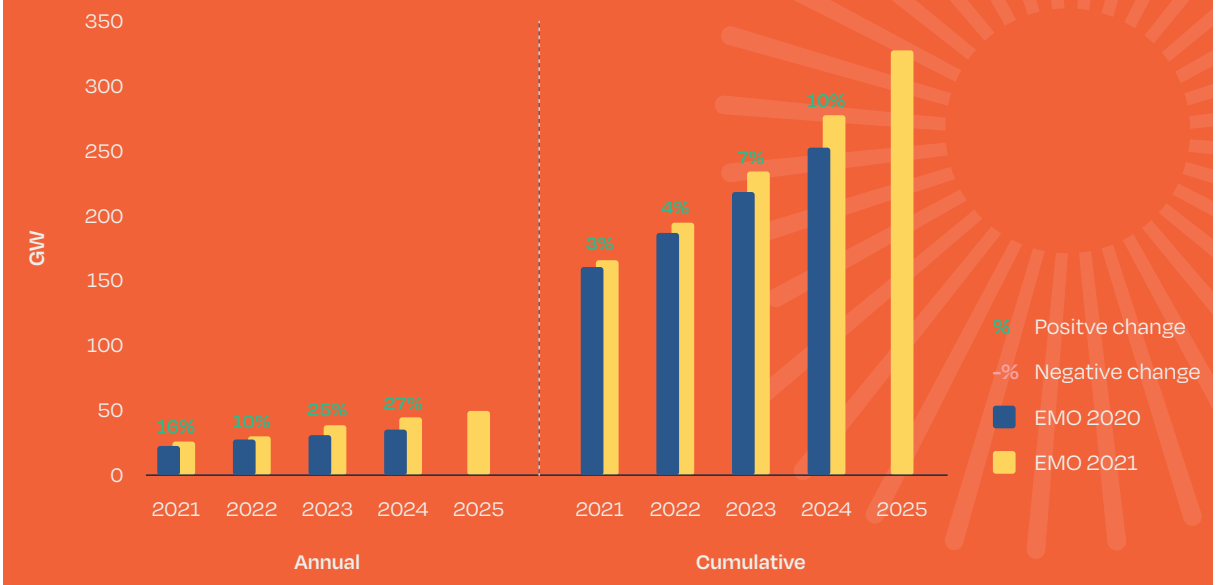


Box 1: Looking back and forth

When we published our previous EU Market Outlook in December 2020, we described the EU solar sector as resilient, despite the effects of the COVID-19 pandemic. Contrary to previous expectations, in 2020, the market had not decreased, but even grown notably by 15% from the previous year. We had revised downwards our expectations for 2020 compared to our EMO 2019 but increased the forecasts for all years between 2021 and 2023. In the EMO 2020, our Medium Scenario assumed 23% growth to 22.4 GW for 2021 and 22% growth to 27.4 GW in 2022, before demand was anticipated to get back to low two-digit levels – with 13% in 2023 and 14% in 2024, as the next climate-relevant EU objectives were far off, in 2030.

In this year's edition, we significantly upped our forecast for all years, thanks to a strong outlook for solar across Europe and improved national policy conditions, above all in Germany thanks to an ambitious new 2030 solar target. Our Medium Scenario now forecasts 25.9 GW in 2021, which means 16% higher demand than what we forecasted last year (see graph, left part). The increased forecast for 2022 is also high, at over 10%, but somewhat lower than in the other years under scrutiny, as we expect the current PV price hike to last for several more months, and have an impact on next year's capacity additions as well. Fuelled by improved policy frameworks in Germany and other countries, and nomalised price levels, we are very upbeat for 2023 and 2024, now projecting 25% and 27% higher deployments than in our EMO 2020, which would result in newly installed capacities of 38.5 GW and 44.6 GW. As a result of the upward revision on annual installation forecasts, cumulative capacity projections have also grown in all the observed years (see graph, right part). Our expectation for total installed capacity in 2021 is 3% points higher than in our EMO 2020, while in 2024 is even 10% points higher, with 25 GW more than we expected last year.

FIGURE 3 COMPARISON MEDIUM SCENARIO EMO 2021 VS 2020



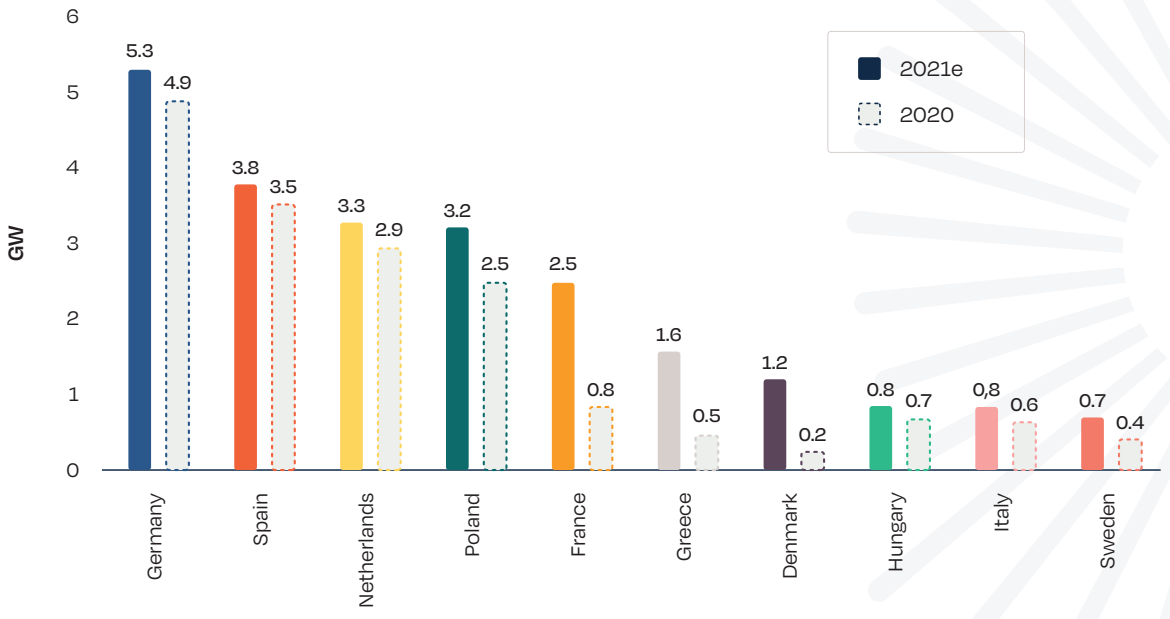
1.1. Top 10 EU solar markets 2020 in brief

The Top 5 markets in the European Union have stayed the same, and among the Top 10, there are only 2 newcomers that are from northern Europe (Denmark and Sweden), replacing two established PV markets, one in central Europe (Belgium), the other in the south (Portugal).

Like last year, **Germany** is again Europe's major solar market in 2021. It connected 5.3 GW, compared to 4.9 GW the year before. The EU's largest economy has largely held the No. 1 position since the start of this century. After a consolidation phase following the first full feed-in tariff based European solar boom, Germany's solar sector has been experiencing a second boost as of 2018 due to a combination of self-consumption with attractive feed-in premiums for medium- to large-scale commercial systems and auctions for systems up to 10 MW, and a tried and tested regulatory scheme on the one the hand; and solar's steadily improving cost competitiveness on the other. The year 2021 was characterised by a revision of the Feed-in Law (EEG) in January, which has made investments in residential and small commercial systems more attractive after a self-consumption levy was eliminated but put a financial burden on larger rooftop self-consumption systems to force this segment into a tender scheme. In consequence, the German market that grew by around 1 GW per year between 2017-2020, is estimated to have grown by less than half a gigawatt or 8% in 2021.

Spain has maintained the second rank in Europe, after installing an estimated capacity of around 3.8 GW in 2021, slightly up from around 3.5 GW in the previous year. Nearly 3 GW was realised from PPA based systems out of a gigantic pipeline under development in Spain. This makes the Southern European country probably the world's largest market for subsidy-free solar, but it also demonstrates that grid constraints can be a major burden for rapid deployment of large solar volumes. The 2.9 GW of solar power plants allocated in two auctions in 2021 will be mostly installed in 2023. The Spanish self-consumption rooftop market is only beginning to emerge, as the country's former 'sun tax' had made investments in that segment impossible. However, the Spanish Recovery Plan considers PV rooftops a key measure for the energy transition, and in June 2021, the government has released 450 million EUR to its regions for investments in self-consumption systems.

FIGURE 4 EU27 TOP 10 SOLAR PV MARKETS 2020-2021



The third spot is taken again by the **Netherlands** after installing an estimated 3.2 GW, up 11% from 2.9 GW added in 2020. The commercial rooftop market remains the main driver of the Dutch solar market. Its share has grown a little over 40%, while the net-metering backed residential segment has seen its portion slightly shrink to around one third, and ground-mounted systems continue to contribute around 20%. After a 110 MW project was installed in 2020, an even larger solar park with 176 MW capacity was awarded in the country's technology neutral SDE++ tender scheme in late 2021. The Dutch solar market could have been even larger in 2021, but the 12 GW project pipeline is facing challenges to timely secure grid connections and land. The country is increasingly looking into multi-functional PV applications, such as floating solar or solar carports. The Netherlands' main drivers for solar continue to be net-metering for the residential and small business segments, while the commercial, industrial, and utility-scale markets rely on the SDE++ tendering scheme. Although SDE++ was recently opened to CCS and energy saving projects, solar still won the major share in the first round of the revised scheme in 2021.

Poland continues to surprise the sector, increasing its annual solar additions again – this time by 28% to 3.1 GW, from 2.5 GW in 2020. This means, Poland keeps the fourth rank. The country is a solar 'newcomer', installing more than a GW in 2020 for the first time. The substantial increase in PV capacity over the last years has been primarily due to a favourable self-consumption scheme for prosumers, a net-metering system that is complemented with a rebate scheme for residential systems, and reduced VAT and income taxes. The micro-generation segment is complemented by an annually held RES auction scheme, where solar increasingly excels also in the segment for systems above 1 MW. In the latest auction for 1 MW+ systems in June 2021, solar was awarded 1.2 GW compared to about 0.3 GW allocated to wind projects.

France remains the EU's fifth largest PV market. It installed an estimated 2.5 MW in 2021, which marks a new record after more than doubling solar grid connections from 0.8 GW in 2020. This can be considered a breakthrough after years of installation levels hovering close to the 1 GW level, when long administrative procedures and challenging grid connection processes hindered developers to speed up installations. In Q3/2021, France reached a total installed PV capacity of 12.3 GW, which leaves nearly 8 GW to go to meet its 20 GW targets by end of 2023, and over 30 GW to reach its maximum goal of 44 GW by 2028. To achieve these goals, permitting procedures will need to be further simplified. Solar PV in France is primarily driven by an extensive tendering scheme for ground-mount and rooftop systems. In 2021, the threshold for rooftop tenders has been increased from 100 to 500 kW, making more systems eligible for feed-in tariffs. However, the prosumer segment is very small today as the value of self-consumed power is under-valued and the right policy frameworks missing.

Greece has more than tripled annual PV deployment to an all-time record of 1.6 GW in 2021, significantly up from 0.5 GW connected to the grid in 2020. Exceeding the annual GW installation level for the first time translates into the sixth rank for Greece among the EU's solar markets. The boom is driven mostly by small ground-mounted PV projects up to 500 kW, for which the government recently extended the feed-in premium until the end of 2022. Greece now has a solar project pipeline of up to 85 GW, and most big energy stakeholders in the country are looking into investing in the domestic solar sector.

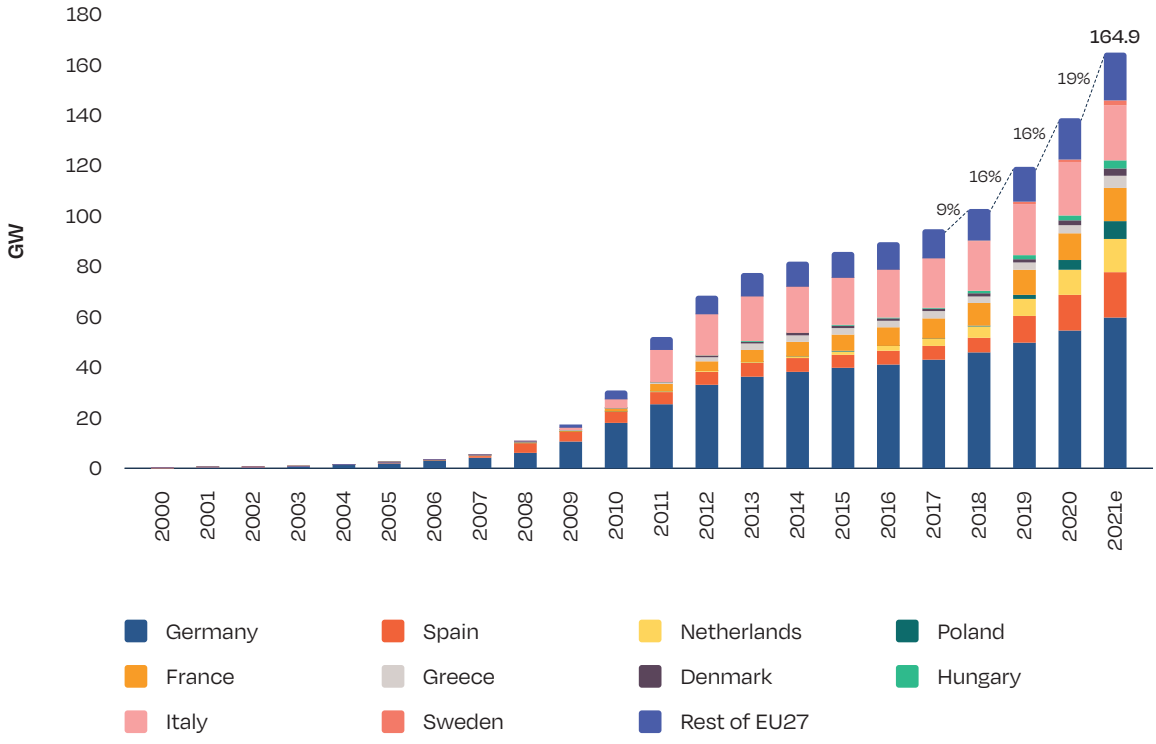
None of the EU's Top 10 solar markets have grown as much as **Denmark** in 2021. The European Union's latest solar shooting star boosted annual installed capacity 6-fold to 1.2 GW, from a mere 0.2 GW in 2020. Gigawatt scale has been achieved almost exclusively through ground-mount utility-scale PV power plants built without subsidies for supplying solar power to corporate buyers. The residential solar market, which blossomed a decade ago with the help of financial incentives, installed negligible PV volumes in the low double-digit MW range, as did the C&I segment.

The other three Top 10 solar markets also increased their deployment rates in 2021, but each of them remained under the 1 GW annual installation threshold. A COVID-19 recovery fund supported 110% tax bonus triggered larger demand for residential and storage installations in **Italy**, but severe permitting issues and disappointing auction results for solar resulted only in 0.8 GW newly installed capacity in one of Europe's largest and most sunny economies. Large interest in the small ground-mount systems segment, and residential and commercial rooftop installations up to 50 kW, have resulted in another very good solar year for **Hungary**, which has increased its yearly solar grid-connections to 0.7 GW in 2021. Though not yet contributing to 2021 installations, Hungary launched a new solar subsidy scheme in December to alleviate energy poverty; the programme is financed from the EU Just Transition Fund. The latest entry to the Top 10 is **Sweden**, where tax incentives and grants have continued to fuel demand. With growing activity in the solar PPA segment, installations have augmented to an estimated record market size of 0.7 GW in 2021.

The European Union's Top 10 solar markets were responsible for 90% of total installations in 2021, increasing their share by 2% points, from 88% in 2020. This is based on new additions of 23.2 GW, compared to 17.2 GW in 2020. The development is a reversal of the trend seen in the previous edition, when the Top 10 group's installation share dropped by 2% points in 2020 over the year before. On the other hand, the share of the Top 5 has continued its downward trend, claiming 70% of the market in comparison to 78% in 2020 and 79% in 2019. While the Top 5 share still seems initially disproportionally large, in reality the share reflects population and economy – these five countries represent around 57% of the European Union's population and nearly two third of GDP. It means that demand for solar has continued its diversification to other EU member states in 2021, which can be also seen in the number of countries installing more solar than the year before. In 2021, almost all EU member states deployed more solar than the year before – with only two exceptions, Belgium and Slovenia. This compares to 2020, when annual growth was recorded in 22 of the 27 EU countries, three less than in 2021.

However, analysis of the members states' National Energy Climate Plans shows that most European policy makers have severely underestimated the interest in solar from their electorates. The first two countries have already met their 2030 NECP targets in 2021 and over half of the EU member states will meet their 2030 targets by end of 2025 (see Chapter 3).

FIGURE 5 EU27 CUMULATIVE SOLAR PV INSTALLED CAPACITY 2000-2021

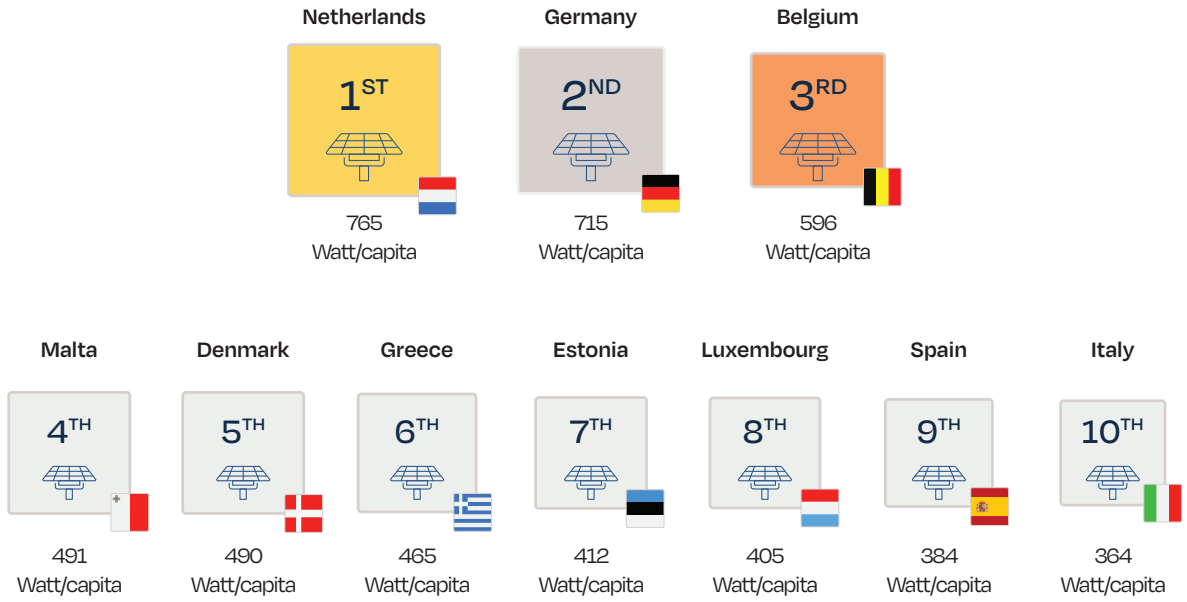


In 2021, the EU-27 member states' total installed solar capacity rankings of the major markets has followed the trend observed for annual additions. The EU's solar power generation fleet increased by 19% to 164.9 GW, from 139 GW in 2020, when growth was also in the two-digit level, but at 16% a little lower (see Fig. 5).

When looking at the developments of the EU markets' cumulative PV capacities at the end of 2021, a few changes can be observed compared to the year before. **Germany** has remained the largest operator of solar power plants in the European Union by far. With new annual additions of 5.3 GW to around 59.9 GW cumulative installed capacity by the end of 2021, the gulf toward the second largest market has again widened. The PV power fleet of Italy, which installed around 0.8 GW in 2021, now consists of 22 GW. As in the previous year, **Spain** keeps the third rank in the EU in 2021, after reaching a total of 17.9 GW. **France** is estimated to produce solar power from 13.2 GW, which means it stays the fourth largest solar electricity generator in the EU. The continued strong solar growth in **the Netherlands**, has brought the country even closer to France: at 13.1 GW, its solar power plant capacity is now only less than 150 MW smaller than that of its French peer.

While the Netherlands have crossed the 10 GW threshold for the first time, all other Top 10 markets remain below that level. Poland has reached 7.1 GW and surpassed Belgium, whose solar power park volume grew to 6.9 GW. Greece and Hungary have kept their rankings at 4.8 and 2.9 GW, respectively. The last seat among the Top 10 is now taken by Denmark, after the Northern European country almost doubled its PV fleet capacity in a single year to a cumulative capacity of 2.8 GW, which was enough to replace Portugal. Other GW-level EU solar fleets at the end of 2021 are operated in Austria, Bulgaria, Czech Republic, Portugal, Romania and Sweden, the same number as in the previous year.

FIGURE 6 EU27 TOP 10 COUNTRIES SOLAR CAPACITY PER CAPITA 2021



SOURCE: United Nations (2020).

Despite its absolute solar growth and outstanding position in the EU, Germany gave away some of its market share, now reaching 36%, which is 3% points less than the 39% it owned in 2020. Italy's EU share dropped by 2% points to 13%. Together, the European Union's two largest operators of solar power generation assets claim a total share of 50% from 81.9 GW in 2021; that's 5% less than the 55% based on 75.8 GW in 2020. The 2021 share of the Top 5 cumulative markets has also slightly decreased to 77%, from 80% in 2020, while the Top 10 now claim the same 92% share.

As impressive as Germany's newly installed annual capacity and its operating power fleet by the end of 2021 is, when it comes to solar power per capita, the EU's most populated member state is no longer the No 1. That honour now goes to the Netherlands, which took over the first rank after reaching 765 W/capita, 42% up from 539 W/capita in 2020. Germany's average installed solar power per person increased by 10% to 715 W/capita, while Belgium kept its third rank in 2021 after improving this metric to 596 W/capita, up from 466 W/capita in the previous year. All other Top 10 EU solar market have per capita installed capacities below the 500 W level, although the average for the last of this group (this time, Italy) was lifted to 364 W/capita, compared to 283 W/capita in 2020 (then, Spain).

In summary, solar shows another strong growth year despite adversary market conditions characterised by the virus and supply shortages. The European Union grid-connected capacity stood at 25.9 GW in 2021, 34% more than the year before and 16% higher than our forecast from the previous EU Market Outlook (published in Dec. 2020). The same pattern holds true for the cumulative installed capacities, increasing by 19% to 164.9 GW. Demand in Germany continues to dominate the EU solar market, both in terms of annual and total solar installations at 5.3 GW and 59.9 GW, respectively, but there is a new No. 1 when it comes to a metric allowing a fair comparison – installed PV capacity per capita. In no other EU member state every citizen has installed in average more power than the Netherlands.

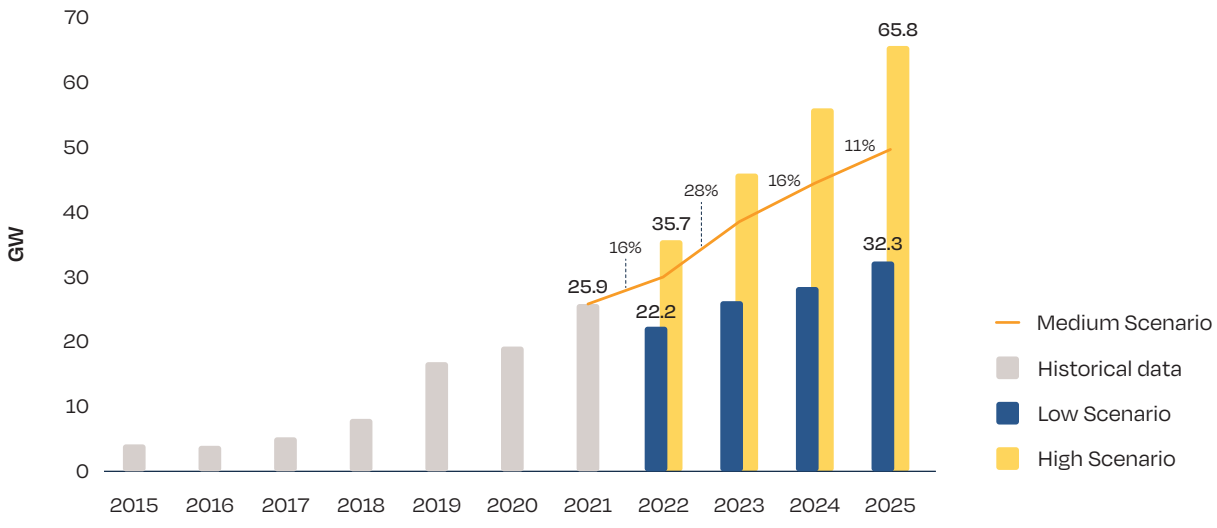
1.2. Prospects 2022-2025

As another very good year for solar comes to an end, the EU solar sector has grown by an estimated 34% to 25.9 GW, which means an all-time high for the European Union, beating the decade old 21.3 GW record from 2011. The coming 4 years until 2025 will be characterised by further strong growth, according to our Medium Scenario. While analysts anticipate inflated module prices will return to 'normal' levels in the second half of 2022, it remains to be seen when exactly this will happen. In any case, the elevated module prices will have negative impacts on certain projects in 2022, and probably even more than in 2021 when developers and EPCs had still volumes on hand that were ordered at much lower price levels, even if the actual quantities received were often less than expected. However, at 16% annual growth rates, 2022 will turn into another record year for solar in Europe and the first time the 30 GW threshold will be reached. With prices back to normal and Germany's massive new plans for solar to gain traction in 2023 and for the first time reaching a 10 GW annual market size, we anticipate a 28% growth rate to 38.5 GW in the EU. Though the growth rates will turn more moderate in the following two years – 16% in 2024 and 11% in 2025 – this will be enough to result in annual solar deployment volumes above the 40 GW level – 44.6 GW in 2024 and at 49.7 GW in 2025, thus nearly touching the 50 GW level.

SolarPower Europe's growth assumptions have previously been much higher than the targets formulated by EU members states in their National Energy and Climate Plans (NECPs); now the difference is even larger. If growth assumptions until 2025 are extrapolated for the coming five years, total installed solar capacity in the EU by the end of 2030 will be about twice as high (see Chapter 3). Indeed, the drivers for solar in Europe are only getting stronger, fostering the foundation for much faster growth in the coming years than many decision makers anticipate:

- Despite the recent solar product price hikes, solar's cost reduction curve is intact – US investment bank Lazard's latest edition of its annual Levelized Cost of Energy Report 2021, released in November 2021, showed a 3% year-on-year decrease to an average of 3.25 USD cents for utility-scale solar, lower than for any other power source.
- Also in 2021, solar won considerable shares in cost-based technology neutral energy tenders in the EU, such as in Spain, Greece, Poland. Winning prices for solar in Germany's solar specific tenders continued to be constantly lower than in the wind editions.

FIGURE 7 EU27 ANNUAL SOLAR PV MARKET SCENARIOS 2022-2025



- The low cost based business case for subsidy-free solar systems is increasingly spreading across Europe, where policy frameworks permit. In Denmark and Spain corporate solar sourcing has already evolved into a key driver for the strong growth of the countries' solar sectors.
- The versatility of solar remains unparalleled, enabling various multi-purpose applications that meet quickly increasing interest now that solar is cost competitive. Examples include rooftop solar for carparks allowing direct EV charging, and relatively new technical solutions such as floating solar or Agri-PV that promise owners of water/land areas to enter energy production while benefiting from further advantages as solar panels offering shading facilities, which reduces evaporation in water reservoirs.
- With mandatory solar for new residential buildings starting in May 2022 in the first German state, Baden Wurttemberg, and the country's new government having announced to create legislation that will require new commercial buildings to include solar, finally the breakthrough for building-integrated photovoltaic solutions is expected in Europe. This will significantly help in widening solar's feature of being an add-on power source in the housing sector into an aesthetic building material.
- SolarPower Europe has listed several policy asks in this EMO as policy frameworks are key to unleash solar's benefits to fully support the European Union's climate goals (see p. 6).

Even though the annual additions for the coming 4 years forecasted in the Medium Scenario seem already very high, there is a realistic chance that the market grows faster (and if the EU wants to meet the 1.5°C Paris target it must). Our **High Scenario** projects 35.7 GW already in 2022 and up to 65.8 GW new solar additions in 2025. While this sounds very improbable from today's view, solar in Europe has surprised us a lot

just very recently, when newly installed capacities in year one of COVID-19 didn't drop as all solar analysts believed, but leaped by 19%. Our High Scenario assumes solar turns into a big beneficiary of the Green Deal, with the 2030 EU renewables target lifted to 45%, Germany's recent solar target doubling to 200 GW by 2030 creating a pull effect on other member states, and our policy asks being swiftly implemented.

On the other hand, the Low Scenario anticipates diminishing demand in 2022 to a volume of 22.2 GW, and growing only to 32.3 GW in 2025. This scenario was modelled on major EU markets implementing policies that would disable crucial solar business models. It also assumes severe trade conflicts with import bans and the EU failing to facilitate significant solar manufacturing capacities along the value chain. Such an outcome is close to impossible when we consider that even an unprecedented pandemic had only limited impact on solar demand in the EU. When observing current solar activities and policy discussions, where the climate crisis is very high on many decision-makers' agendas, we can see the low solar ambition in many member states' NECPs are indeed a topic of concern (see p. 27).

This year's EU Market Outlook's PV market scenarios 2022 to 2025 show continuous, two-digit annual growth rates that are all slightly higher than in our previous edition (see Fig. 8). The Medium Scenario now forecasts 18-20% growth rates compared to 16-17% levels last year, adding around 162.7 GW to reach 327.6 GW by the end of 2025. This means the EU solar power generation fleet will double within four years from the 164.9 GW in operation today. It also means that the member states' solar targets with a combined capacity of 335 GW in their 2030 National Energy Climate Plans (NECPs) will be reached five years early in our most likely market scenario. The High Scenario sees the EU reaching a total solar capacity of 371.5 GW in 2025, but even our Low Scenario assumes additions of 105.2 GW to operate a 270 GW solar capacity by the end of 2025.

FIGURE 8 EU27 TOTAL SOLAR PV MARKET SCENARIOS 2022-2025

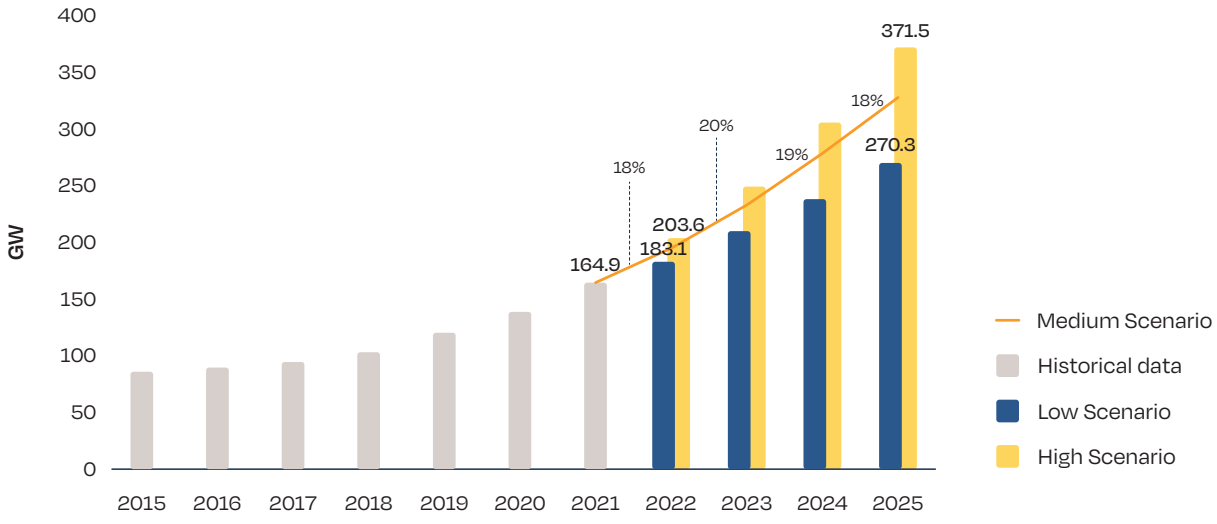
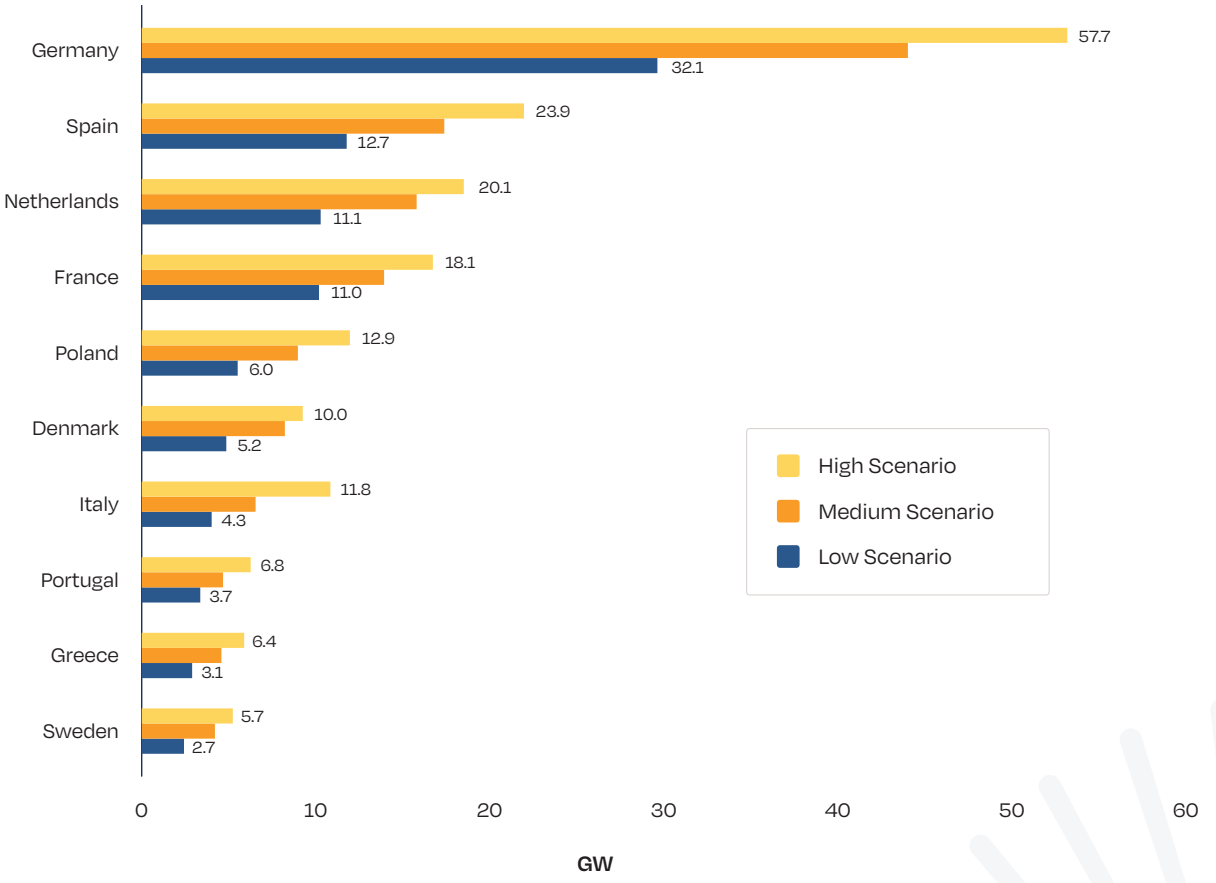


FIGURE 9 EU27 TOP 10 SOLAR PV MARKETS ADDITIONS 2022-2025



We are once again more upbeat on the solar developments in the Top 10 EU markets over the coming years (see Fig. 9). For most of these countries, the 4-year installation forecasts from 2022 to 2025 (listed in the order of the Medium Scenario assumptions) expect again more power additions than in last year's outlook.

For long-time market leader **Germany** the assumptions were raised significantly. With the ambitious solar plans of the new government, we now except the country to grid-connect 32 GW over the next four years even in the Low Scenario, which is as much as we had anticipated for the same period in last edition's High Scenario. The much more likely Medium Scenario forecasts the installation of 47.7 GW, which is nearly 80% higher than last edition's assumption and almost as much as we estimate for the three following solar markets together – Spain, the Netherlands and France. Driven by regular auctions, a gigantic PPA project development pipeline, and a quickly growing self-consumption rooftop segment, **Spain** is supposed to install 18.9 GW by 2025, about 2 GW higher than believed previously. Backed by its large rooftop market and solar's success in the regular technology neutral auctions, the **Netherlands** is also expected to add about 2 GW more than thought before, which would result in 17 GW of new installations in the next four years. **France** has more than doubled its annual solar installation and exceeded the 2 GW level for the first time in 2021, indicating the knot could be untied and a multiple gigawatt market the new normal, which would be needed to meet its solar targets. Our significantly increased forecast sees France grid-connecting 15.1 GW solar until 2025. We continue to

see a lot of solar growth opportunities for **Poland**, with a newly installed capacity of 9.7 GW over the next four years, again part of the Top 5 markets. But the forecast is somewhat difficult with an upcoming change from the lucrative net-metering system as the main market driver of Poland's solar boom to a net-billing system, and utility-scale systems from a new auction scheme considered as the new pillar of growth. The EU's new solar shooting star is **Denmark**. After auctions have opened the field for ground-mount solar in the Northern European country, proving its cost competitiveness when outcompeting wind in recent technology neutral tenders, a strong trend to PPA-based systems has become evident, with announcements for several 100+ MW solar power plants. Denmark is expected to install 8.9 GW by 2025. On the other hand, **Italy** is still caught in the waiting line to tap its huge solar potential and build on its first solar boom phase a decade ago. We see 7.1 GW of new solar connected to the Italian grid by 2025. The only newcomer to the listing of the Top 10 solar markets in the next four years is **Sweden**, where a tax incentive scheme has fuelled the residential sector, and PPA based systems are meeting increasing interest.

Our analysis sees the Top 10 EU solar markets install 138 GW from 2022 until 2025 in the most probable Medium Scenario, 91.9 GW in a Low Scenario and 173.0 GW in the High Scenario.

FIGURE 10 EU27 TOP SOLAR PV MARKETS PROSPECTS

Country	2021 Total capacity (GW)	By 2025 Total capacity medium scenario (GW)	2022-2025 New capacity (GW)	2022-2025 Compound annual growth rate (%)	Political support prospects
Germany	59.9	107.6	47.7	16%	☀
Spain	17.9	36.8	18.9	20%	☀
Netherlands	13.1	30.2	17.1	23%	☀
France	13.2	28.3	15.1	21%	☀
Poland	7.1	16.8	9.7	24%	☀
Denmark	2.8	11.7	8.9	43%	☀
Italy	22.0	29.1	7.1	7%	☁
Portugal	1.5	6.6	5.0	44%	☀
Greece	4.8	9.8	5.0	19%	☀
Sweden	1.8	6.3	4.6	37%	☀
Belgium	6.9	10.9	3.9	12%	☀
Hungary	3.0	6.4	3.4	21%	☀
Austria	2.5	5.4	2.9	21%	☀
Ireland	0.1	2.8	2.7	120%	☀
Bulgaria	1.3	3.7	2.4	30%	☀

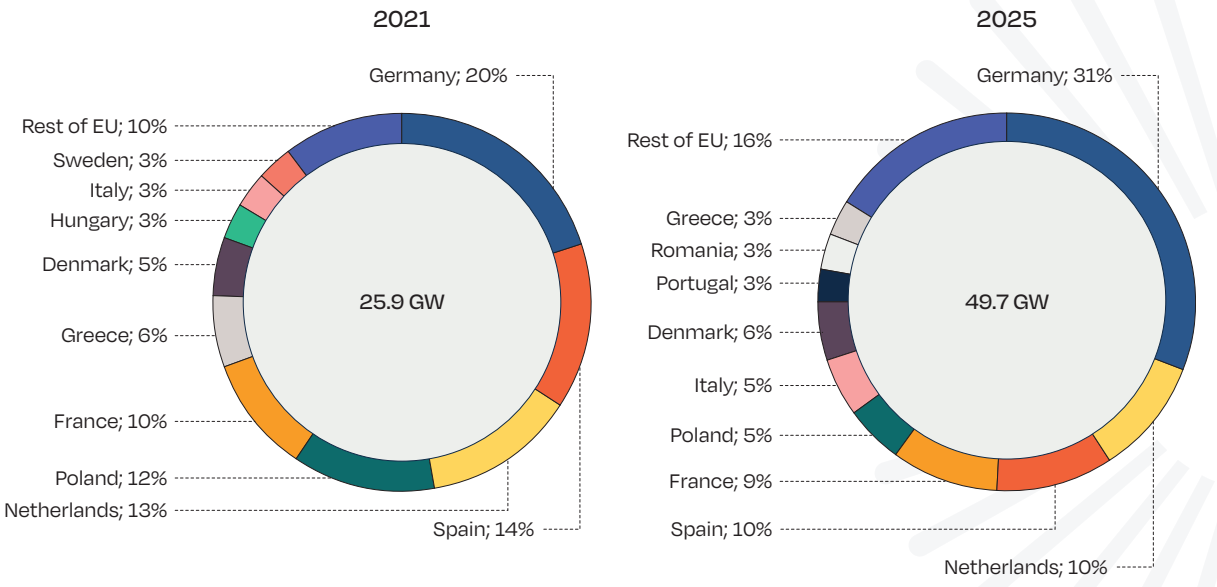
Already bright in the previous EMO edition, our updated 4-year weather forecast for the 15 largest EU solar markets has become even sunnier (see Fig. 11). Now, we see a very sunny business environment for solar power in all but one EU country in the coming years. Only for Italy, we continue to see clouds on the horizon. That might seem strange, as there is political support for solar in Rome. A tax incentive scheme funded from COVID-19 recovery funds has increased demand for residential solar and battery storage. But the large, sunny Southern European country has again remained a sub-GW volume market in 2021 despite its 51 GW by 2030 NECP goal. Solar has failed repeatedly in the technology neutral tenders, and permitting has also kept the PPA segment from taking off.

Beyond Italy, there are a number of issues that need to be addressed across the European Union to fully unleash solar's potential, as explained in the chapters on policy recommendations (see p. 6) and our updated NECP assessment (see p. 27). However, in general the outlook for solar is only getting brighter.

We anticipate the largest 15 EU solar markets to grid-connect 152.4 GW of new PV capacity in the coming 4 years based on our most probable Medium Scenario, compared to 109.6 GW in the 2020 published EMO 4-year forecast.

In 2025, the EU solar market is expected to almost double compared to today – 49.7 GW vs. 25.9 GW. **Germany** will still deploy more solar than any other member state but its share will be much larger than in 2021 – 31% vs. 20%. The growth assumptions for Germany have changed significantly due to its new 200 GW solar target in 2030. In the previous edition, we had assumed that Germany's share would be 20% in 2024. Germany will be followed by the **Netherlands**, **Spain**, **France** and **Poland**, the same group presenting the Top 5 in 2021 but in a different order. Although the Top 3 will have an even larger combined market share in 2025 than today – 51% vs. 47%, this only due to Germany's big solar ambition. For the Top 5 or Top 10, the annual shares are decreasing over time, indicating a further diversification of solar demand to more EU member states.

FIGURE 11 EU27 SHARES OF TOP 10 SOLAR MARKETS IN 2021 AND 2025



In the past few months, we have surveyed the European Union's solar PV manufacturing landscape. We not only aimed at finding out the latest production capacities in the main segments along the value chain in the EU27 member states plus Norway[4], we also wanted to get a comprehensive picture of the status and plans in solar manufacturing. Europe has a vibrant and growing R&D and solar manufacturing scene – with active and new companies looking at opportunities to invest in the quickly growing solar sector as the key to the EU's carbon neutrality goals. The companies active in silicon, ingot/wafer, cell, module and inverter manufacturing and offering commercial products in 2021 are displayed on our solar map (see Fig. 12).

As our recently published *EU Solar Jobs Report 2021* shows, **inverter** production offers the highest job intensity in the solar manufacturing segment. Today, inverter manufacturers are also the backbone of solar manufacturing in the EU with at least 9 stakeholders employing nearly half of all manufacturing jobs and a total production capacity of 60 GW. Several of these companies are also international leaders, among them SMA from Germany and Fronius from Austria.

When looking into the European Union's solar module value chain, the largest manufacturer is active upstream, in the **polysilicon** segment. Wacker Chemie is the EU's only company to operate polysilicon production facilities with a capacity of around 60 metric tons in Germany, which translates into over 20 GW of cell/module products.

Silicon ingots & wafer manufacturing, the next step in the solar value chain after polysilicon production, is barely existing in the European Union. Only one small integrated module producer in France has few ingot/wafer capacities, while most of Europe's 1.7 GW wafer capacity is located in Norway, where low cost hydro enables production at competitive cost and low carbon footprint. The EU is home to a promising next-generation wafering start-up, NexWafe, which has been developing a process that produces much less waste than the traditional ingot/wafering process. NexWafe is planning to start construction of a pilot line in Germany in 2022 and targets 3 GW by 2025.

The EU's **solar cell** production capacity stands at only around 0.8 GW today, but several companies are planning to expand or enter that segment. In Germany, Meyer Burger has opened a 400 MW factory for high-efficiency heterojunction solar cells in 2021, following on Enel's 200 MW line in Italy, which was opened in 2020. Both companies have already announced expansion plans, Meyer Burger to 7 GW by 2027 and Enel Green Power to 3 GW. Enel is the only company so far that has won a grant for a solar manufacturing project from the EU Innovation Fund's first round in November 2021. A 100 MW cell factory with next generation technology, based on silicon-perovskite tandem cells, is currently being built by Oxford PV in Germany (but it is not listed on the map as other projects that are in the planning stages).

4 Though not a EU member, we also included Norway in the map due to its importance in Ingots & Wafers segments. Beyond the EU-27, there are a number of other existing and planned solar manufacturing projects in Europe.

Most solar cell manufacturers, including the companies listed above, produce for internal use as they also assemble solar modules. In contrast, most of the EU's module manufacturers don't make their cells, but currently import them from Asia. As pure solar module manufacturing requires the lowest investment cost among the different stages of the solar module chain, this solar manufacturing segment has been seeing the largest activity, though mostly from small and local companies, each with capacities in the sub-GW range. In 2021, at least 49 module manufacturers have operated factories in the European Union.

Next to silicon-to-module and inverter manufacturing, the European Union is also home to world leading players in other parts of the solar value chain, such as the **Balance-of-System (BOS)** field, including fixed mounting structures and solar trackers as well as processing materials and production equipment for cell/module production. One German PV module manufacturer, Solarwatt is even producing stationary solar battery energy storage systems.

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 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.

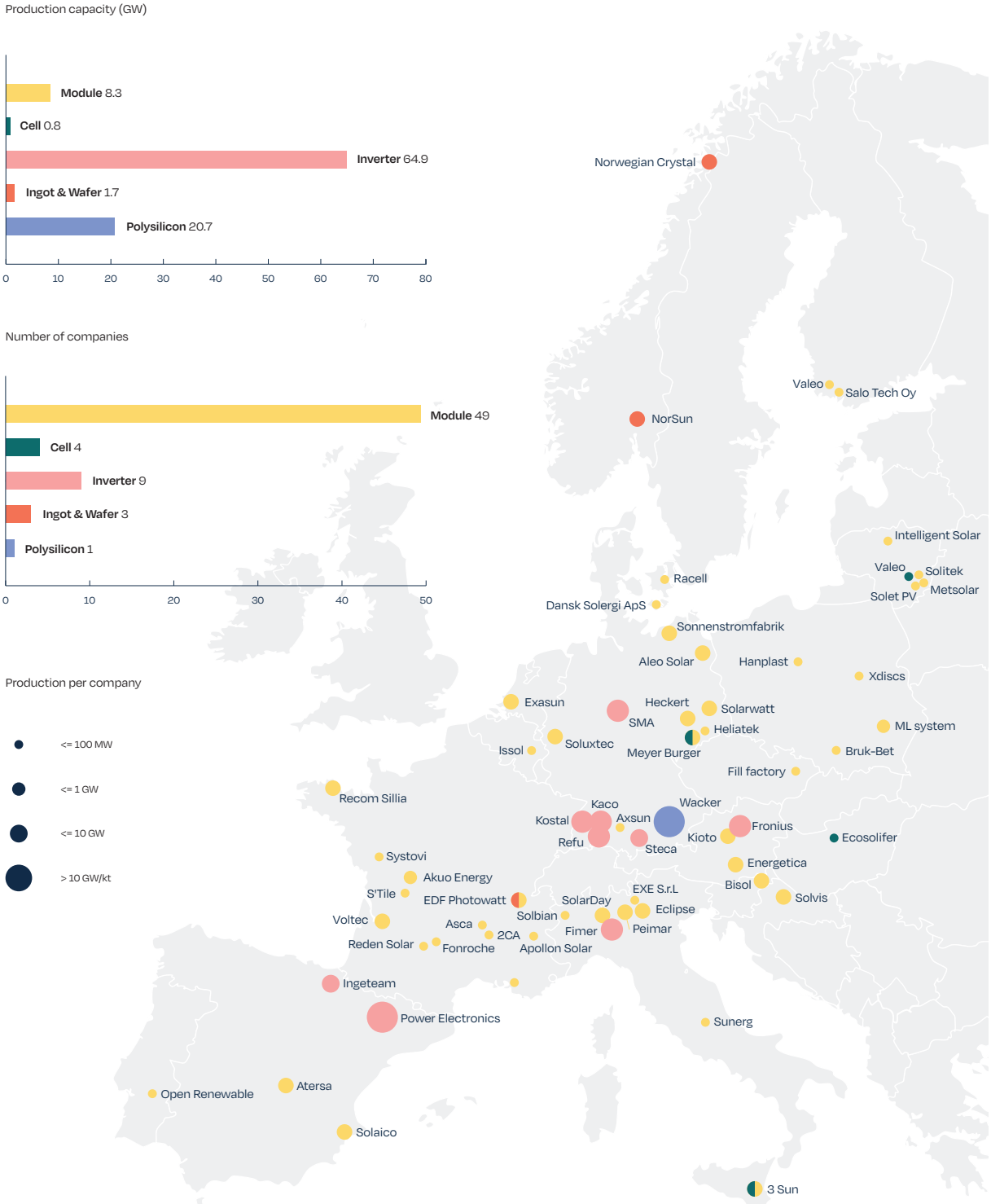
However, as today the majority of solar products in the EU are imported, the manufacturing sector is very small compared to China. As the European solar market has recently entered a new growth phase, and increasing faster than most analysts had been forecasting, there is a new window of opportunity for a domestic solar manufacturing sector.

To support the many industrial consortia that have put forward new industrial projects and are looking for financing to establish or expand production in Europe, SolarPower Europe, in partnership with EIT InnoEnergy and with the support of the partners of the **Solar Manufacturing Accelerator**, has launched the **European Solar Initiative** (ESI; www.europeansolarinitiative.eu). The initiative combines an industrial platform that gathers and structures the industry, and an investment platform that aims to de-risk and accelerate new manufacturing projects. The aim is to re-establish 20 GW PV silicon-to-module manufacturing capacity in Europe by 2025, enabling local PV manufacturers to capture a significant portion of the EU market, which is expected to deploy around 50 GW by that year.

The overall ESI ambition is to improve European energy security by investing in jobs for a technology that already adds more power generation capacities than any other and will shoulder the major responsibility of keeping European lights on in the long term.

This PV Manufacturing Map in an ongoing project. If you believe that your company should be featured, please contact us at info@solarpowereurope.org.

FIGURE 12 EU27 AND NORWAY SOLAR MANUFACTURING MAP



3 NECP and EU 2030 market outlook

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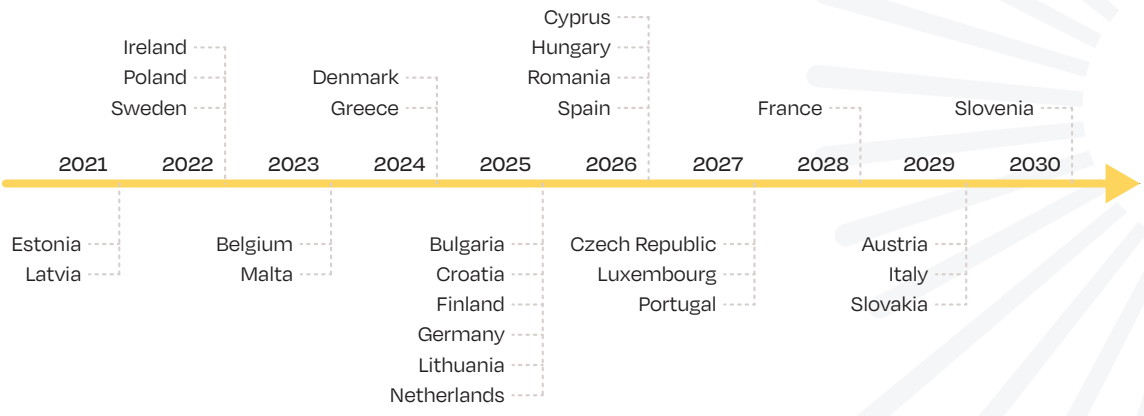
In last year's report, we carried out an assessment of EU member states' National Energy and Climate Plans (NECPs), analysing the measures that are key for solar deployment, such as the level of ambition of solar targets, the policy framework for prosumers, actions to ease administrative procedures, and so on. For each member state, we included information on their national solar target's level of ambition and outlined key challenges to solar deployment.

For this year's edition, we have carried out an updated review of member states' performance towards the achievement of their solar targets, based on the latest market information available and our most-likely scenario projections. Our market analysis has shown an improved outlook for solar across Europe, with many countries having more installed capacity than previously anticipated. According to our market development projections, all EU member states are on track to reach their national solar targets by 2030 or earlier (Figure 13). On one hand, this reflects solar's exceptional performance when it comes to cost competitiveness and technological versatility, while on the other hand, it clearly demonstrates that the level of ambition of national solar targets needs to be raised significantly. For example, Estonia and Latvia have reached their 2030 goals already today, while Poland, Ireland and Sweden will do so through 2022.

FIGURE 13 TIMELINE OF EXPECTED NECP SOLAR TARGET ACHIEVEMENT



As a matter of fact, our Medium Scenario projections indicate that 15 of the member states will have already reached their 2030 goals no later than 2025, while the remainder will do so no later than 2030 (see Figure 14). In other words, solar deployment under business-as-usual conditions will be sufficient to overachieve targets in all countries. Therefore, in order to give an additional boost to national markets, NECP solar targets need to be raised, at minimum, above our 2030 Medium Scenario projections.

FIGURE 14 EU27 SOLAR PV CUMULATIVE CAPACITY IN 2025 AND 2030 COMPARED TO NECP TARGET

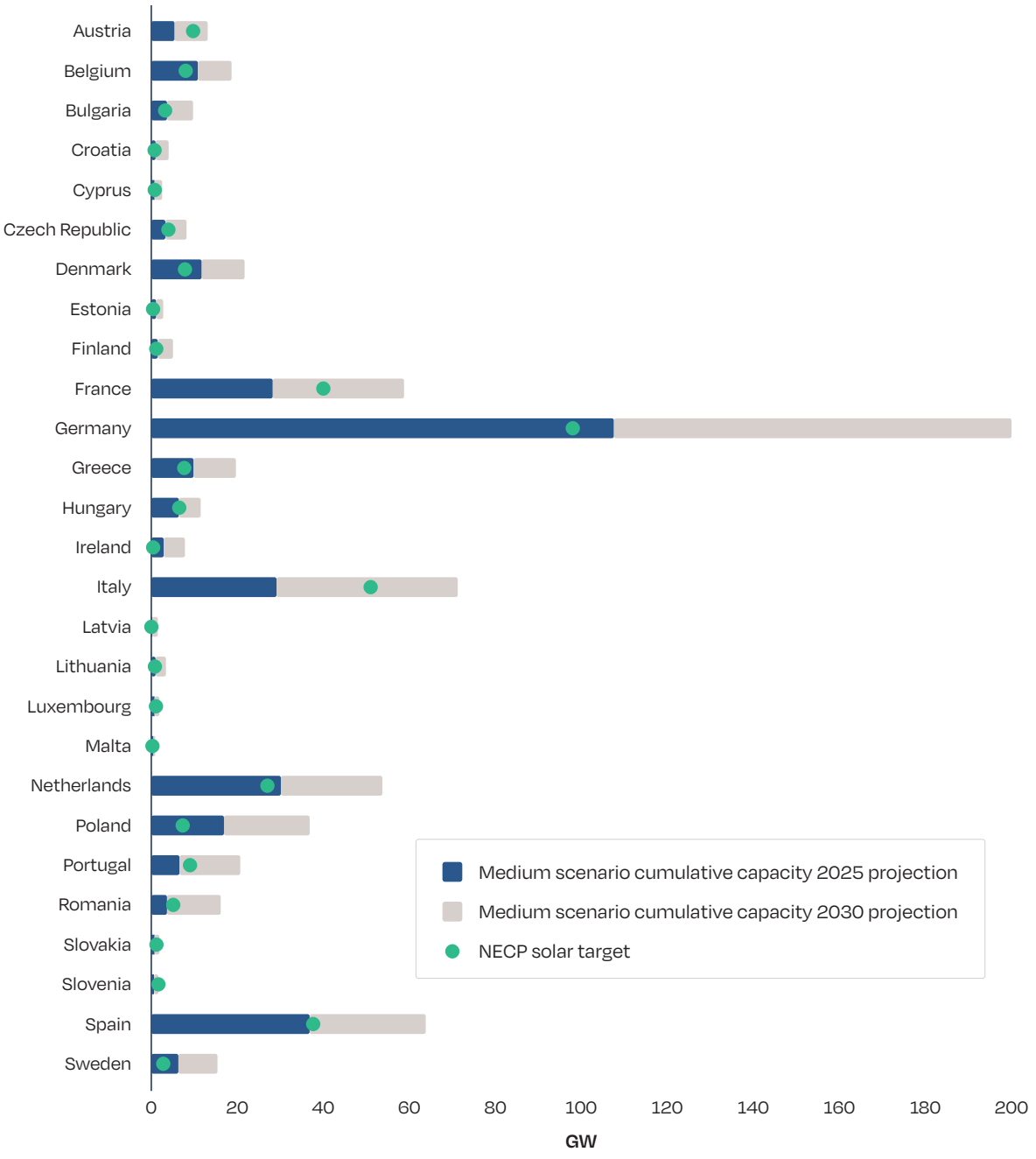
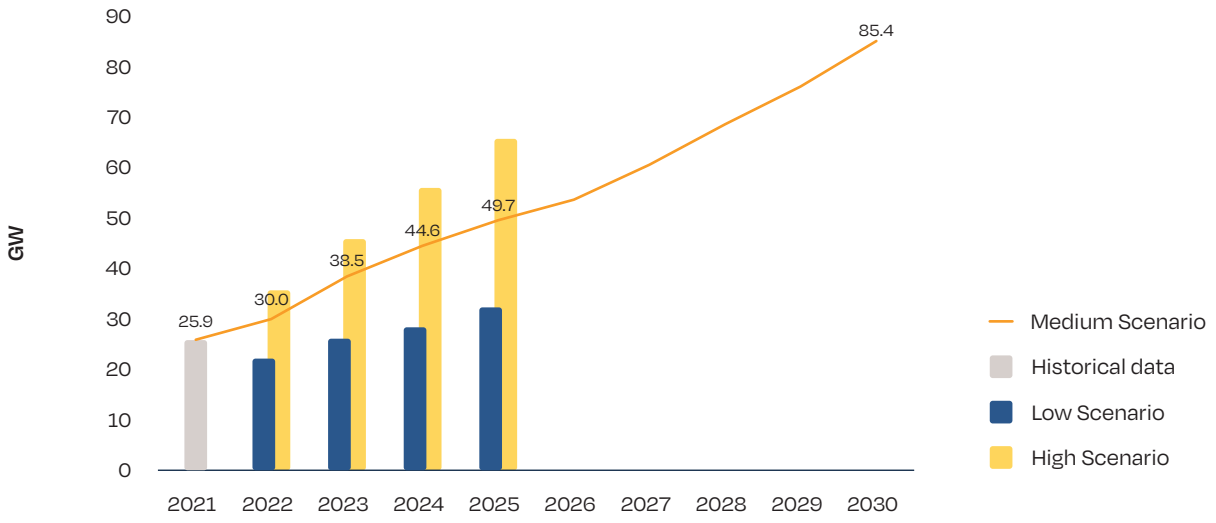


FIGURE 15 EU27 ANNUAL SOLAR PV MARKET SCENARIOS 2021-2030



Against this background, the revision of the NECPs planned for 2023 will be fundamental to adjust solar ambition so 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 92% from the nearly 26 GW installed in 2021 to about 50 GW in 2025. We anticipate further strong growth in the second half of the decade due to improved policy conditions and further technology cost reductions. In our Medium Scenario projections, we foresee an 85 GW annual solar market in 2030, increasing 72% from 2025 levels and 230% compared to 2021 (Figure 15).

3 NECP and EU 2030 market outlook

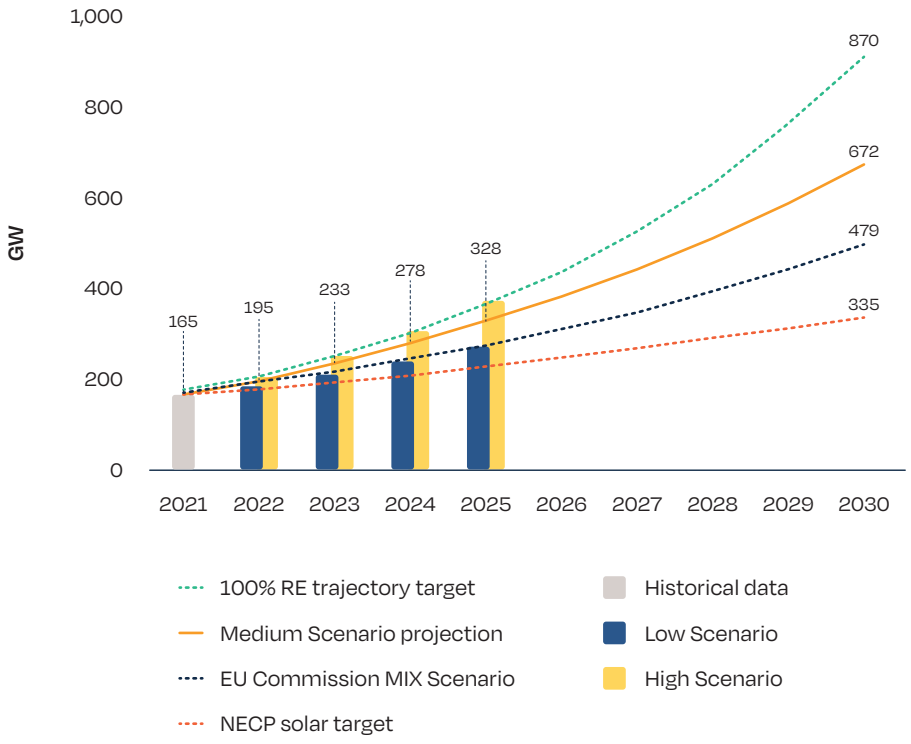
/ continued

Such an expansion in the annual market will be reflected in cumulative installed capacities. According to our modelling, the total solar fleet in the EU will increase from 165 GW installed today to 328 GW in 2025, and 672 GW in 2030 (see Figure 16). The urgent need to revise member states' NECP solar target can be observed in the graph below, where the aggregate PV capacity goal from NECPs, at 335 GW, only represents half of the capacity installed under the Medium Scenario projections. This analysis also highlights the importance to revise the EU Commission's European Green Deal policy scenarios, which, at present, fail to recognise solar's potential. With only 479 GW of solar modelled under the EU Commission MIX Scenario, this total installed capacity falls significantly short (29%, or 193 GW) of our Medium Scenario projections.

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. According to SolarPower Europe and LUT modelling, the cost-optimised trajectory towards climate neutrality in 2050 corresponds to a 45% RES target by 2030. To reach this milestone, it will be necessary to install 870 GW of solar by then, which is 29% or 198 GW higher than our model's most-likely scenario projections.

In the following section, we have updated our analysis of each member state's performance towards the achievement of its solar target as defined in the NECP. In a few cases, when national governments have set out a higher solar target than what indicated in the NECP, we have included this information in the charts. This helps shed some light on expected market developments for those member states who already raised their solar ambition. However, as the formal revision of the NECPs will only take place in 2023, we have kept the current targets for all member states.

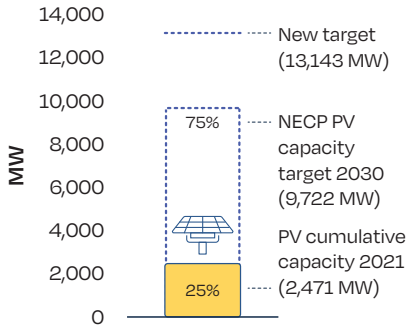
FIGURE 16 EU27 TOTAL SOLAR PV MARKET SCENARIOS 2021 – 2030 AND 100% RE TRAJECTORY TARGET



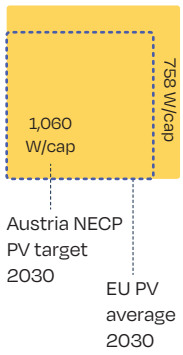
NOTE: Values for EU Commission MIX Scenario are based on a 1.25 DC/AC conversion ratio assumption, as suggested in Jaeger-Waldau et al. (2021): The Role of Photovoltaics in the Response of the European Member States to the European Green Deal.

NECP AUSTRIA

Solar PV target 2030 achievement rate



Solar PV capacity 2030 Watt /capita

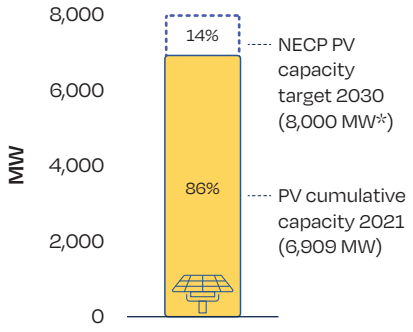


Key market and NECP challenges:

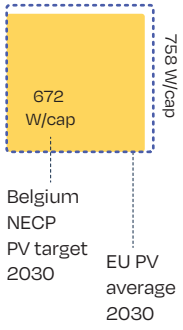
- **Grid congestion.** Grids are currently seen as a bottlenck for all scales of PV size. At distribution level, the grid needs to be expanded, but there is no clear plan at the moment. At present, in some areas, PV systems over 30 kvA have to overcome power supply lines with additional costly cables to get grid connection.
- **Workers availability.** The Austrian solar PV industry is currently facing a boom in demand, which the current workforce cannot fully meet. The local industry has flagged the urgent need of new skilled workforce, especially at installation level, to accommodate future growth.
- **Administrative procedures.** In spite of the very ambitious and comprehensive Austrian solar rooftop programme, the Austrian NECP lacks a proper evaluation of the administrative challenges and ambition in remedy measures, in particular for larger-scale PV.

NECP BELGIUM

Solar PV target 2030 achievement rate



Solar PV capacity 2030 Watt /capita



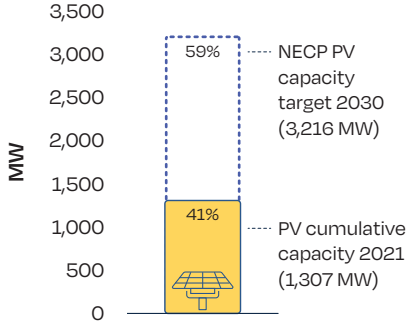
*: Average between low and high targets.

Key market and NECP challenges:

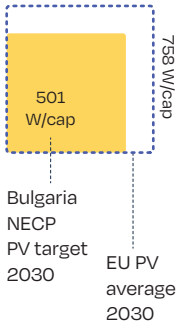
- **PV target.** The solar target should be more ambitious in a country with high potential like Belgium. The study "Towards 100% renewable energy in 2050" shows that the potential in Belgium on well-oriented rooftops and ground-mounted PV on maximum 10% of the territory is 170 GW, compared to the 8 GW target in the Belgian NECP.
- **Administrative procedures.** The fragmentation of the Belgian plan is most apparent with regard to solar auctions, where no overall auction plan at federal level targets solar. While Wallonia includes information on auction design, but no details on volumes and schedules, no information is available for the Flemish counterpart.
- **Grid integration and flexibility.** The plan does not assess the importance of modernising the distribution grid, despite the high share of prosumers. In addition, the plan has mixed quality in the flexibility frameworks, with the two regions at times focusing on different aspects and the federal level adding an additional layer of complexity. Lastly, the transition from net-metering schemes to prosumer schemes valuing demand-side flexibility, already advanced in Flanders, should be closely monitored.

NECP BULGARIA

Solar PV target 2030 achievement rate



Solar PV capacity 2030 Watt /capita



Key market and NECP challenges:

- **PV target.** Bulgaria's solar target remains low as PV will only account for 2.6% of electricity in 2040. Yet Bulgaria benefits from high irradiation rates, notably in the south of the country, and has an important solar potential, which is not reflected in the current target.
- **Administrative procedures.** The plan mentions measures to simplify administrative procedures, but these measures are significantly lacking ambition.

3 NECP and EU 2030 market outlook

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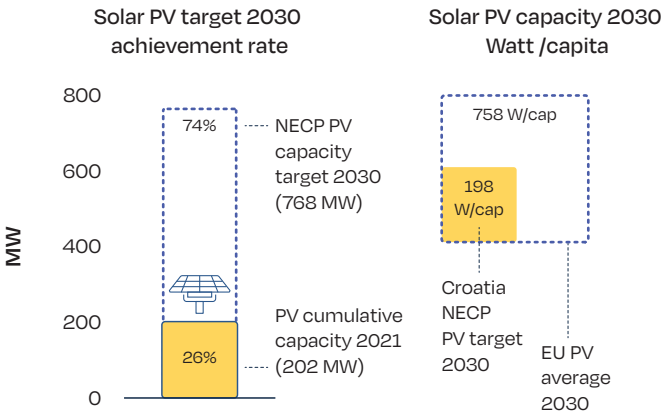
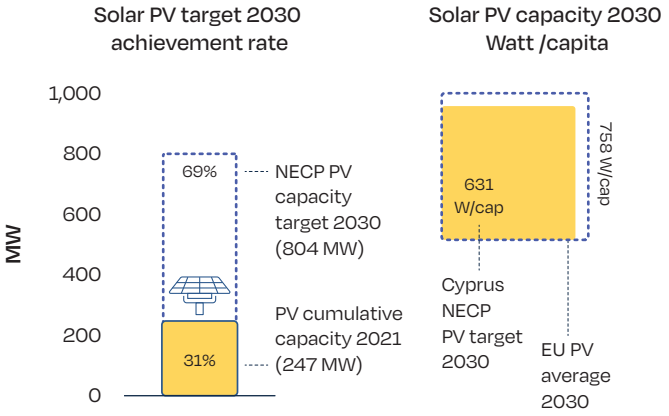
NECP CROATIA



Key market and NECP challenges:

- **PV target.** Croatia has shown an important willingness to support solar development. Yet, although the plan includes extensive information, including year-by-year installed capacity, the PV capacity target is at the conservative end of the spectrum, with only 600 MW of new additions over 10 years.
- **Auctions.** The NECP mentions the existence of an auction plan over the next three-years. The publication and the implementation of such a plan will be critical to drive the growth of solar in Croatia.
- **Prosumers.** Croatia has set itself a target of development a 300 MW capacity of prosumers by 2030, driven by a tax exemption of self-consumed electricity and direct marketing, accompanied with an ambitious programme for PV in buildings. A further regulatory review should set a framework for active customers and renewable energy communities.

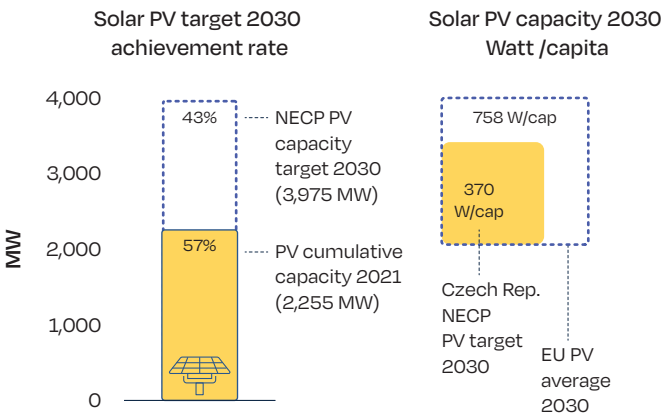
NECP CYPRUS



Key market and NECP challenges:

- **Grid and land contraints.** An island in the middle of the Mediterranean, Cyprus still does not have an interconnection with mainland. Having no storage capacity or smartness to avoid high curtailment levels, the power grid is not in a good condition to well integrate solar projects.
- **Regulated market.** The country is undergoing a process of liberalisation of the energy market, moving from a fully vertically integrated system to the possibility for private players to participate in market dynamics. A fully functioning liberalised market is expected by the end of 2022.
- **Poor financial landscape.** An important obstacle to the development of large-scale PV projects is the poor support from banking sector to PV project financing, which poses a challenge to accessing financial support and worsens investment conditions.

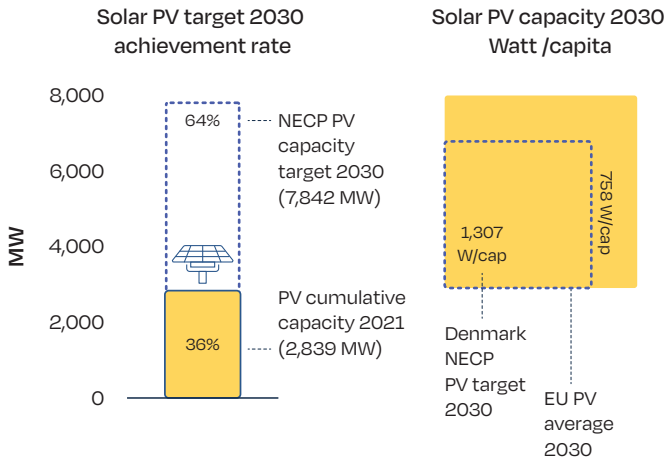
NECP CZECH REPUBLIC



Key market and NECP challenges:

- **PV target.** The NECP outlines in detail, on a year-by-year basis, projected solar developments in the Czech Republic, giving a good visibility to investors. However, considering the country's solar potential, the PV target appears underwhelming. Against this background, the goverment acknowledges that the target will be surpassed by a large extent.
- **Public acceptance for large-scale solar.** In the country there is a perceived general lack of support for large-scale solar, due to the fact that the past feed-in tariff regime granted very generous subsidies to large-scale PV projects. Since new utility-scale projects have not been built in the last 10 years, new projects might face public acceptance concerns.
- **Workers availability.** The sudden increase of demand for solar in the Czech Republic has led to a shortage of skilled workers, especially at installation level. This could become a major bottleneck and limit in particular the deployment of smaller rooftop installations.

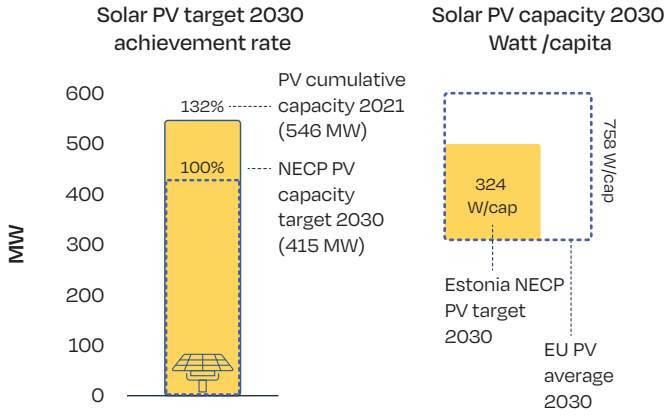
NECP DENMARK



Key market and NECP challenges:

- **Uncertain new tariff regime.** Details on the new tariffs that solar projects will have to pay to secure grid connection have not been unveiled. However, it is expected that this new regime, which should be introduced by January 2023, will challenge the business case for projects located in production dominated areas.
- **Prosumers.** Denmark has made important efforts to have a better understanding of the opportunities and barriers of prosumers. However, the incentives for prosumers are relatively low and self-consumption is lagging behind in Denmark. In addition, the plan does not detail how the Clean Energy Package provisions on collective self-consumption will be implemented.
- **Grid development.** Denmark has developed a vision for the future of its grid, also addressing an expected growth of renewable energies. However, some measures - including the new tariff scheme - may not support this development although the country will see several GW of solar projects that will need grid connection within the next five years.

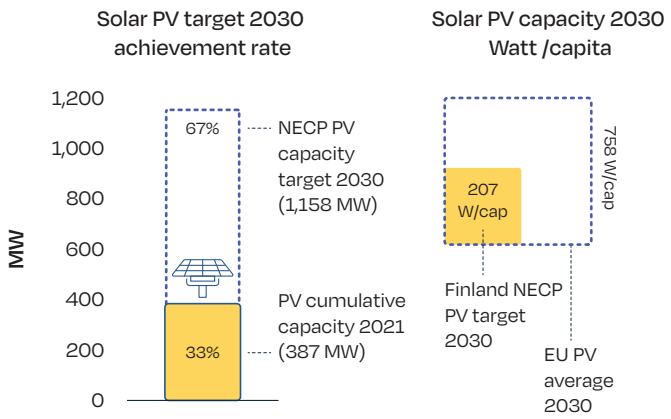
NECP ESTONIA



Key market and NECP challenges:

- **PV target.** Despite ambitious RES targets and detailed trajectories for solar capacity and generation, the solar ambition remains very low, as the country has already reached the 2030 PV capacity target set out in the plan. The solar target should be increased further.
- **Administrative procedures.** Estonia has created a manual of proceedings for project developers and has taken steps to identify, with local authorities, suitable areas for the development of solar projects, which is a significant best practice. As part of the implementation of the RED II, measures to further simplify administrative procedures and introducing a one-contact-point system should further facilitate the deployment of new solar projects.
- **Prosumers.** The development of solar prosumers is a clear objective of the Estonian energy policy and the plan includes an estimated potential for new and renovated buildings. The country already proposes financing support for prosumers, but the development of support frameworks for individual and collective self-consumers will be critical to develop the market.

NECP FINLAND



Key market and NECP challenges:

- **PV target.** The Finnish solar target results into just about 900 MW of solar installed over ten years, much below its potential. The ambition should be raised, including through the setting of solar auctions.
- **Administrative procedures.** The plan does not contain information on current or future measures taken to simplify administrative procedures. The implementation of the RED II in that regard, in particular for prosumers, will be important for facilitating the development of new projects.
- **Prosumers.** The Finnish government has commissioned a study on self-consumption and its barriers. On that basis and as part of the implementation of the RED II, the government should introduce or improve the support framework for solar PV prosumers.

3 NECP and EU 2030 market outlook

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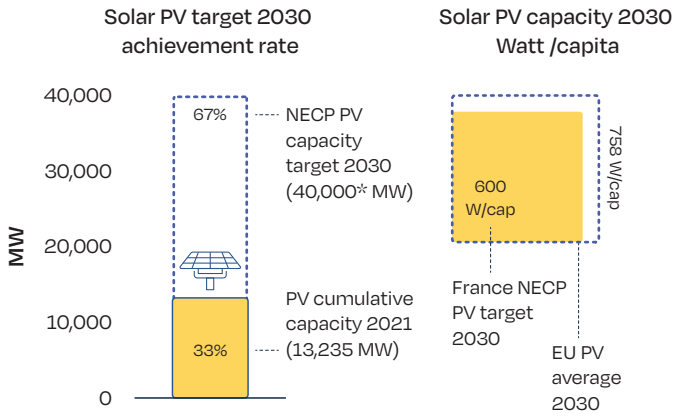
NECP FRANCE

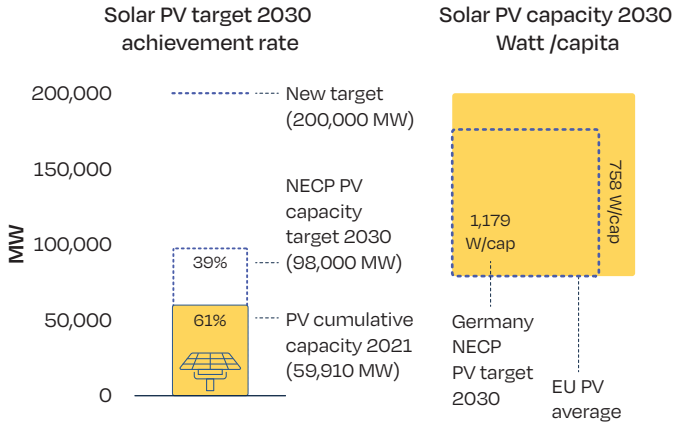


*: Average between low and high targets for 2028, rounded up to 40 GW.

Key market and NECP challenges:

- **Administrative procedures.** Solar project developers in France are facing tight regulation, challenging grid connection processes and long administrative procedures, which need to be clarified and simplified. Administrative deadlines should also be shortened.
- **Access to land.** Several bureaucratic hurdles are due to the difficulty in accessing land for ground-mounted PV projects, in particular agricultural land. A plan needs to be developed with regard to the use of land for solar projects taking into account the real impact on soils and biodiversity. At the same time, innovative PV solutions with low issues in land availability - such as agri-PV and floating solar, applications in which France is a pioneer - should be further encouraged.
- **Prosumers.** Self-consumption in France remains a small market compared to the country's potential. Support mechanisms for self-consumption projects need to be adapted so as to enhance the value of all electricity produced, self-consumed, and injected into the grid.

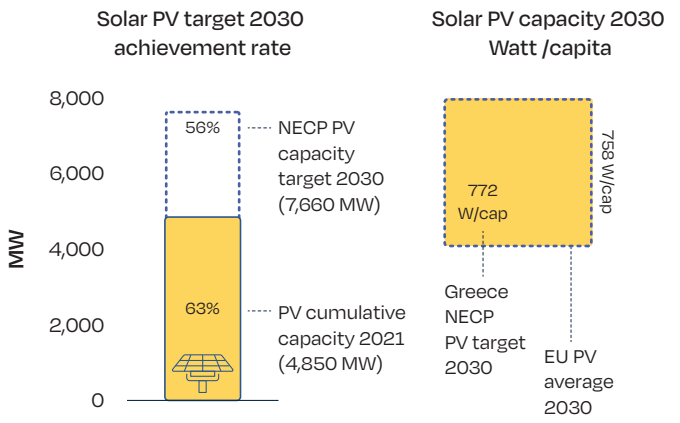
NECP GERMANY



Key market and NECP challenges:

- **Auctions.** Since the last change in the auction scheme, introduced in March 2021, mid-sized PV rooftop systems between 300-750 kW can choose between a low-remuneration feed-in tariff or contracts for difference through tenders. This has resulted in a sharp decrease of installed capacity in this segment, which has been a major contributor to solar in Germany. In its coalition agreement, the new government announced that this issue will be looked into.
- **Prosumers.** The current support scheme for self-consumption needs to be revised in order to meet the new 200 GW target by 2030. Prosumer feed-in rates are automatically adjusted depending on reaching certain installation thresholds. This system needs to be updated in light of the new solar ambition, in order to make the feed-in rates economically attractive for self-consumers.
- **Flexibility and storage.** Solar and storage prosumers face significant red tape and have to acquire a costly metering system when becoming active consumers and providing flexibility services.

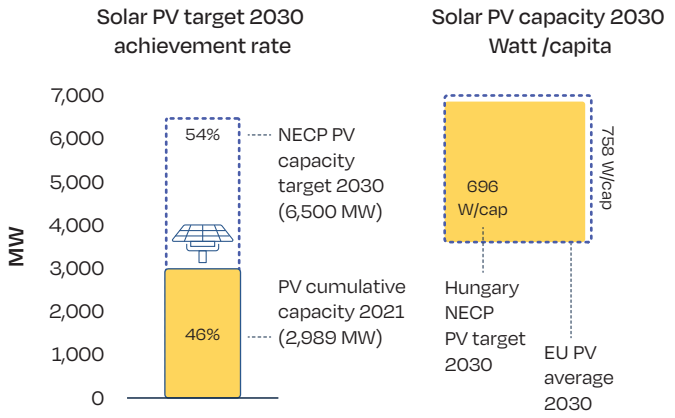
NECP GREECE



Key market and NECP challenges:

- **PV target.** With the current and expected market developments, it is projected that the NECP target of 7.7 GW of solar will be reached already in 2024. The government is going to revise its national target to better reflect increased EU climate goals. An ambitious solar PV target will be key to support the country's market expansion.
- **Grid development.** At present, grid congestion at medium and high voltage levels are inducing solar developers to connect at ultra-high voltage level, which is an expensive option compared to the alternatives. Grid expansion and reinforcement will be instrumental to allow further solar deployment.
- **Prosumers.** While large-scale solar is expandind rapidly across the country, the residential market is developing very slowly and struggles to gain pace. Policy action should be taken to support the expansion of small-scale solar.

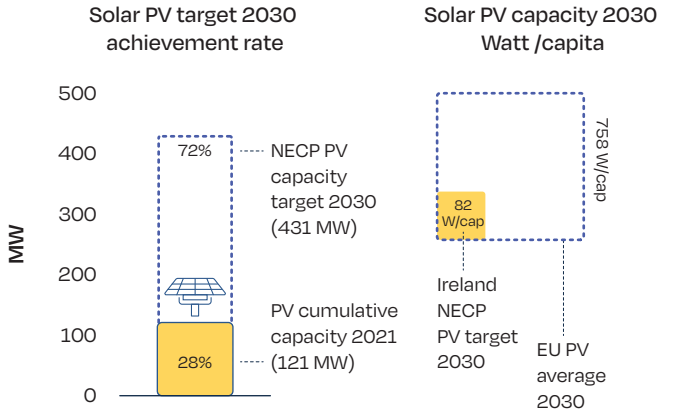
NECP HUNGARY



Key market and NECP challenges:

- **Prosumers.** The plan proposes a specific target for the development of prosumers as well as a comprehensive set of enabling measures. However, it does not provide a lot of details on the precise support schemes for prosumers, and in particular for residential prosumers for whom the net-metering scheme will have to be phased out in 2024.
- **Administrative procedures.** The plan should develop the amount of information existing on administrative measures, and in particular identify the one-contact-point system foreseen in the RED II.
- **Grid development.** While utility-scale PV developers face increasing difficulties to find grid connection agreements, the plan does not contain any measure related to grid investment, in particular distribution grid, and grid modernisation through the deployment of smart grid technologies.

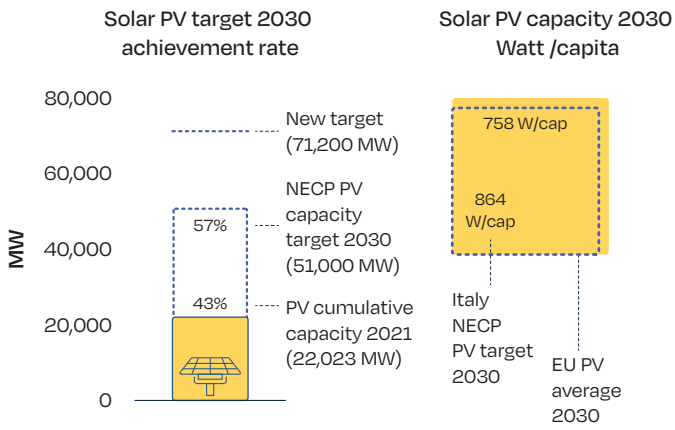
NECP IRELAND



Key market and NECP challenges:

- **PV target.** Counterintuitively, Ireland's additional measures scenario assumes a much lower PV deployment than the existing measures scenario, with a 431 MW target in 2030. With only 380 MW added through 2030, the country's expected solar capacity per capita is among the lowest in the EU.
- **Administrative procedures.** The plan mentions that measures are being established but does not discuss these measures in detail. Further measures should be put in place to ease the administrative burden, which can create heavy barriers to investments in renewable projects. Furthermore, the need for standardised local administrative requirements and fees, which currently differ widely depending on local authorities, should be addressed.

NECP ITALY



Key market and NECP challenges:

- **Permitting procedures.** Stringent permitting restriction pose a major challenge to the country's solar ambitions, generating up to six years of delay to project development. The government tried to address the permitting issue through a simplification decree, whose first results will be seen in about two years.
- **Access to land.** Under the current auction scheme, solar PV projects do not have permission to be built on agricultural land. As a result, auctions have been largely undersubscribed so far. Cooperation with regions will be essential to identify suitable land for solar PV projects.
- **Grid development.** The Italian plan contains detailed information on the upcoming challenges, including a quantification of the required investments, but does not give a clear vision on measures that will be taken. Monitoring the implementation of the proposed regulatory changes will be critical.

3 NECP and EU 2030 market outlook

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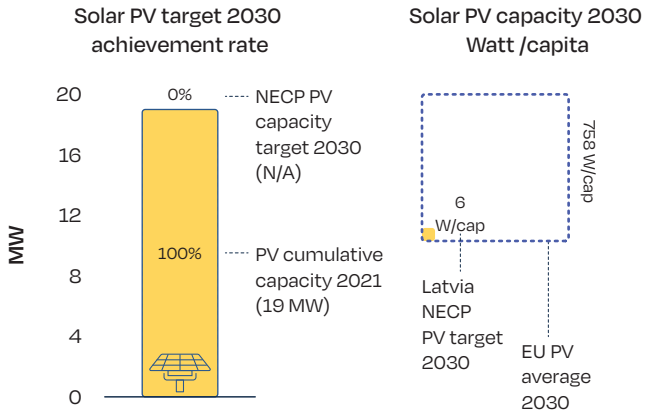
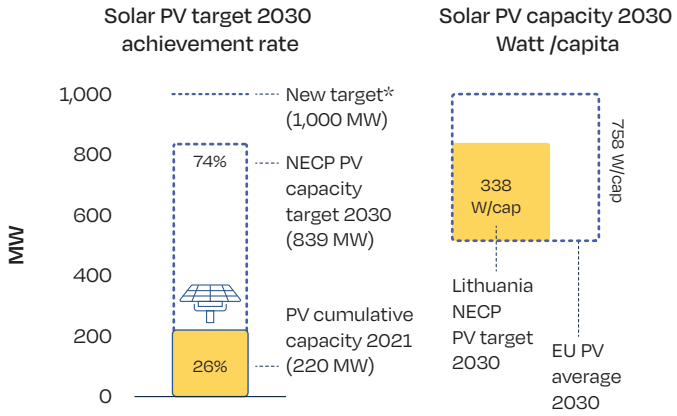
NECP LATVIA



Key market and NECP challenges:

- **PV target.** The Latvian NECP has set an ambitious target for the development of renewables. Yet, there is no plan nor target or auctions for the installation of solar. This does not give investors enough visibility for their investments.
- **Prosumers.** A specific plan should be set to encourage prosumers, based on support schemes, tax exemptions, and the development of collective self-consumption.
- **Administrative procedures.** The plan does not assess possible difficulties that could be encountered by PV project developers, nor does it propose remedy measures or measures to implement the Clean Energy Package.

NECP LITHUANIA

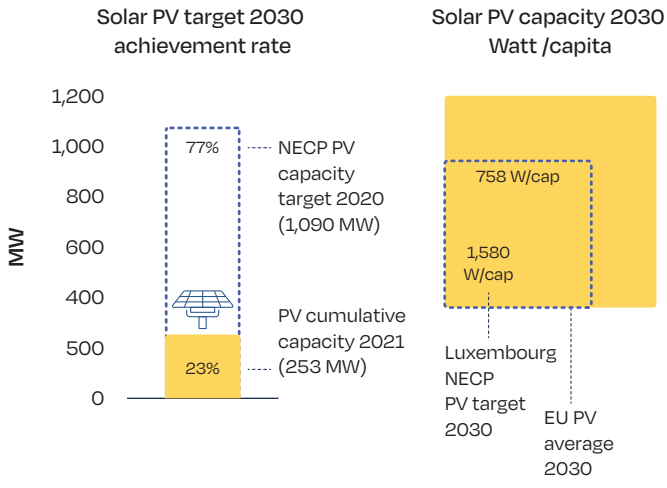


*to be reached by 2025.

Key market and NECP challenges:

- **PV target.** In 2021, the country adopted a new solar PV target of 1 GW installed by 2025. This positive development should lead to a significant upward revision of the NECP target, giving clear visibility on the solar ambition towards 2030.
- **Prosumers.** Lithuania has developed a complete vision for the development of solar prosumer, with clear objectives and a comprehensive set of measures to support their development. It is crucial, however, that this plan is followed up and implemented smoothly to foster distributed PV deployment.
- **PPAs.** While the plan includes extensive information on different measures supporting PV deployment, a framework for Power Purchase Agreements still needs to be developed.

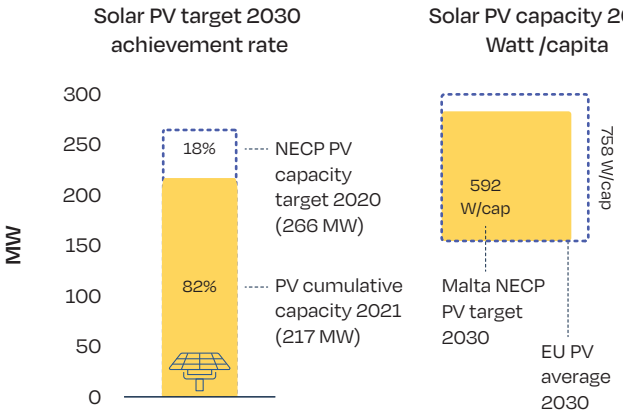
NECP LUXEMBOURG



Key market and NECP challenges:

- **Auctions.** The NECP indicates that the new multiannual plan for tenders will be published, with tendered volumes subsequently increased each year. However, details of the volume and designs are not included.
- **Prosumers.** The plan shows very good provisions for solar prosumers and is developing several interesting incentives. In particular, the proposed measures will tackle the different barriers to self-consumption, from public incentives, to awareness raising and financing. The self-consumption schemes need to now be fully implemented in the national law.
- **Administrative procedures.** The plan contains interesting measures to simplify the administrative procedures linked to the support schemes and the financing schemes for prosumers. This however needs to be completed by the set-up of a clear "one-contact-point", which should simplify the development of solar projects.

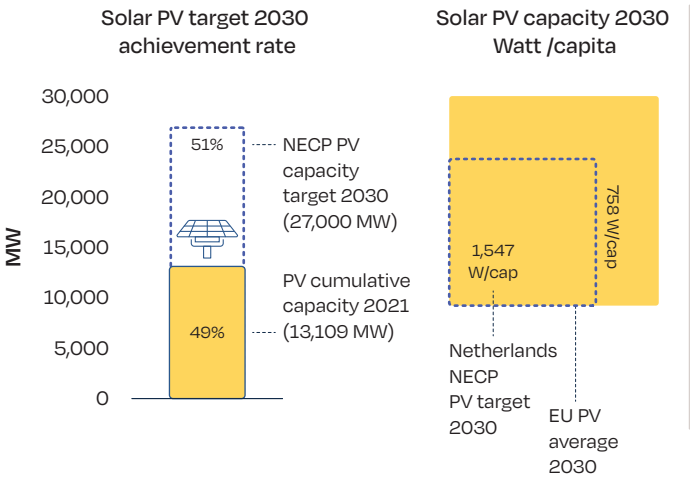
NECP MALTA



Key market and NECP challenges:

- **PV target.** The trajectory of solar capacity remains low due to several factors such as physical and spatial limitations, resource availability, cost of land and other issues. As a result, only 78 MW are planned to be installed over the next ten years. In addition, no information on auctions is available.
- **Prosumers.** The plan proposes measures to incentivise the development of self-consumption. Yet, it does not include a proposal to transpose the Clean Energy Package with regard to collective self-consumption. In addition, the NECP could give increased visibility to developing prosumer schemes by quantifying the potential or setting a target for the development of prosumers.
- **Administrative procedures.** While specific provisions to facilitate the administrative proceedings for self-consumption and distributed renewables are included, and it is mentioned that the country is preparing the implementation of the Clean Energy Package, the plan should contain more detailed measures or procedures set up to implement CEP provisions, and at least a better assessment of the situation.

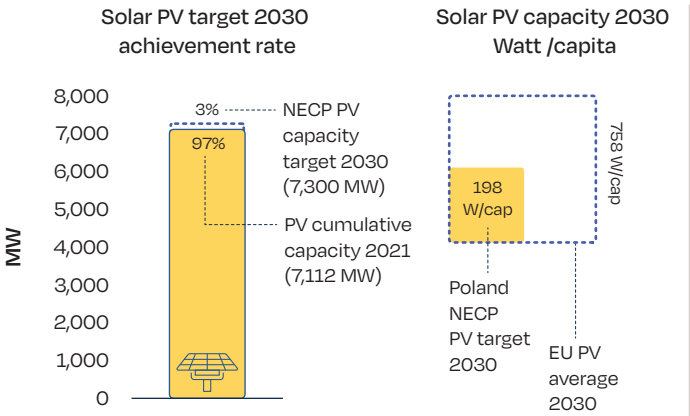
NECP THE NETHERLANDS



Key market and NECP challenges:

- **Grid availability.** Limited capacity of the Dutch power grid could pose a significant challenge to solar deployment in the country. Lack of grid capacity at the middle and high voltage level is expected to lead to long delays and possibly project non-realisation.
- **Land availability.** The large-scale sector is exposed to the challenge of securing suitable land for solar deployment. Land availability issues often come together with public acceptance concerns in relation to the use of agricultural land for solar projects. The industry is aiming to tackle these issues by ensuring a quota of local participation in renewable energy projects and by developing a biodiversity label for large-scale projects.

NECP POLAND



Key market and NECP challenges:

- **Grid availability.** One major challenge for the solar sector is the lack of grid connection points for new projects. This exacerbates the delay on project completion, which is already experiencing trouble derived from the current supply chain disruptions and price hikes.
- **PV target.** With the current 7.3 GW target in trajectory to be reached no later than 2022, it becomes apparent that the Polish government needs to significantly raise the target in the NECP revision planned in 2023.
- **PPAs.** Poland has an important potential for PPAs, with to date 4 projects of 141 MW concluded. Yet, the plan does not address the existing barriers to PPAs, such as the regulatory requirements for direct energy supply or the EU-ETS costs exemption for energy intensives using PPAs.

3 NECP and EU 2030 market outlook

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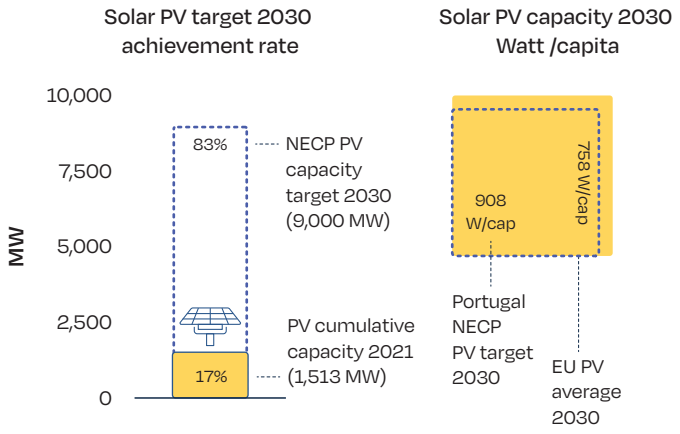
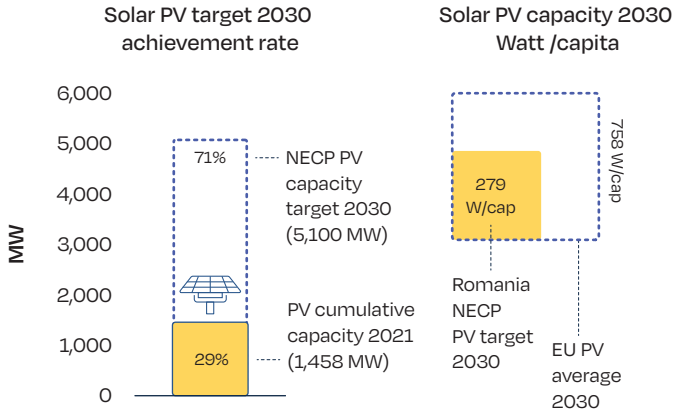
NECP PORTUGAL



Key market and NECP challenges:

- **Permitting procedures.** At large-scale level, permitting remains a challenge for solar developers. The procedure requires to carry out a very demanding environmental impact assessment study. Moreover, long delays in official entities responses, as well as asking additional elements before building permit creates more uncertainty. To address this, permitting guidelines drafted jointly by the government and the solar sector are under preparation. The self-consumption also faces delays on registration procedure, namely long delays in onsite inspections have obliged the administration to give provisional certificates for projects to go ahead with their grid connection procedures.
- **Prosumers.** While the large-scale segment will drive PV installations in the country, self-consumption remains a limited market in Portugal. Currently there is no support scheme for prosumers, who feed their excess electricity into the grid at market prices.
- **Auctions.** The solar market in Portugal has significantly developed, driven by successful auctions in 2020. However, the plan does not detail the auction schedule in the coming years, nor the volumes. No information about the type and volumes expected for January 2022 has been disclosed at the time of writing.

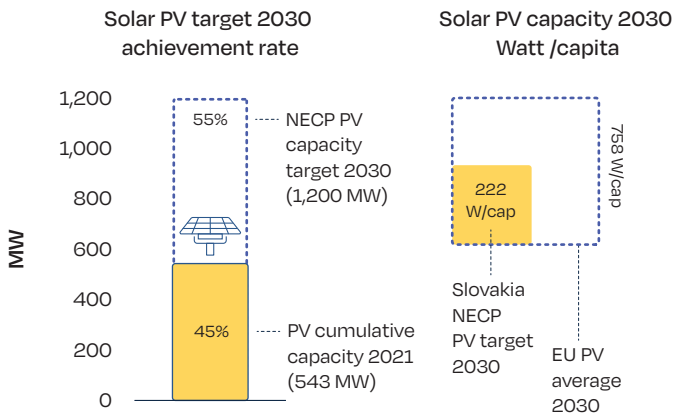
NECP ROMANIA



Key market and NECP challenges:

- **PV target.** The target anticipates a 3.7 GW growth over 10 years, which is more than double the cumulative installed capacity in the country. However, these targets do not fully reflect the potential for Solar development in Romania, which is one of the highest in Europe. According to the current target, in 2030 the country would have a limited solar penetration compared to its more ambitious peers.
- **Auctions.** The support for RES through auctions is only mentioned implicitly, whereas details on volumes, schedules and design for renewable and solar tenders are absent.
- **Prosumers.** Positive elements are included in the final Romanian plan for prosumer support schemes. At the same time, the plan should be more ambitious on prosumer development.

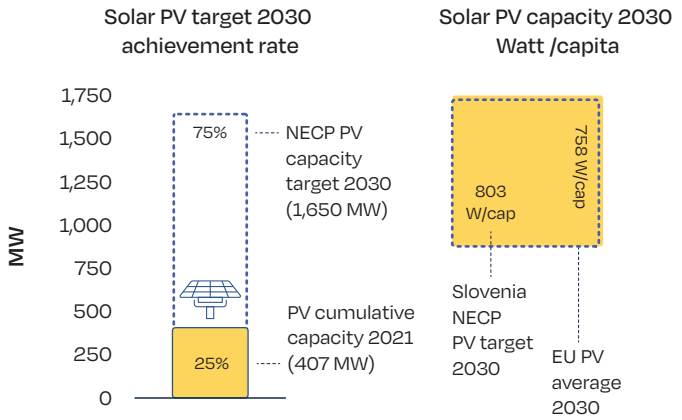
NECP SLOVAKIA



Key market and NECP challenges:

- **PV target.** Both the overall ambition for RES deployment and the solar PV contribution remain low. The plan could be updated with more accurate information, as the goals and trajectories are inadequate and rely on outdated data. Though the PV target has increased significantly compared to the previous NECP draft, with 648 MW of new capacity installed through 2030, solar ambition remains limited.
- **Auctions.** The plan outlines general information about RES auctions, but not specifically for solar. Moreover, the indicated capacity of auction schemes appears low.
- **Prosumers.** The Slovakian plan does assess the prosumer capacity in the country. However, it does not give details on the support schemes that will be developed to incentivise self-consumption, including collective self-consumption.

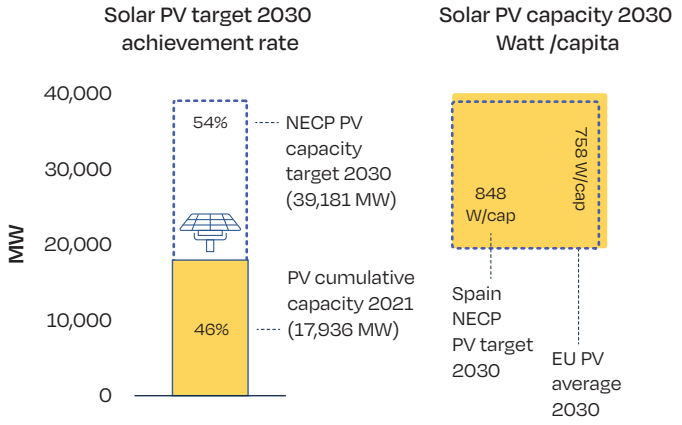
NECP SLOVENIA



Key market and NECP challenges:

- **Auctions.** The NECP does not include information on auction design, volume and schedule. This poses a significant challenge to PV project development in the medium term.
- **Prosumers.** Objectives set out in the plan include improving the role of active consumers and providing financial support for prosumers. However, it is important that these objectives are enshrined into law and accompanied by developed regulatory frameworks, such as collective self-consumption. In addition, there are concerns about the long-term stability of the regulatory framework which are harming the investment environment.
- **Administrative procedures.** The plan contains interesting proposals to simplify administrative procedures, whose implementation should be closely monitored. However, the list of measures should be completed. The administrative procedures are still very extensive, comprehensive, and difficult to understand. In addition, there is no specific contact point for the permit granting procedure, which could significantly ease processes.

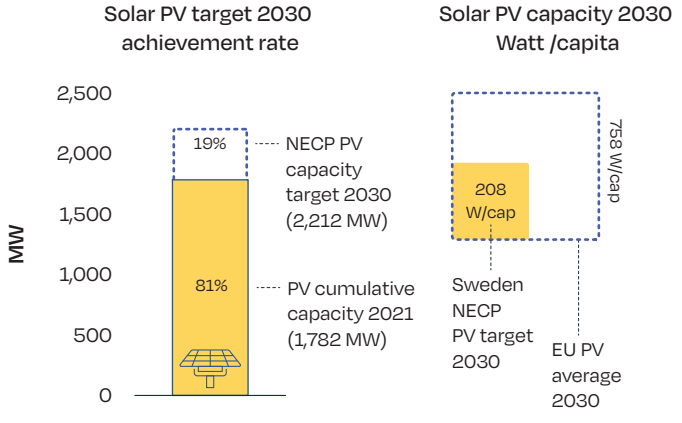
NECP SPAIN



Key market and NECP challenges:

- **Permitting procedures.** The large amount of solar projects under development in the country are facing tight permitting challenges. Regulation passed in 2020 imposes strict deadlines to the projects under development, putting pressure on both developers and the administrative authorities to complete the procedures in time.
- **Social acceptance.** In the areas where numerous projects are under development, a not-in-my-backyard attitude is growing among local communities. The solar industry aims to address this challenge by integrating shared-value principles in the design of projects and through stronger communication efforts on the socio-environmental benefits of large-scale solar parks for local communities.
- **Prosumers.** Self-consumption systems face lengthy permitting times, both at the administration and at the network level, due to non-homogeneous processes across municipalities, and the reduced exemptions of network access permits for rooftop PV. In addition, it takes around 6 months to finalise the procedure that remunerates excessive production of electricity, a period in which consumers do not receive any income.

NECP SWEDEN



Key market and NECP challenges:

- **PV target.** The plan shows relatively low ambition for solar energy before 2030 with 430 MW of newly installed solar capacity and a resulting low value of PV penetration by 2030. However, a higher ambition of solar capacity is shown post-2030 with more than 7 GW installed capacity.
- **Auctions.** The plan does not include any information on the future auction schedule, volume and design. Providing more visibility to investors here will be critical. The government has not announced any tender since the publication of the NECP.
- **Permitting procedures.** Permitting for large-scale projects faces hurdles when it comes to authorisation at regional level. While the national government and local municipalities are supporting project development, the limitation comes primarily from Länsstyrelsen, the regional branch of national authorities.

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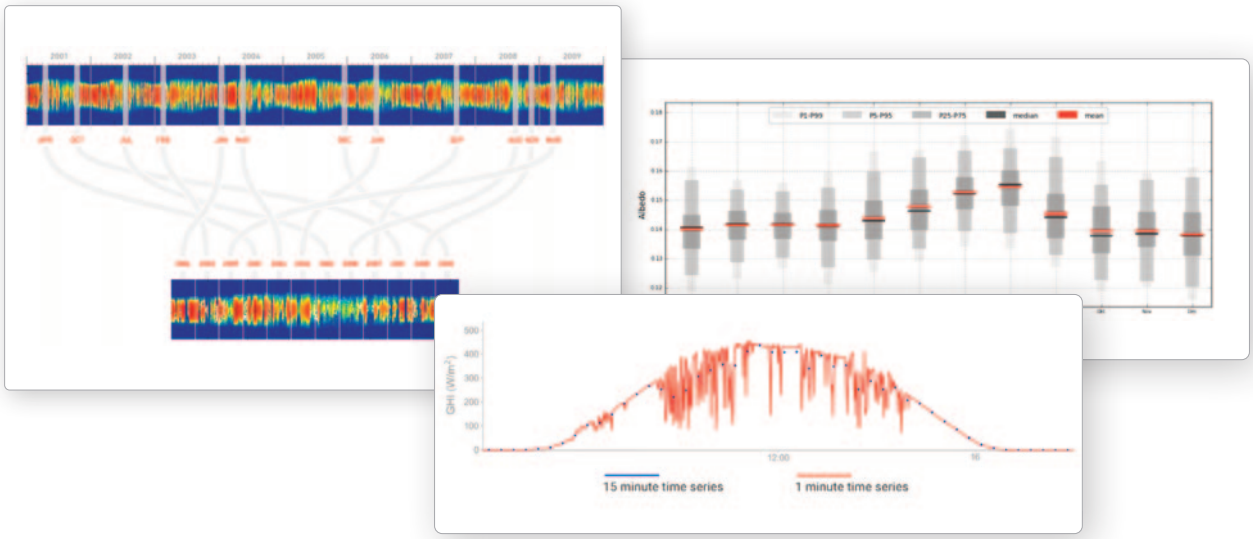

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4 GW-scale solar markets

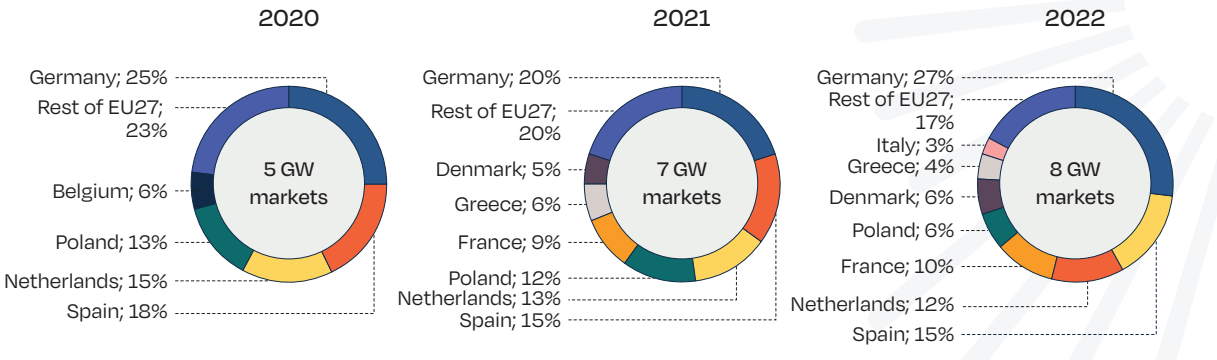
50 MW, Romeral, Cuenca, Spain. © Iberdrola

In 2021, seven EU solar markets installed more than 1 GW of solar – Germany, Spain, the Netherlands, Poland, France, Greece and Denmark (see Figure 17).

The number of GW-scale markets has increased by two compared to the five from last year. While the top four markets – Germany, Spain, the Netherlands and Poland – have remained stable, three new entrants have filled the remaining slots. France, ranked fifth, comfortably surpassed 2 GW of annual installations, after a lackluster performance in 2020. At position six we find Greece, who installed more than 1 GW for the first time since 2013. But the biggest surprise in this list is Denmark, which joins the GW club for the first time ever. The country is having a stellar performance in 2021 with 1.2 GW of expected annual additions, which is more than twice the capacity installed in 2012, the best year so far. For 2022, we expect the group to broaden further, with Italy reaching the GW scale after a long while.

1.	**GERMANY** SolarPower Europe	SolarPower Europe
2.	**SPAIN** Unión Española Fotovoltaica (UNEF)	UNEF
3.	**THE NETHERLANDS** Holland Solar	Holland Solar
4.	**POLAND** PSF & PV Poland	PV Polska
5.	**FRANCE** Syndicat des Énergies Renouvelables (SER)	Syndicat des Énergies Renouvelables
6.	**GREECE** HELAPCO	HELAPCO
7.	**DENMARK** Danish Solar Power & the Danish PV Association	dansk solkraft; Dansk Solcelleforening

FIGURE 17 EU27 GW-SCALE SOLAR MARKETS 2020 - 2022



4 GW-scale solar markets / continued

FIGURE 18 NUMBER OF SOLAR GW MARKETS IN THE EU27

The expansion of solar technology in different geographies across the EU will continue over the next years, as countries identify solar as the most versatile and cost-competitive solution to their climate and energy needs. In 2023, we expect to reach 11 GW markets across the European Union, which will become 12 by 2025 (Figure 18).

For this chapter, we have invited national solar/renewables associations from our members representing this year's EU GW solar markets to provide their local expert views on their home countries (which, however, sometimes differ from our estimates that are based on several sources). For those countries for which we did not receive contributions from national associations, we have written the overviews based on our SolarPower Europe research.

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1. Germany

Towards A 15 GW Annual Market Soon

Overview of Solar PV Developments

Over the first 10 months of 2021, 4.4 GW was installed in Germany, compared to 3.9 GW in the same period last year. With an average of 446 MW installed per month, the market is assumed to install 5.3 GW by the end of 2021, an 8% growth compared to 2020, when 4.9 GW was added. That is a slowdown compared to the 26% growth rate between 2019 and 2020.

Nonetheless, Germany holds on to its roles as both the continent's largest solar market in Europe and the largest operator of solar PV. With a new government coalition in place and the Green Party taking responsibility for the Environment Ministry, the Agriculture Ministry, and the newly created Economic & Climate Ministry, the outlook for solar in Germany looks even more promising. We expect 7.9 GW additions for 2022 and 10 GW in 2023, when the market will exceed this threshold for the first time.

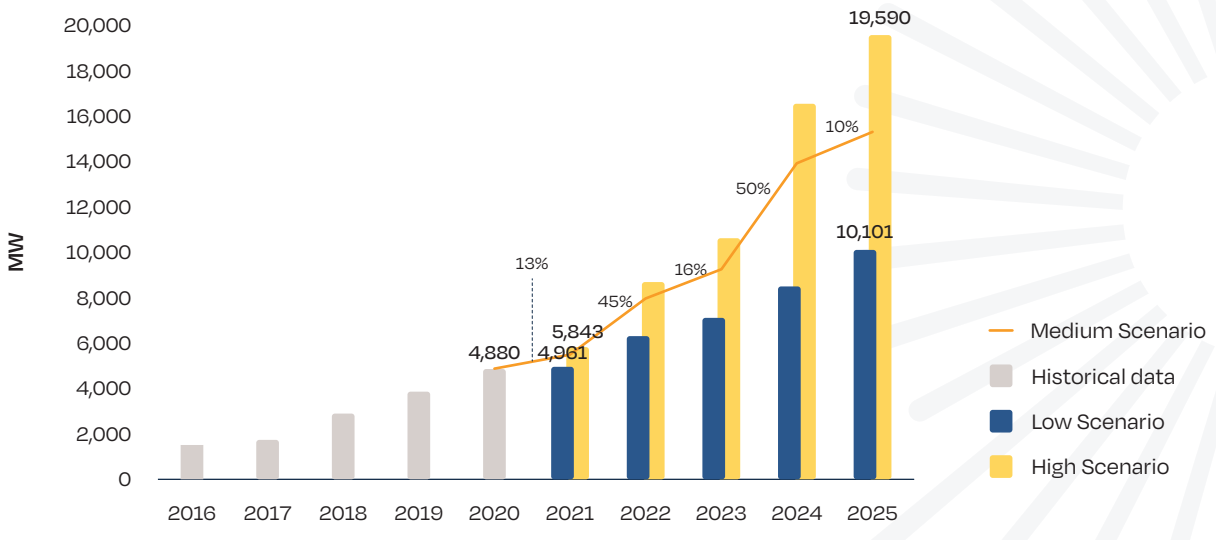
Solar PV Targets in Germany

In its agreement published last month, the new German coalition formed by the Social Democrats (SPD), Greens and Liberals (FDP) have highlighted the crucial importance of solar in the energy transition. While the Renewable Energy Act 2021 (EEG 2021) set a 100 GW total installed solar PV capacity target by 2030, the new government coalition agreement sees a doubling of the target to 200 by 2030. With an installed capacity of 60 GW at the end of 2021, Germany is committed to install 140 GW within 9 years, which means to almost quadruple its total PV fleet during this decade. The new agreement also confirms the phase out of nuclear as planned, with the final reactors to be switched off in 2022. Moreover, the coalition strives to move forward the coal phase out from 2038 to 2030.

In June 2021, the new Climate Protection Act set a binding path to climate neutrality and moved the year of achievement to 2045 instead of 2050. The interim GHG emission reduction target for 2030 is also raised to 65%.

The new coalition is committed to meeting 80% of its electricity from renewable sources by 2030, up from

FIGURE GW1 GERMANY ANNUAL SOLAR PV MARKET SCENARIOS 2022-2025



the 65% target under the former government. The former government did already introduce a national Emission Trading System (ETS) for heating and transport fuels in January 2021,which expands the EU-wide ETS that currently does not cover the fuels used in the heating and transport sectors. A transition phase has started with a fixed and rather low CO_2 price of 25 EUR, increasing each year up to 55 EUR in 2025, and will be followed by an auction system with minimum and maximum prices starting in 2026. However, the new coalition has agreed to make sure that the CO_2 price, which is currently around 60 EUR, will not fall below that level anymore for longer periods, and if needed implement national measures for this purpose.

Drivers for Solar Growth

Within the context of **large-scale auctions**, Germany has had three types of tenders that involve solar: a **technology-specific** tender for ground-mounted projects above 750 kW (in March and December 2021) and **mixed wind and solar tenders**. The technology specific tenders took place three times a year with a volume of 2 x 150 MW, 1 x 175 MW, and 2 x 500 MW; the latest one started in November 2021 with a capacity of 509.52 MW The technology-neutral tenders awarded in 2020 repeated the pattern of the previous year, with solar winning all the auctioned capacity.

To support the achievement of its renewable energy targets, in 2018, the previous government coalition agreed to organise **extra tenders** over 3 years, accounting for a total solar capacity of 4 GW (2019: 1 GW; 2020: 1.4 GW; 2021: 1.6 GW), in addition to the regular tenders. On top of these three tender types, in March 2021 the second technology-neutral **innovation tender** took place, where solar & storage projects were awarded all the 258 MW tendered capacity. In the previous round in September 2020, nearly all the 650 MW capacity was awarded to solar projects, with more than half of this capacity including battery storage. In addition, the first **rooftop tender** for solar systems with a capacity above 300 kW held in February 2021 was oversubscribed. A total of 213 MW bids were accepted for 150 MW initially tendered. The second tender for rooftop started on December 1, 2021. Finally, Germany's Federal Network Agency launched a 50 MW **innovative solar tender** for floating solar, carports and agri-PV in October 2021 with a bidding deadline set for April 2022.

5.35 MW, Martnitz, Germany. © IBC Solar

With the Climate Protection Act, the former government agreed to give a short-term boost to renewable deployment through higher tender volumes for 2022. Auctioned solar PV capacity will grow from 1.9 GW to 6 GW, with the extra capacity equally divided between utility-scale and rooftop systems. Starting from 2023, tenders for solar are planned to stay around 2 GW per year. However, following the new coalition agreement, we can expect to see this number to be revised upward in the coming months.

The **self-consumption** regime underwent profound changes with the approval of the new EEG law in January 2021. On the negative side, as of this year, only PV systems with a capacity below 300 kW will fully benefit from the self-consumption scheme. Installations between 300–750 kW can only sell up to 50% to the grid for a feed-in market premium. Alternatively, operators of this system range can now participate in tenders. As a result, many systems between 300-750 kW were installed in March 2021 as the transition period in the EEG expired in April. In the following months, a decrease in projects above the 300 kW threshold was observed, confirming the negative impact of the new law on the segment.

On the positive side, the newly formed coalition reached an agreement to abolish the **renewable energy surcharge (the so-called EEG surcharge)** as of January 2023. This comes after the country had decided in October 2021 to slash this levy by 43%, from 6.5 down to 3.7 euro cent per kW. Starting from January 2023, operators of small commercial systems from 10–30 kW no longer have to pay the FIT surcharge for their self-consumed solar power. The new EEG law raised the threshold for which rooftop systems are fully exempted from the EEG levy for self-consumption, from 10 kW and 10 MWh/year to 30 kW and 30 MWh/year. This will induce the deployment of small commercial systems.

In the future, the government will be counting on the federal budget and revenues from Emission Trading Systems to offset the financial loss of the EEG surcharge to develop renewables.

While the new government wants to make **solar installations mandatory on all new commercial buildings,** it wants to establish solar as a common feature for residential homes. This builds on decisions of several German states to require solar installations for new buildings. Following Hamburg, Bremen, and Baden-Wurttemberg, Berlin decided in June 2021 to make rooftop PV obligatory on all new and renovated buildings with a usable area of at least 50 square meters as of 2023. The first state to start with mandatory solar installations on residential buildings will be Baden-Wurttemberg in May 2022.

The EEG revision also brought positive changes for **community solar systems**, a segment that has lagged behind expectations for years. Among others, operators do not have to supply power directly to the tenant, but also via third parties, like utilities, which is expected to make the scheme more useful.

As shown in SolarPower Europe's recent *European Market Outlook for Residential Battery Storage 2021–2025*, Germany continues to be the **key European market for home batteries**, with 121,000 units expected for 2021, which is equivalent to a storage capacity of almost 950 MWh. The latest amendments to the Energy Industry Act in June 2021 included a removal of double charges and levies to battery systems, enabling better utilization of batteries' flexibility potential in the energy system. For the next 5 years, Germany is expected to remain Europe's biggest market by far for residential batteries thanks to a very strong solar market and very high retail power prices, as well as high demand for EVs and a quickly increasing number of solar systems dropping out of the 20-year long FIT scheme.

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Next to capacity generated by the self-consumption regime and auctions, **PPA-based projects** are the third pillar of solar development in Germany. The large-scale merchant solar is an emerging trend in the German market. EnBW inaugurated the country' largest PV system, a 187 MW subsidy-free solar park is the largest PV plant in November 2021. As utilities, large investment funds, and private investors are very active in this segment, we anticipate the PPA market to grow strongly in the coming years.

Challenges

The new government needs to revise the current FIT/FIP scheme. The popularity of solar has been resulting in quickly dropping feed-in rates in recent times, which are automatically adjusted once certain installation thresholds are met. As these thresholds are based on conservative growth assumptions, solar is now about to reach levels that make investment for households unattractive at times labour and solar system prices have significantly increased.

Another challenge is the auction scheme for systems between 300–750 kW introduced in March 2021. The appetite for mid-sized rooftop systems, which have been a major contributor to solar deployment in Germany in recent years, is already decreasing. However, the new government's coalition agreement does commit to reviewing this issue.

The key task will be to get all the jigsaw pieces together – incentivise investors for rooftop and power plant segments, smoothen permitting, educate enough installers, and create local acceptance for 140 GW to be installed in the next 9 years.

Authors: *Raffaele Rossi, Christophe Lits & Michael Schmela, SolarPower Europe.*

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2. Spain

The challenges of our ambition

Solar power is entering into a maturity phase in Spain. During the last three years, around 9 GW have been installed, tripling the existing capacity at the end of 2018. The leadership of Spain in the renewable PPA market, the two auctions carried out in 2021, and the growth of rooftop PV, have set the foundation for maintaining the pace of the solar market in coming years. However, both policymakers and the industry have to bear in mind that the maintenance of a GW-size industry will require careful attention.

Drivers for solar growth

Following a process that lasted a few years, the Spanish Parliament approved in the Climate Change Act in May 2021, fixing a dual target for renewables in 2030: a 42% share in final energy consumption and a 74% share in electricity generation. The law also includes a clause to review (only upwards) the targets in 2023. In order to meet these targets, the Spanish National Climate and Energy Plan (NECP), also approved in 2021, **foresees a solar PV capacity as high as 39.2 GW in 2030** – an increase of nearly three times from around 13.6 GW now.

In addition to the visibility given by the energy policy, the main driver for solar growth in Spain is **its competitiveness**, in both ground-mounted plants and self-consumption.

In **ground-mounted plants**, the economic competitiveness of the technology (favoured by economies of scale), the terrain and solar resource availability, and the regulatory stability of recent years have fostered a supportive ecosystem that has attracted the interest of different actors: national utilities, European utilities, companies from the oil & gas sector, IPPs, solar developers, investment funds, etc. This situation is acknowledged by international observers, such as market research firm IHS Markit, which considers Spain as the fifth most interesting market in the world to invest in renewables.

As a result of this ecosystem, a considerable number of developers and IPPs have deployed GW-size portfolios that have been sold to newcomers also pursuing brownfield development. Significant activity in mergers and acquisitions (M&A) is making Spain one of the largest sectors in Europe for transactions in renewables. In addition to M&A operations, several companies are considering going public, which speaks about the good health and prospects of Spanish solar companies.

The pillar for the impressive development of last years have been **PPAs**. All large-scale solar capacity

50 MW, Azaila, Teruel, Spain.

© Iberdrola

commissioned during 2020 (2.9 GW) and 2021 (1.9 GW up to Q3) has been developed without any type of public aid or regulatory scheme, that is, all by means of PPAs or merchant projects. According to the Renewable Energy Country Attractiveness Index from EY, Spain ranks **world's first in the associated new PPA Corporate index**. Spain is also **the leading PPA market in Europe**, according to RE-Source.

The PV rooftop market is not as mature as ground-mounted solar. The current framework was achieved only in 2020 with the removal of the Sun tax on self-consumption, allowing automatic surplus remuneration and collective and through-the-network facilities. Both companies and the end-consumer market have been gradually gaining pace since then.

Installed power has been consistently increasing during last years (715 MW in 2020, +30% compared to 2019), but Spain is still far below the top European self-consumption markets and the potential of its solar resource.

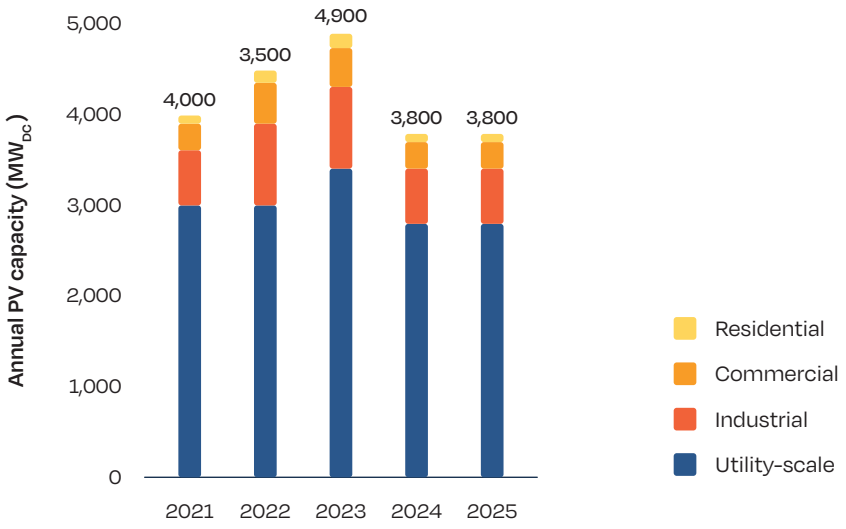
On the policy side, the main driver to be expected in the short term is the **National Self-Consumption Strategy**, whose near approval was announced by the government, which will include measures to foster this segment. In addition to policy, it has to be remarked that Spanish **national Recovery Plan** considers PV rooftop as one of the main measures related to energy transition. In fact, the government approved in June 2021 Royal Decree 477/2021, authorising the transfer of 450 million EUR to Spain's autonomous communities aimed at giving investment grants to self-consumption in the following segments:

- Industry and agriculture: 150 million EUR
- Commercial: 100 million EUR
- Residential, Public Administrations and Tertiary Sector: 200 million EUR

Autonomous communities now have to pass their own regulation to open the process for requesting the aids. The program will support projects until the end of the funds, or up to 2023. If all the funds are assigned – which is considered certain – the government can double the initial assignment of funds, transferring another 450 million EUR to the regions.

Another driving force for PV rooftop is given by the high wholesale electricity prices we are seeing in Q4 2021, which serves as a **wake-up call** for many, particularly industrial and commercial players.

FIGURE GW2 SPAIN ANNUAL SOLAR PV MARKET SCENARIOS 2021-2025, BY UNEF



SOURCE: UNEF.

In terms of **outlook**, expectations are very positive, with some remaining questions marks that need to be followed closely to evaluate their impact.

In the ground-mounted segment, as said, the installed capacity was already above 1.9 GW by Q3 2021, a figure that will reach around 3 GW at the end of the year, according to our estimates. For 2022, the market will still be relying upon PPAs and we consider it will develop similarly to 2021. The two auctions carried out in 2021 (January and October) allocating 2.9 GW of new solar PV capacity will increase the figures of deployment in 2023.

In the PV rooftop segment, in 2021 it is expected that the market will continue its gradual expansion. The impact of **national recovery plan funds, that could make the market boom**, will be seen from 2022 onwards.

Challenges

Regarding the **challenges**, and treating first ground-mounted plants, it is obvious that the higher the volume of projects under development, the larger the burden on companies, the authorities, local communities and other stakeholders.

This general effect is increased by the Royal Decree-law 23/2020, which imposes strict deadlines on the plants under development: all projects with network access permits in force when the Decree was approved have to obtain **their environmental authorisation no later than April 2022**. This deadline obliges companies to advance fast on their permitting procedures and puts strong pressure on the administrative authorities, who are struggling to process the volume of files.

On the local communities' side, the sheer volume of projects going through local permitting (amounting to two to three times the NECP targets), has started to generate a **NIMBY**[5] effect in recent months. Certain local associations are opposing utility-scale renewable plants, requiring a significant communication effort from the companies and UNEF about the benefits and the real impacts of solar power on land use and biodiversity, mitigating the risk of negative misunderstandings spreading.

For rooftop PV the main challenge is the length of permitting times, both at the administration and at the network level, due to non-homogeneous processes across municipalities, and the reduced exemptions of network access permits for rooftop PV. In addition, the support program stemming from the national recovery plan is slowing decision making by clients, who are now waiting for the funds to be available in their region.

Conclusions

The high targets of Spanish NECP and the success of the national solar power market calls for **excellence from all parties: companies, administration and policy makers. In other words, our ambition has to overcome our challenges to maintain the supportive solar** ecosystem that put Spain in the **world's top 10 largest markets.**

On the policy side, it is key to ensure regulatory stability and to eliminate the 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, presenting projects with the highest standards in terms of environmental sustainability, positive social impacts and transparency.

Authors: *José Donoso,* Director General; Alejandro Labanda, Head of Regulation and Studies, Unión Española Fotovoltaica (UNEF).

5 NIMBY - Not In My BackYard.

3. The Netherlands

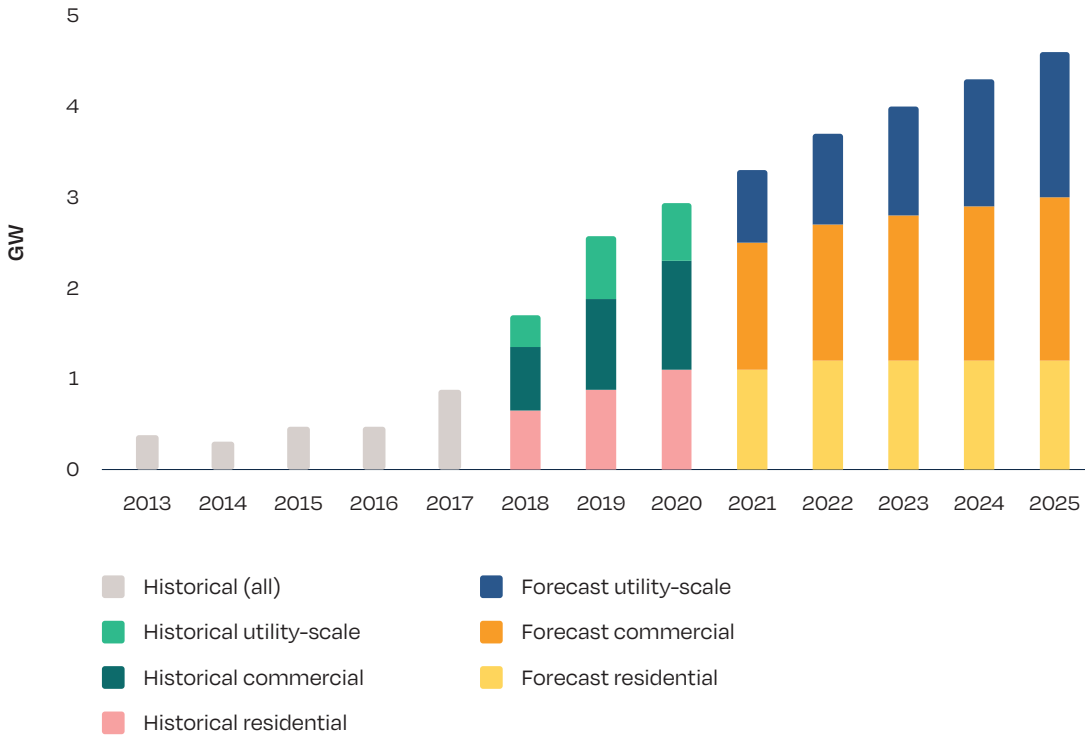
12 GW project pipeline, solar must now compete in tenders with CCS

Despite the COVID-19 crisis, the market in the Netherlands looks sunny with capacity additions of almost 3 GW in 2020 and a project pipeline of 12 GW with SDE++ subsidy-awarded projects. This pipeline includes both rooftop commercial and ground-mounted projects, with rooftop comprising the lion's share. The main challenge now is to ensure that these projects are built. Currently around 70% of solar projects reach completion, including a timely grid connection. Many favourable project development areas in the Netherlands are now experiencing grid congestion, which means no new projects can be connected to the grid. Despite this challenge, it is expected that the Dutch solar energy market will continue to grow again to pass 3 GW in 2021 and 4 GW in 2023 (see Fig. GW3).

Many system-size records in 2020

In 2020, the biggest market segment in the Netherlands was the commercial rooftop market with a share of more than 40% (approx. 1.2 GW) of the total market. The residential market had a share of almost 40% (approx. 1 GW) while the market for ground-mounted and floating solar PV accounted for more than 20% (approx. 0.6 GW). While its relative market share decreased, the residential market kept growing steady in absolute terms. This part of the market is expected to stabilise at a level of about 1.0-1.2 GW per year. Residential solar is an important market segment

FIGURE GW3 NETHERLANDS SOLAR PV MARKET SCENARIOS 2022-2025, BY HOLLAND SOLAR



SOURCE: Holland Solar.

for the Netherlands, especially in creating awareness and support for the energy transition among citizens, leading to greater acceptance of the spatial consequences that come with introducing ground-mount solar power plants and wind energy into the energy mix.

In October 2021, a 176 MW solar park was granted subsidy in the SDE++. Once realised, this will become the largest solar park in the Netherlands. An increasing number of floating solar projects were also completed in 2021, the largest of them is the Sellingerplas project, with more than 72.000 solar panels –the largest in Europe. This is in line with an increasing interest in multifunctional use of space, like solar carports. In May 2021, a 35 MW solar panel carport was constructed on a festival site in Dronten.

Dutch policy/RE targets

The Netherlands has an impressive solar pipeline of over 12 GW. With this pipeline, and the successful completion of several wind projects, it is likely that the 2030 National Climate Agreement target of 35 TWh/yr renewable energy production on land will be met. However, the Dutch National Climate Agreement was agreed upon in 2019 and does not yet consider the higher targets related to EU's new ambition of 55% GHG emissions reduction by 2030. On top of that, the target does not include a forecast for the increase in demand for renewable electricity for the industry, built environment and mobility. The sector is now discussing what the new national ambitions for renewable energy production on land ought to be. New renewable energy production targets will be needed for the sector to be able to participate in the yearly tender scheme SDE++ after 2023.

Local participation has a more prominent role in Regional Energy Strategies (RES)

As established in the National Climate Agreement, the renewable energy sector is striving for 50% local participation in renewable energy projects. As the pipeline moves up, more and more projects have a significant component of local participation in terms of finance (e.g., local ownership), and spatial impact. In the code of conduct written by Holland Solar and relevant NGOs, key requirements for participation are highlighted and the code of conduct is demonstrating its impact. Not all projects are delivered without hiccups from local residents, but including local companies and residents in development processes shows that a win-win situation can be achieved. Project developers in the Netherlands do need supportive local governments that ensure a level-playing field for discussions between the developer and local residents. Smoothing this element of developing ground mounted solar parks is one of Holland Solar's priorities.

Biodiversity label and research lead to double land use

Concerns from municipalities and environmental NGOs have led the Dutch solar sector to set up a large-scale research project to develop ways to maximise existing biodiversity in and around ground-mounted solar parks. The project will allow developers of these parks to request a biodiversity label from an independent certification institution to prove their contributions to nature in addition to producing green electricity. The label will be based on independent scientific research done by the Wageningen University, a renowned institution for nature and biodiversity research. With this new label, the sector has managed to solidify its licence to operate in the Netherlands when it comes to ground-mounted solar parks.

Reducing perceived risks of fire for rooftop solar

In the past few years insurance companies in the Netherlands have become increasingly vocal about the alleged increased risks of fire caused by rooftop solar installations. The discussion incited by the insurance companies has caused the market for large scale rooftop solar to slow down. In November 2021, an independent study initiated by the Dutch government proved that risks of fire are limited. In addition, the sector met with the national fire brigade, insurance companies, and representatives of the insulation industry to create a new code of conduct for large scale solar roofs. This new code of conduct satisfies requirements from insurance companies and ensures that building owners can be confident their commercial solar installations are fire-safe. The code of conduct can be found here.

Drivers for solar growth

The Dutch residential solar market is driven by net-metering. 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 up until 2031 has not (yet) made it through parliament. Due to a political deadlock, and the limited powers of the interim government in place since March 2021, – the current government is holding off on putting this proposal to a vote. This degressive path is based on a seven-year payback time for the prosumer, assuming 30% self-consumption and an optimal situation. In the light of the new Fit for 55 discussions in Brussels, in particular the proposed changes to the Energy Taxation Directive, the current Dutch proposal would become outdated. Therefore, the sector intends to develop a proposal in which a seven-year payback time can be achieved, while the net-metering scheme is also gradually and clearly reduced over the years in order to incentivise more flexibility in the system. Nonetheless, with more than 1.5 million households (about one fifth of all Dutch households) having solar panels, this segment is and will continue to be an important driver for continuous growth in the Dutch Solar sector.

The commercial and utility-scale market in the Netherlands is driven by the SDE++ tendering scheme, where 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 on offer, depending on technology (wind, biomass, solar), size, and application (ground-mounted, rooftop, floating). The ranking in the scheme is based on Euro per kt of CO_2 avoided. The maximum SDE++ contribution decreases every year, so with increasing module prices and increasing logistic costs there is a chance that, for the 2022 round, this decreasing subsidy level will need to be mitigated. In the 2020 round in October, a total of 3.6 GW solar projects were granted subsidy. About half of that is ground-mounted and the other half is large rooftop solar. The expectation is that solar energy projects can be developed, without any incentives, based on PPA contracts by 2025 at the latest. Utility-scale solar is estimated to reach grid-parity around 2023, depending on the development of electricity prices.

41.4 MW, Sellingen, the Netherlands. © GroenLeven

Challenges

One of the main challenges for the solar energy sector in the Netherlands is to timely secure grid connections. For the coming years the sector is expected to face serious delays and possibly project non-realisation caused by a lack of grid capacity on the higher and middle voltage levels. Additional reserve capacity will be put into general use by the grid operators in 2022. Legal limitations to cable pooling, which combines solar and wind projects in co-location with batteries, also have to be resolved urgently. The sector is contributing to this discussion by maximising the grid connection per installation to 70% of the maximum capacity. For the years 2022-2025, battery and flexibility solutions provided by the market will require more incentives from grid operators and the Dutch government.

Another challenge the 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. With the current political deadlock, the sector is anxiously waiting for the position of the new government on the right to continue using agricultural land for the production of solar energy.

Authors: *Peter Molengraaf,* President*; Wijnand van Hooff,* General Manager*; Amelie Veenstra, Policy Director; Nold Jaeger,* Public Affairs, Holland Solar.

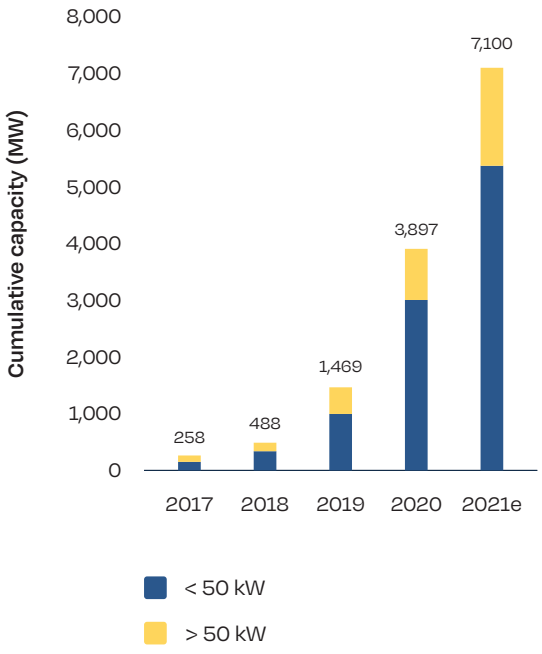
4. Poland

Fom small towards large-scale solar

In Poland, we have been observing the dynamic development of photovoltaics for over two years. All plans and forecasts for the development of this sector in Poland are underestimated. At the end of September 2021, there were 6.3 GW of PV installed capacity. It is estimated that this total capacity will surpass 7 GW by the end of 2021. Most of this capacity will be constituted by small PV systems below 50 kW (micro-installations), which are expected to grow to over 1 million units by the end of the year (see Figure GW4).

This substantial increase in PV capacity has been primarily due to a favourable self-consumption scheme for prosumers, a net-metering system that uses a discount mechanism to balance out across the annual energy that was delivered to, and purchased from, the grid. In 2021, prosumers producing energy in up to 10 kW installations, could feed one unit of energy into the grid, and receive 0.8 units of energy for free. For larger installations above 10 kW this ratio is 1 to 0.7. Moreover, prosumers do not pay the distribution fees for using the grid. An additional support for micro-installations came also from dedicated governmental programs such as the rebate scheme "My Electricity", which provides a maximum 5.000 PLN (1.089 EUR) for home systems sized between 2-10 kW, with the possibility to deduct part of the cost from income tax.

FIGURE GW4 POLAND SOLAR PV CUMULATIVE CAPACITY 2017-2021



SOURCE: PSE and ARE.

The large growth in the number of micro-installations in Poland proved to be challenging for distribution networks and is leading to changes in the policy framework. On 1st April 2022, the net-metering system will be replaced by a new net-billing system, whereby the amount of electricity introduced and taken from the grid will be balanced in an hourly settlement using a metering system. Under the new scheme, prosumers will be rewarded for surplus energy fed into the grid at the wholesale price, and they will pay for the consumed energy just like other electricity consumers. The new system is a significant step back for prosumers and will extend the time of return on investment or even make it impossible, depending on energy prices and installation costs. This is the reason why households interested in generating energy for their own use will want to install their systems before the new prosumer billing system is launched. We anticipate that this change will drastically reduce the market for small rooftop systems.

However, even if the deployment of micro-installations slows, we expect a strong development of another PV segment: large-scale solar projects. The growth of this segment will be primarily driven by national tenders. Auctions are carried out at least once a year by the Energy Regulatory Office (URE), where projects below 1 MW and above 1 MW are placed in different baskets. The first technology neutral auction for projects above 1 MW held in November 2018 was dominated by wind energy, but the situation already started to change by the following auction in December 2019, when PV projects equalled the capacity awarded to wind farms.

The last auction in June 2021 showed a great solar performance, with more than 1.2 GW of awarded PV projects compared to about 0.3 GW allocated to wind projects. The reference price for PV was 320 PLN/MWh (69.7 EUR/MWh), and the maximum price at which the

energy was sold was 243 PLN/MWh (52.9 EUR/MWh). The difference between these prices of 79 PLN/MWh (16.8 EUR/MWh) shows the high competitiveness of solar technologies and the increasing supply of large-scale solar projects. For the next auction in December 2021, it is expected that solar will take the majority of the 998 MW tendered capacity.

The auctions for systems below 1 MW are also being dominated by solar. As a result of the last of these auctions, which also took place in June 2021, almost 1 GW of new capacity will be installed.

Interest in large-scale solar is due to the fact that Poland is already experiencing a shortage in energy production capacity, and this trend is set to become even stronger due to the imminent decommissioning of numerous conventional plants as their lifecycle comes to an end. With regulatory barriers obstructing onshore wind development, PV is currently the only technology that can deliver new energy production capacity within a short timeframe.

The demand for green energy in the coming years in Poland will also be driven by the energy-intensive enterprises who seek to secure access to clean, affordable energy to fuel their production and lower their carbon footprint. This requires the liberalisation of regulations on the construction of energy networks and enabling the deployment of direct lines connecting a PV installation with the end user. Legal changes facilitating such a solution were proposed in the draft amendment to the energy law and the RES Act.

The PV sector in Poland is struggling with a few obstacles, above all the lack of grid connection points for new installations and the current problems with the timely implementation of projects, which is a consequence of the global price hikes and delays in PV manufacturing. On the positive side, in the medium term, falling renewable energy costs, the changing role of coal and new business models in the energy sector – including micro-sources and distributed energy sources – are just some of the trends that will shape the solar market in Poland. All these factors contribute to increasing the societal awareness of environmental issues and improve people's support to the transition to renewables.

Maintaining the pace of new capacity increase would also be facilitated by the implementation of the so-called cable pooling – the possibility of sharing a power line for PV and wind farms. It not only solves the problem of the lack of connection infrastructure, but also perfectly implements the idea of complementing various renewable sources – windmills can provide electricity at night, autumn and winter, and photovoltaics on summer and spring days.

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

64.6 MW, Witnica, Poland.

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5. France

Reaching the 2 GW level

Overview of solar PV developments

The French solar fleet has entered an acceleration phase: for the first time, more than 2 GW were connected in less than a year. With 621 MW connected during the third quarter of 2021 and 2,162 MW connected over the past 12 months, the French solar fleet now amounts to 12,329 MW. These figures show that there has been a significant development in the solar sector since the start of the year, particularly in the medium and large rooftop segments.

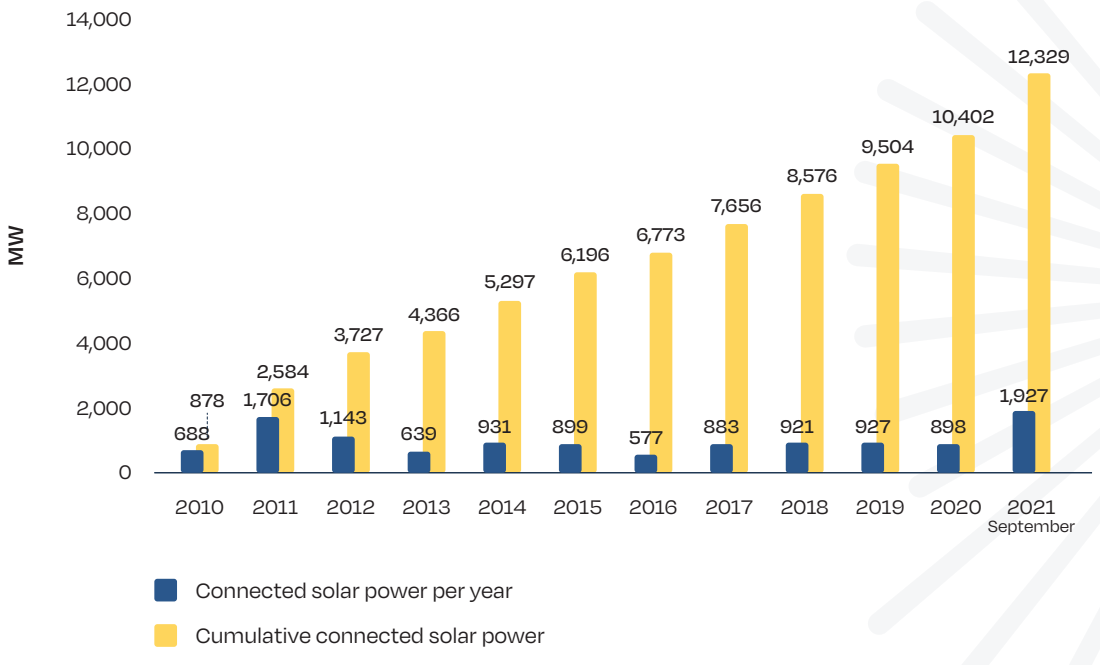
Electricity production from photovoltaic sources stands at 4.8 TWh in recent months, thanks to new connected capacities. The coverage rate for electricity consumption by solar energy thus stood at 5% during the third quarter of 2021.

Solar PV targets in France

The 2015 Energy Transition for a Green Growth law set The 2015 Energy Transition for a Green Growth law set ambitious goals for 2030, which were also confirmed in the Climate & Energy Law adopted last year. These objectives have been implemented for each technology through the Multi-Annual Energy Programme (MAEP). This defines clear trajectories and volumetric objectives for the coming 10 years. The MAEP objective for the end of 2023, which requires an operating solar fleet of 20.1 GW, has achieved more than half its goal, currently standing at 61.3%.

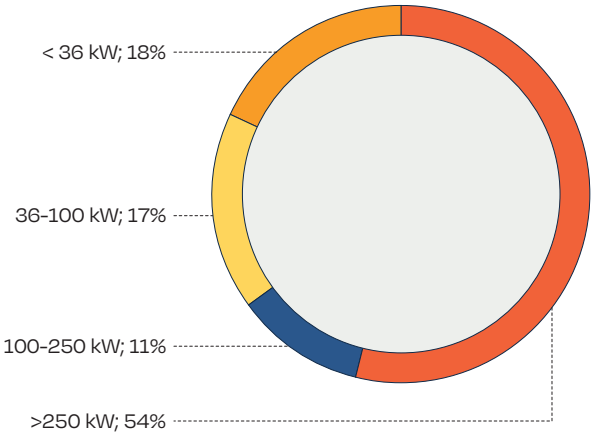
A revised version of the first MAEP, adopted in spring 2020, confirmed the willingness to strongly accelerate the development of the French 'solar park'. The new targets presented for 2028 lie between 35.1 GW and 44 GW in cumulative capacity. These targets suggest that the annual market needs to rise to 3 to 4 GW per year between now and 2028. This means between 330 and 400 km² of ground-mounted PV area will be installed in France, with between 150 and 200 km² of rooftop installations. Therefore, solar power is positioned as one of the most important contributors to the French energy transition.

FIGURE GW 5.1 FRANCE ANNUAL AND CUMULATIVE SOLAR PV CAPACITY 2010-2021, BY SER



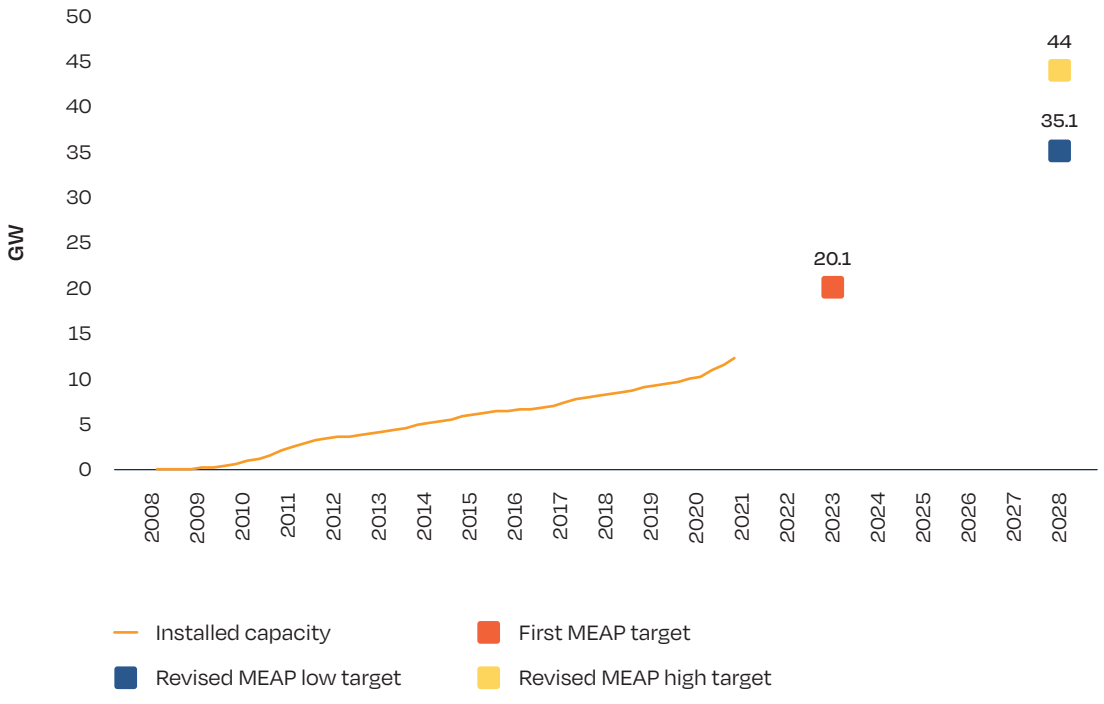
SOURCE: SER.

FIGURE GW 5.2 FRANCE CUMULATIVE SOLAR PV GRID CONNECTED CAPACITY Q2 2021, BY SER



SOURCE: SER.

FIGURE GW 5.3 FRANCE MULTI-ANNUAL ENERGY PROGRAMME SOLAR PV TARGETS, BY SER



SOURCE: SER.

In a longer-term perspective, it is also important to note that, in its recently published report which studied six main scenarios to reach carbon-neutrality, RTE (the French transmission system operator) foresees 70 to 208 GW of solar capacity installed in 2050.

Drivers for solar growth

Calls for tenders are the main driver for achieving solar growth targets, with 3.2 GW scheduled every year. Two-thirds of these tenders will be ground-mounted installations. The remaining third will be accounted for by rooftop installations.

For many years, the French renewable energy association (SER) advocated that projects for rooftop installations below 500 kW should be exempt from tendering procedures and eligible for a feed in tariff (FIT), in line with the current EU State Aid Guidelines. After more than a year of work with the French government, the new threshold has been implemented this autumn. Raising the FIT threshold from 100 kW to 500 kW is making things easier for this market segment, where projects were previously limited by tendering procedures. There is no doubt that this change will generate renewed impetus to develop rooftop installation projects.

Additionally, the self-consumption market for which a dedicated framework has been put in place is growing rapidly, but still represents a small installed capacity. In Q2/2021, 134,111 installations were self-consuming, representing 597.5 MW.

Challenges

Reaching a target of 44 GW of solar power in France by 2028, compared to the 11.7 GW currently installed, requires regulatory changes that support the growth of all market segments.

First and foremost, one needs to widen the perimeter of eligible land in calls for tenders for ground mounted projects. Given the 2028 MEAP target, and given that the distribution of major projects remains constant, we can expect almost two thirds of solar power to be installed on the ground. Therefore, a general reflection on land use is necessary to take into account the real impact of PV projects on soils and to facilitate their development. In addition, innovative PV projects with especially low land-use impact, such as agri-PV and floating solar, should be encouraged.

Agri-PV: solar on greenhouses in Lüe, France. © SMA

Moreover, the development of photovoltaic projects is tightly regulated. Some administrative procedures and architectural planning issues have to be clarified and simplified. Some local services may have an ambiguous and debatable interpretation of the framework in place. This can sometime go beyond current regulation, such as fire protection rules. Administrative deadlines also need to be shortened.

France promotes a low carbon footprint solar PV industry. The carbon criteria in the call for tenders is seen as a fundamental pillar of an industrial strategy which should go hand-in-hand with the market development. In line with what SER advocated, the carbon criterion is now set at 550 kg CO_2 e/kW in the new call for tenders' specifications, which were published this summer. This criterion is also now required to apply to the new FIT for rooftop installations. Thanks to the work of strong R&D centers (INES, IPVF, etc.), the development of the French industry's innovation capacities and technological breakthroughs will also improve competitiveness.

Finally, as mentioned above, self-consumption is still a small market for solar PV energy. The support mechanisms for self-consumption projects need to be adapted so as to enhance the value of all electricity produced, self-consumed, and injected into the grid. This needs to occur at a level that allows the projects to be financially secured. Opening up self-consumption without penalising consumers, who are not always able to consume all of their production, is another way forward.

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

6. Greece

The Renaissance of the Greek PV market

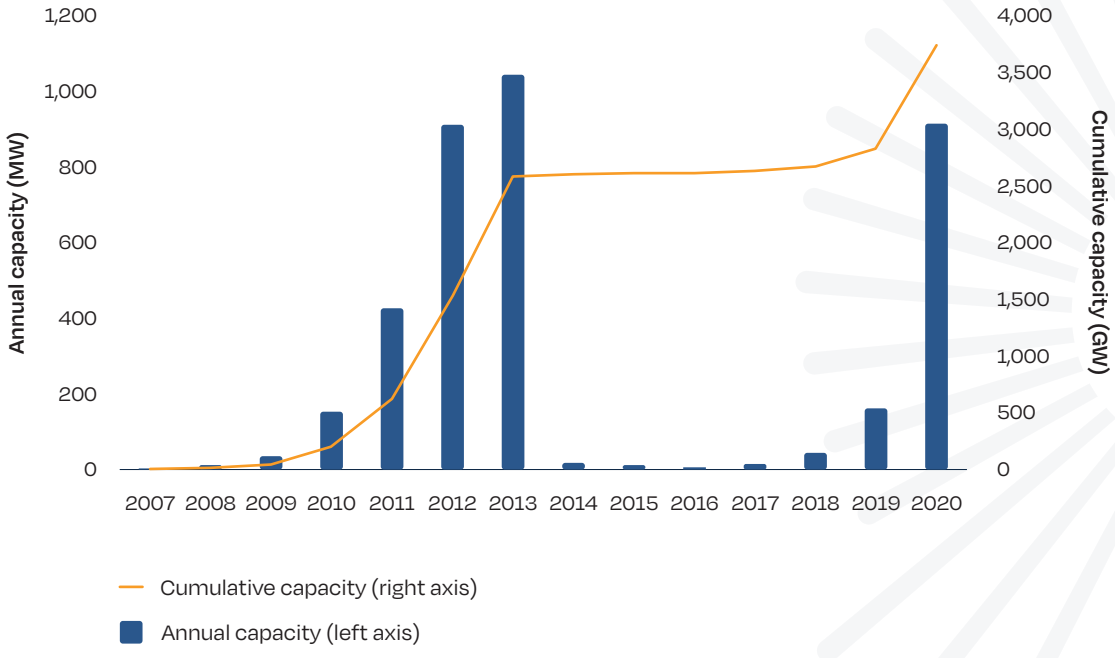
In 2020, amidst the COVID-19 crisis, Greece installed 0.9 GW of PV, half of which were connected to the grid by the end of December, while the rest in 2021. A legislation which passed by the Greek Parliament in 2020 gave the right to PV developers to secure a higher tariff for the energy fed into the grid, based on a declaration of "readiness for connection" and not on the actual connection date. As a result, there was a boom in installations before year end.

The 2021 market is expected to reach the 1 GW threshold, as there is currently a boom of investments, mainly for medium and large-scale ground-mounted PV projects. Most connected systems have a capacity of 500 kW (a trend which is expected to continue in 2022 as well) while larger systems are expected to take the lead in the years to follow, as more large-scale projects mature and reach the construction stage.

Recent legislation has extended the feed-in-premium scheme for systems up to 500 kW until the end of 2022, and this has triggered a lot of interest by medium-size investors. Up to now, the potential pipeline of PV projects in Greece has reached 85 GW, including many large portfolios of hundreds of megawatts each. All major energy players in Greece are now investing in PV, including all oil and gas majors, while there are many foreign investors in the country as well.

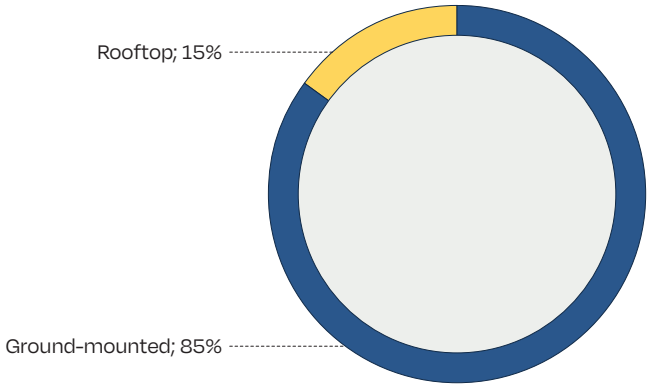
At the same time, the Greek government is revisiting relevant legislation aiming at the simplification of the authorization process. Drastic changes have already been decided in 2020 and more positive measures are expected by year end 2021 and 2022. At the same time, the regulatory framework for energy storage is being prepared and is expected to be in place in Q1-2022. Up to now, there are applications for 12 GW of stand-alone large-scale storage systems, making use of old regulations. The government plans to have auctions for storage in 2022 (for stand-alone storage systems) and 2023 (for PV plus storage systems).

FIGURE GW 6.1 GREECE SOLAR PV MARKET DEVELOPMENT 2007-2020, BY HELAPCO



SOURCE: HELAPCO.

FIGURE GW 6.2 GREECE SOLAR PV CUMULATIVE CAPACITY SEGMENTATION 2020, BY HELAPCO



SOURCE: HELAPCO.

The National Energy and Climate Plan (NECP) foresees a share of 63% for RES by 2030, and a PV cumulative capacity of 7.7 GW by the end of the decade. This plan is now being revised to take account of the recent more ambitious EU targets. It is realistic to expect that the new target for PV will be over 10 GW by 2030. As a result, the outlook for PV looks bright with the market floating around at least 1 GW per year until 2025.

The government is planning to continue the auction scheme for PV and wind until the end of 2025. In total, 3 GW will be auctioned, and, considering the cost of each technology, PV is expected to win two thirds of the total capacity. Apart from auctions, PV investors now have the option to participate in the wholesale markets for subsidy-free projects or sign a corporate PPA with interested consumers. Although these last

1 MW, Kastoria, Greece.

options are new for Greece, they are expected to take a large portion of the market in the years to come.

The real bottleneck for fast PV deployment is now the availability of grid capacity. Most of the medium-voltage grids are now congested, and the same will happen soon with the high-voltage grids (150 kV). Most major players are now looking at the ultra-high voltage of 400 kV, an option which increases the overall cost of their projects. Nevertheless, even considering the rise in equipment cost worldwide, PV projects in Greece remain a profitable and attractive investment.

Contrary to the ground-mounted projects, which dominate the Greek PV market, the residential market is developing very slowly. Self-consumption is now beginning to emerge, mainly in the commercial sector, while the government plans to re-introduce a feed-in-tariff scheme for the residential sector. Energy Communities are also becoming popular around the country, while PV systems will be allowed again in the largest islands (such as Crete) where the market was frozen for many years.

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

5 MW, Mesokomo, Greece.

7. Denmark

Overview of PV developments

In 2021, for the first time since the beginning of solar PV installation in Denmark, the country expects to imminently become a gigawatt-scale market. This crucial milestone has been driven by the utility-scale market, which has demonstrated steady growth in recent years, and is poised to enjoy even stronger development in coming years. So far, Danish utility-scale solar has not been promoted through public auctions, but has been relying on subsidy-free solar projects. While large-scale solar is in the process of expanding rapidly beyond the GW level, the rooftop PV segment presently remains small in size. The residential market peaked in 2012 and, except for a small trail into 2013, has decreased to a low baseline, with limited growth perspective. The C&I market has also been fairly small for many years but is starting to pick up with promising growth rates, with a good position to continue the positive upward trend.

Drivers for solar growth

As of October 2021, the accumulated utility-scale capacity in Denmark is 773 MW_{AC} distributed into 41 parks, including 173 MW_{AC} installed this year. Based on information collected from the five major solar developers, an additional capacity of 800 MW_{AC} is expected to be grid-connected in the final months of 2021. With a total project pipeline of 20 GW_{AC}, these developers expect to install 1.5-2 GW_{AC} per year over the next five years.

The Danish utility-scale market benefits from well-functioning and transparent regulations, with respect to planning permission and grid connecting procedures. This does not mean that the requirements and formalities are less demanding than in other EU solar markets, but an efficient dialog and problem-solving attitude can be expected when interacting with municipalities and utilities.

Besides the favourable conditions for planning permissions and grid connection, there are several additional factors that explain this significant interest in large-scale solar parks. Increasing power prices, an expected further price reduction of solar PV components, the maturity of the PPA market, increased opportunities to use lowland and wetland areas, where current drains with a new climate agreement for the farming sector are set to be removed to increase CO_2 accumulation, and the emergence of hybrid wind-solar projects all play a role in the rising focus on solar utility projects. Further drivers are provided by the public sector, with potential

33.9 MW, Zeeland, Denmark.

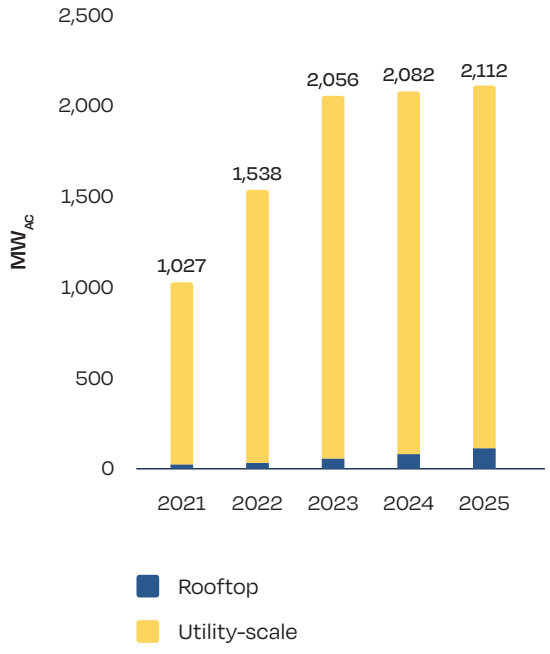
© European Energy

state-sponsored incentives, guidelines or roadmaps for a stronger support with a minimum deployment target of renewables for all Danish municipalities. A temporary support scheme to decrease grid connection costs is also currently in place, and may be prolonged beyond 2022.

By contrast, the market for C&I installations have been quite limited for the last six years, with an average capacity around 15 MW_{AC} per annum. In this market several factors support the assumed high CAGR of 25% and 66% respectively, namely new openings for third-party financing, increased depreciation for systems up to 1 MW by 116% in 2022, opportunities to establish energy communities and overall commercial focus on the renewable energy. Factors that may work against this growth would be the limited economic incentive – unless a high degree of self-consumption can be ensured. Furthermore, the network codes for such generators do represent a significant administrative burden and can demonstrate to be difficult to fulfil, which may also reduce the growth compared to the outlook presented in this analysis.

Regarding the residential segment, thanks to an attractive support scheme between 2012 and 2013 more than 80,000 residential systems were installed. However, since 2014, when the last PV systems benefitting from this support scheme were completed, only ca. 2,500 installations with a total of 10 MW_{AC} have been installed per year in this category. Basically, the economic incentive for private homeowners is quite limited, due to the challenge to reach a sufficient degree of self-consumption. Thus, today the driver for residential installations remains to be idealism and ambitions of individual homeowners to contribute to the green transition, as well as energy efficiency requirements from building codes. Cheaper batteries may generate a more positive business case in this market, which is expected to grow with a 20% compound annually growth rate over the next five years.

FIGURE GW 7.1 DENMARK SOLAR PV MARKET 2021-2025, BY DSP AND DPVA



SOURCE: Danish Solar Power (DSP) and Danish PV Association (DPVA).

Challenges

A delayed and uncertain new tariff regime for grid connection should be introduced by January 2023. While the details of this measure are still unknown, the new tariffs producers would have to pay are expected to be fairly high. Moreover, there will be a geographic differentiation of the grid connection tariffs, which will be higher in those areas where PV are most likely to be installed – the less populated parts of the country. In addition, the current support scheme decreasing grid connection costs is only temporary, and its extension is subject to discussion.

Additional challenges come from the interaction with external stakeholders. As in other European countries who are experiencing large growth of utility-scale solar, there are risks of an increased local resistance to large ground-mounted projects. We also signal a reduced municipality support for permitting of new renewable projects that is linked to the outcome of municipality elections taking place in late 2021.

For all markets, challenges are also expected to last until the end of 2022, which introduces significant uncertainty to this outlook. This includes, on top of a continuation of the current high module prices, difficult commercial conditions with respect to price renegotiations for PV modules and chaotic shipping conditions as seen in the second half of 2021, which might influence the finalisation of the PV projects currently under construction.

Outlook

While 2021 is expected to be the first year when solar reached the GW scale in Denmark, this status will also be maintained in the future. Our five-year outlook foresees that the market will reach 1.5 GW_{AC} in 2022 and will surpass the 2 GW_{AC} mark from 2023 onwards, driven by the large demand for large-scale solar. If the bulk of installed capacity will keep belonging to the utility-scale segment, rooftop installations are also on a positive growth path. The annual market of residential and C&I solar combined will grow from 27 MW_{AC} in 2021 to 112 MW_{AC} by 2025.

Author: *Thomas Aarestrup Jepsen,* CEO, Danish Solar Power; *Flemming Kristensen,* Chairman of the board, Danish PV Association.

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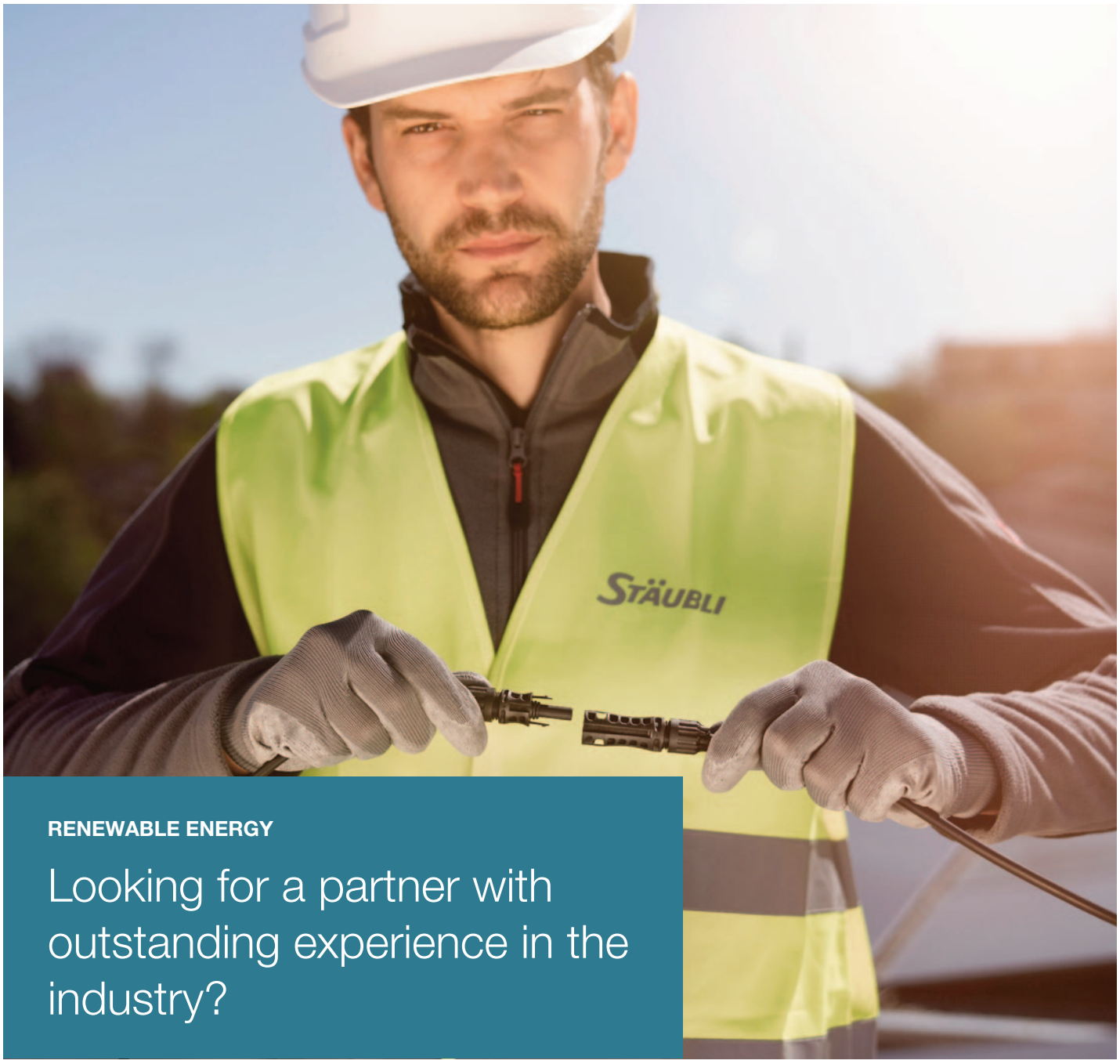

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