EU Market Outlook

For Solar Power

2022 - 2026

SolarPower Europe


SMARTENERGY
Leading the way in green hydrogen.
smartenergy.net
H₂
Green Hydrogen
Solar PV
Wind Power

Foreword

A message from Kadri Simson, European Commissioner for Energy.

This year has taught us of the grave importance of a secure, home-grown energy system, one that cannot be manipulated for geopolitical purposes. That system needs to be based on renewables.

Solar has a very important role to play as it can be deployed fast, and already make a real difference in the current crisis. The Commission is doing all it can to support the deployment of solar energy.

With renewables at the core of our REPowerEU Plan, we increased the proposed renewable energy target for 2030 to 45%. Going to 45% will be no small effort. It means more than doubling the share of renewables in the next 8 years, and tripling of the deployment speed that we have seen over the last decade.

With the Solar Strategy adopted this year, we are aiming to bring online over 320 GW of solar photovoltaic by 2025 and almost 600 GW by 2030.[1]

These are all very ambitious plans, but with the Solar Strategy we have set a clear policy line on how to get there. Part of this is making rooftop solar panels mandatory. To remove possible barriers to achieve our goals, the Commission has also brought forward actions to speed-up and simplify permitting procedures that are currently slowing down the industry. We have proposed an Emergency Regulation on faster permitting for renewable projects, including specific provisions for solar deployment.

Barriers also come in the form of our market design. Right now, we are operating with a design that reflects our energy world of yesterday, not our renewables-based future. Early next year we will propose a reform of the electricity market.

With demand for solar energy growing, we should be ready to seize the opportunity on the supply side. We have just launched the EU Solar PV Industry Alliance to seize the tremendous industrial opportunity on offer. The alliance will help us to expand manufacturing capacities for more innovative, more efficient, and more sustainable solar PVs.

I would also like to take the opportunity to thank Solar Power Europe for your leadership. You have always given us a very valuable perspective of the industry. Your voice is heard at the Commission loud and clear. We very much appreciate your support in ensuring that the legislation that we are making today can help us with what we want to achieve – an unprecedented deployment of solar energy across the EU.

Year 2022 has been excellent for solar deployment, with a record 41 GW installed. This is more than double what was installed in 2020. This is not the reason to slow down. Let this year's results inspire us to work even harder and lay the right foundations for the EU solar market of the future.

1 GW given in AC units. In DC units: over 380 GW of solar photovoltaic by 2025 and almost 750 GW by 2030.

SOLARGIS

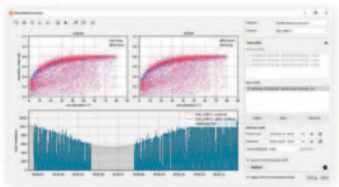
Solargis Analyst

Unlock the potential of your solar data

Stop struggling with spreadsheets and manage your solar resource data with a tool designed by solar data analysts for solar data analysts

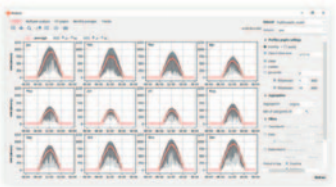
Organize data

Import and combination capabilities to avoid errors in handling your data. Export options for easier team collaboration.



Visualize data

Plots, visualizations and comparisons specifically designed for solar resource data. All from a single user-friendly platform.



Analysis and quality control

Automatic error detection tools, manual flagging, calculation and reporting options to highlight potential issues in your data.

For more information visit

solargis.com/analyst

SOLARGIS ANALYST

Foreword

Welcome to the European Market Outlook 2022 – 2026,

Only history will tell, but it is likely that Europe will remember 2022 as the year the solar age truly began. Today's fossil-fuel and nuclear induced energy crisis has put solar in the spotlight like never before. Solar ticks all three boxes of the previously assumed energy trilemma – sustainability, affordability, and security of supply. Less costly, and more versatile, solar is easier to deploy than any other power source. Only solar can empower individual energy self-sufficiency. It's high time to acknowledge the reality of the energy landscape, and take solar seriously.

Just look at the numbers: our preliminary market analysis for 2022 sees 41.4 GW newly installed solar PV capacity this year, an impressive annual growth of 47% from the 28.1 GW installed in 2021. It's also over double what was installed just two years ago in 2020. We are confident that further annual market growth will beat all expectations, exceed 50 GW deployment level in 2023, and more than double from today to 85 GW in 2026. While this is the 'most likely' forecast, we could see up to 68 GW installed next year, and nearly 120 GW of annual installation in 4 years.

Embedding these growth numbers in our mindset is key – each and every stakeholder in energy politics needs to be aware that imminently, solar will be at the center of the European Union's energy system. This requires thorough planning. Getting the numbers right in the upcoming 2023 revision of EU Member States' 2030 National Energy and Climate Plans (NECPs) is crucial. Current NECPs all severely underestimate solar; as our analysis shows, over three quarters of EU countries will have reached their 2030 targets 5 years early, and all of them at least 3 years early. It's also worth taking a look at the detailed descriptions of the 10 EU markets that have now reached GW-level size – they have installed at least a GW of solar in 2022.

The solar wave in the coming years will be nothing short of seismic. With that in mind, we have highlighted five key areas to get Europe ready for solar:

1. **Dramatically expand the pool of solar installers.** This year, many more Europeans could have already become independent from gas imports if there had been more qualified technicians to install and grid-connect their solar systems. Fixing the installation bottleneck is the top priority.
2. **Maintain regulatory stability.** While Europeans want solar and investors are ready, the wrong signals from state market interventions can significantly slow down today's gigantic solar momentum.
3. **Don't forget the grid.** Solar stakeholders are increasingly reporting grid connection issues, both on the transmission and distribution levels. We need to take this challenge seriously, and also enable flexibility through setting indicative 2030 targets for energy storage.
4. **Streamline administrative procedures.** Permitting is not just an issue for wind. Solar faces administrative challenges too – this cannot be taken lightly. To absorb the necessary solar power plants to come we need improved spatial planning and permitting procedures, which have to be designed in harmony with people and nature.
5. **Reinforce access to green and reliable manufacturing.** Europe needs to be able to source solar products sustainably and from reliable supply chains. The EU cannot exchange one dependency for another. A powerful domestic solar industry, at the centre of a diversified, global solar supply chain , is critical.

Fortunately, Europe is hearing the solar sector's calls. The European Commission already has our asks on its 2023 agenda, as EU Energy Commissioner, Kadri Simson highlights in her foreword. A much higher 2030 target has been set as part of the landmark EU Solar Strategy published under the REPowerEU strategy in May 2022. There is a new Solar Skills Initiative, permitting is being addressed, and the EU is also looking into ways to reinforcing sustainable, responsible, and transparent supply chains – alongside our own efforts in the Solar Stewardship Initiative. In December 2022, the European Solar PV Industry Alliance (ESIA) was launched to support local manufacturing along the value chain in Europe.

These are the right moves, but we must be fast. Again, the long-term market forecast is much higher than policymakers anticipate, and the first European companies have already begun to set their eyes on US solar manufacturing capacities in response to their strong incentive package. EU plans in the first half of 2023, around revamping state subsidy rules for critical manufacturing, and a new European Competitiveness Strategy, will define Europe's place in the global solar race.

Sleeves up, and let's go to work to get ready for the solar age in Europe!

WALBURGA HEMETSBERGER
Chief Executive Officer

DRIES ACKE
Policy Director

MICHAEL SCHMELA
Executive Advisor & Director
Market Intelligence

Table of contents

Lead author: Michael Schmela, SolarPower Europe.

Market intelligence and internal co-authors: Jonathan Gorremans, Christophe Lits & Raffaele Rossi, SolarPower Europe.

External co-authors: José Donoso, UNEF (ES) ; Paulina Wojciechowska, PSF, & Stanislaw M. Pietruszko, PV Poland (PL); Wijnand van Hooff, Amelie Veenstra & Nold Jaeger, Holland Solar (NL); Marie Buchet, SER (FR); Federico Brucciani, Italia Solare, Michelangelo Lafronza, ANIE Rinnovabili, & Alessandro Scipioni, Elettricità Futura (IT); Susana Serôdio, Gonçalo Martins & Mariana Carvalho, APREN (PT); Jacob Klivager Vestergaard, Green Power Denmark, & Flemming Kristensen, DPVA (DK); Stelios Psomas, HELAPCO (EL); Oskar Öhrman & Anna Werner, Svensk Solenergi (SE).

External contributors: PV Austria (AT); ODE, EDORA (BE); APSTE (BG); SEAPEK (CY); Solární Asociace (CZ); European Energy (DK); Fortum (FI); BSW-Solar (DE); MANAP (HU); ISEA (IR); ILR (LU); REWS (MT); RPIA (RO); SAPI (SK); ZSFV (SI).

Text editing: Bethany Meban, Lily Murdoch & Thérèse O Donoghue, SolarPower Europe.

Please cite as: SolarPower Europe (2022): *European Market Outlook for Solar Power 2022-2026*.

Published: December 2022.

ISBN: 9789464669015.

Contact: info@solarpowereurope.org.

Thanks to our Sponsor Members:

Design: Onehemisphere, Sweden. contact@onehemisphere.se

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

2022 was the year when solar power displayed its true potential for the very first time in the EU, driven by record high energy prices and geopolitical tensions that largely improved its business case. No longer constrained by severe supply chain bottlenecks and COVID-19 related restrictions, the 27 EU Member States saw 41.4 GW of new solar PV capacity connected to their grids, a 47% increase compared to 2021.

Such a steep increase did not seem possible one year ago, when the solar market had already expanded by 41% to 28.1 GW, marking the best year in history. But the role of solar has drastically changed since then, as the EU and its Member States have identified this technology as a green, affordable and unmatched rapid solution to reducing their dependence on Russian fossil fuels. The record-breaking 2022 EU solar market is 38% or 10 GW higher than what we expected one year ago, and even 16% or 5.5 GW above our High Scenario from December 2021.

Like last year, Germany is again Europe's biggest solar market in 2022 with 7.9 GW of newly installed capacity, followed by Spain (7.5 GW), Poland (4.9 GW), the Netherlands (4.0 GW), and France (2.7 GW). While the Top 5 EU markets stayed the same, Portugal and Sweden have entered the Top 10, at the expense of Hungary and Austria. For the first time, all Top 10 markets are also GW-scale markets. In 2022, 26 out of 27 EU Member States deployed more solar than the year before.

The EU's solar power generation fleet increased by 25% to 208.9 GW, from 167.5 GW in 2021. Total solar capacity across the EU has exceeded 200 GW, only four years after it passed the 100 GW milestone in 2018. With 68.5 GW Germany maintains its role as the largest operator of solar power plants in the EU. Spain is now ranked 2nd, reaching a total of 26.4 GW thanks to an extraordinary market growth. It takes this spot from Italy, which was in control of the EU's second largest solar fleet since 2011.

When it comes to solar power per capita, the Netherlands continues to lead the way. In 2022, the Netherlands not only reached the remarkable milestone of more than 1,000 watt of installed solar power per inhabitant, it also widened the distance to Europe's powerhouse, Germany, which had 816 W/capita installed at the end of 2022.

For most Member States, the 4-year installation forecasts from 2023 to 2026 expect significantly more power additions in comparison to last year's EU Market Outlook. This is driven primarily by Germany and Spain, who are expected to add 62.6 GW and 51.2 GW more solar respectively over the next four years.

This year's EU solar market scenarios 2023 to 2026 show continuous, two-digit annual growth rates that are all significantly higher than in our previous edition. At a 29% annual growth rate, 2023 is set to be another record year for European solar: the new EU ambitions set under the REPowerEU plan, along with the need to tackle the current high electricity prices, will drive the sector to 53.6 GW in 2023, according to our Medium Scenario. It will be the first time that the 50 GW threshold is reached, and will also be the year when two countries, Germany and Spain, are expected to exceed 10 GW annual installations for the first time. In 2024, our Medium Scenario anticipates a 16% growth rate to 62.3 GW, followed by 74.1 GW in 2025 and 85.2 GW in 2026, more than doubling the current market size.

New additions will bring total solar capacity to 262 GW in 2023 and 484 GW in 2026, more than doubling today's operating fleet. This pathway is also more or less aligned with the REPowerEU interim target of 400 GW (320 GW_{AC}) by 2025.

In the period 2027-2030, we expect that additional growth will take place thanks to improved policy conditions and further technology cost reductions. The total solar fleet in the EU is projected to reach 920 GW under a Medium Scenario and 1,184 GW under a High Scenario. Both scenarios largely surpass the 750 GW solar by 2030 target set in the EU Commission's REPowerEU strategy, by 24% and 58% respectively.

Our revised assessment of solar developments in the context of the EU Member States' National Energy Climate Plans (NECPs) shows that 21 EU Member States will have already reached their 2030 solar goals no later than 2025, while the remaining 6 Member States will do so no later than 2027. According to our updated forecast, the NECP aggregate target will be reached already in 2025 under business-as-usual conditions.

While this is very positive news for the sector, and for the entire EU, it also indicates that the ambition should be raised further at both the EU and Member State Level. Reaching the Terawatt milestone by end of the decade would pave the way for a multi-TW solar development towards 2050 that is needed for the EU to remain on track to deliver on its climate ambitions.

Policy recommendations

Fit for a Solar Future

The energy crisis has catapulted Europe into a new paradigm. The well-known energy trilemma between sustainability, affordability and security of supply is now pointing unambiguously in the same direction: accelerating solar, renewables, and electrification.

It is within this context that we present this year's European Market Outlook for Solar Power. Clearly, solar is delivering for Europe's citizen and businesses. Annual installations in 2022 beat all expectations, and projections for the next years see that trajectory accelerating even more. The European Union may well become a 100 GW annual market within the next four years with solar uptake speeding up in all European countries. Solar will be the kingpin of Europe's energy system, and 2022 will be marked as the year that this reorientation kicked off in earnest.

It is time to take the solar reality seriously. We should take a moment to fully grasp what these figures mean and the opportunity it represents for Europe's security, prosperity, and stability. Let's get ready for solar.

Getting ready for solar starts with planning. The upcoming revision of European National Energy and Climate Plans (NECPs), expected for June 2023, is a key moment. If there is one message from this report for policymakers across Europe: take a good look at these projections, embrace the opportunity, and reflect it in your revised NECPs.

The biggest mistake we can make is to take things for granted. Getting ready is an action, it's the opposite of complacency. We have set out the five key points that need attention and action now from EU and national decision makers to grasp the solar opportunity:

1. **Growing the pool of certified solar installers and skilled workforce**
2. **Maintaining regulatory stability and investor certainty for solar and renewables**
3. **Enabling smoother integration of solar PV in the grid, especially on distribution level**
4. **Improving spatial planning and permitting procedures for solar in harmony with people and nature**
5. **Ensuring sustainable and reliable solar PV supply chains**

1. **Growing the pool of certified installers and skilled workforce.**

   The strong demand for solar is a major opportunity for high quality job creation in communities across Europe and for workers across all segments of employment. Citizens place a high value on jobs that contribute to the energy transition.

   Skilled labour, however, risks becoming a real bottleneck to the deployment of solar PV. To meet official EU energy security goals – the REPowerEU plan -, the number of people employed in the solar sector will need to double in the next years, from 466,000 full time employees in 2021 to more than 1 million in 2030. Up to 80% of this workforce will be needed for the installation of solar PV on buildings, which – helpfully – aligns with skills required for the wider electrification of buildings like the installation and certification of heat pumps and EV charging infrastructure.

   EU and national decision makers need to take firm action to grow the pool of skilled workforce for solar. The EU can help coordinate national efforts to establish training programmes, particularly when it comes to mutual recognition of qualifications between Member States, and in ensuring that content of training programmes aligns with EU regulation and directives.

   At national level, firstly, **Member States need to thoroughly analyse and assess the skills gap** – a requirement that is expected to land early 2023 in the European Performance of Buildings Directive. They should then require universities and training providers to create courses accordingly and stimulate close cooperation between education institutions and the solar industry. Member States should also encourage young people to study and acquire these skills and pursue technical careers, for example through workshops in secondary

education. Second, **Member States should incentivise companies to undertake their own training programs** setting up enabling frameworks and financial incentives, for instance through tax reductions. Lastly, local authorities and municipalities should take neighbourhood approaches to solar deployment and building electrification, adding rooftop solar to all the houses in a neighbourhood at once to optimise the time and impact of the skilled workforce.

2. **Maintaining regulatory stability and investors certainty for solar and renewables.**

Member States have taken a variety of extraordinary measures in response to the energy crisis. The European Commission attempt to create a common framework, suggesting an EU-wide cap of 180 EUR/MWh on electricity market revenues from inframarginal technology generators until June 2023, has been welcomed by the solar industry but has not delivered the streamlining of measures across Europe. To the contrary, the spreading patchwork of measures, even applied retroactively in some cases, is creating a chilling effect on solar investors especially with regards to Power Purchasing Agreements. Market interventions should be clearly defined and time-limited to finance targeted measures that protect the most vulnerable in society from high prices. **The European Commission should issue clear guidance in order to support the proper implementation across Europe.**

The crisis also has sparked a deeper criticism of the EU electricity market fundamentals with calls for overthrowing the Internal Energy Market and the "merit order effect" as a way to decouple electricity from gas prices. SolarPower Europe welcomes the European Commission plan for a revision and further optimisation of electricity market functioning but emphasises this should not be done in a rush and be conducted in full transparency and with appropriate time for consultation with the industry. First and foremost, **any initiative should start with accelerating the implementation of currently agreed electricity market legislation**. That in itself will help to swiftly and significantly reduce the times that gas sets the marginal price for electricity.

3 **Enabling smoother integration of solar PV in the grid, especially on distribution level.**

Solar developers are reporting long delays in getting grid connections agreement or are unable to access grid capacity altogether. This is largely due to systematic underinvestment in electricity grid infrastructure and a suboptimal policy environment. It is, however, essential that grids are able to integrate large volumes of new solar and wind capacity, especially at the distribution level, and avoid curtailing, i.e. wasting, cheap, renewable electricity.

The EU Clean Energy Package includes several helpful elements that should facilitate grid connection of solar PV, through **improved network development plan practices and modernised remuneration schemes for distribution system operators.** Yet, the implementation of these provisions at a national level are delayed or incomplete.

In addition, EU and national policymakers should also develop clear strategies to boost flexibility and battery storage, starting by **setting indicative 2030 targets for storage at both EU and national level**, and removing double taxation of energy storage technologies.

Making solar mandatory for new and existing commercial, industrial, and public buildings, as proposed by the European Commission under REPowerEU, will provide grid operators with much-needed visibility and predictability to plan. This in turn will accelerate the integration of solar in distribution grids.

It is essential that all income profiles can benefit from solar – especially those most vulnerable to high energy prices. Member States should remove all limitations to third-party investment models and **develop comprehensive collective self-consumption schemes** to allow more people – including and beyond energy communities – to benefit from solar PV within low-voltage grids.

Policy recommendations

4 **Improving spatial planning and permitting procedures in harmony with people and nature.**

Permit-granting procedures for solar PV can take up to 5 years, which is incompatible with the deployment pace required by REPowerEU objectives. Member States, therefore, need to speed up spatial planning and permitting procedures, while maximising citizens and local participation and ensuring biodiversity protection.

Member States should designate priority areas of low environmental footprint as soon as possible, and latest within one year after entry into force of the Renewable Energy Directive. These areas should focus on artificial surfaces such as rooftops, transport infrastructure, industrial areas or brownfields, amongst others, where projects can benefit from accelerated and simplified procedures, including the rule of *silence means agreement* for the permit.

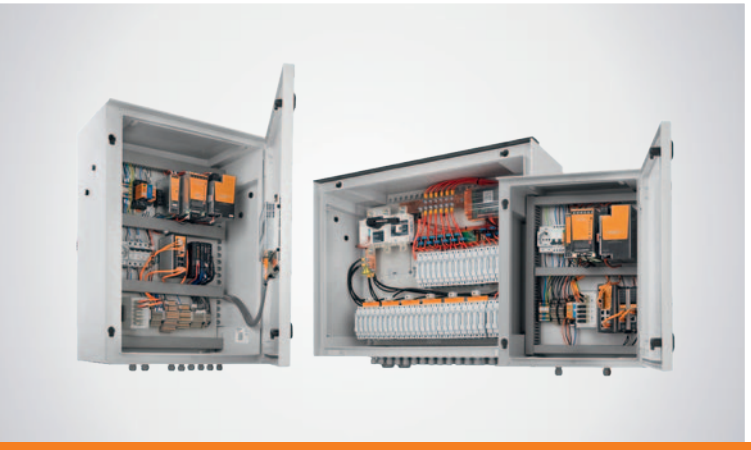
Improving the quality and the speed of permitting processes will require further staffing and skilling of local, regional, and national authorities. To ensure more efficient application of impact assessment and permit-granting process, Member States need to develop guidelines for Strategic Environmental Assessment and Environmental Impact Assessment for solar deployment, in line with EU and national nature laws, including a set of harmonised methods and aggregated data on ecological features of areas across Member States. This will facilitate the work of permitting authorities on all levels.

5. **Ensuring sustainable and reliable supply chains.**

The expected boom in solar PV deployment requires a good look at the sustainability and reliability of the supply chains. Today, Europe does not have a strong manufacturing industry along the supply chain for solar modules and is highly dependent on Chinese imports, especially for ingots and wafers. but also cells. The newly launched European Solar PV Industry Alliance should look at **mobilising public and private finance for European solar PV manufacturing projects to scale up as soon as possible, making best use of all existing and new European financing instruments**, notably via the REPowerEU chapter in the national recovery and resilience plans. Considering the proliferation of assertive industrial strategies around the world, especially in India and the US, it is essential for Europe to move fast and big on this matter, allowing support to upfront investment (CapEx) and operating costs (OpEx) alike.

Europe must nevertheless still be integrated in a global value chain and has, therefore, the leverage to ensure that imported products are sustainable from an environmental, social and governance point of view and that there is transparency on materials and component origins. Supporting and recognising multi-stakeholder industry-driven schemes such as the Solar Stewardship Initiative can be instrumental in enhancing sustainability and transparency in the global solar value chain. It also facilitates effective cooperation between policymakers, civil society and industry on tackling present and future sustainability challenges faced by the solar sector. In parallel, the **EU must accelerate Free Trade Agreement negotiations with trading partners with a view to ensure steady and diversified supply of critical raw materials, components and solar modules.**

Convince yourself from our reference projects:
www.weidmueller.com/pv-references



PV Solutions

Efficient operation & installation of all PV systems

Whether you are designing PV systems on the roof, ground or even on water, we are the partner at your side:

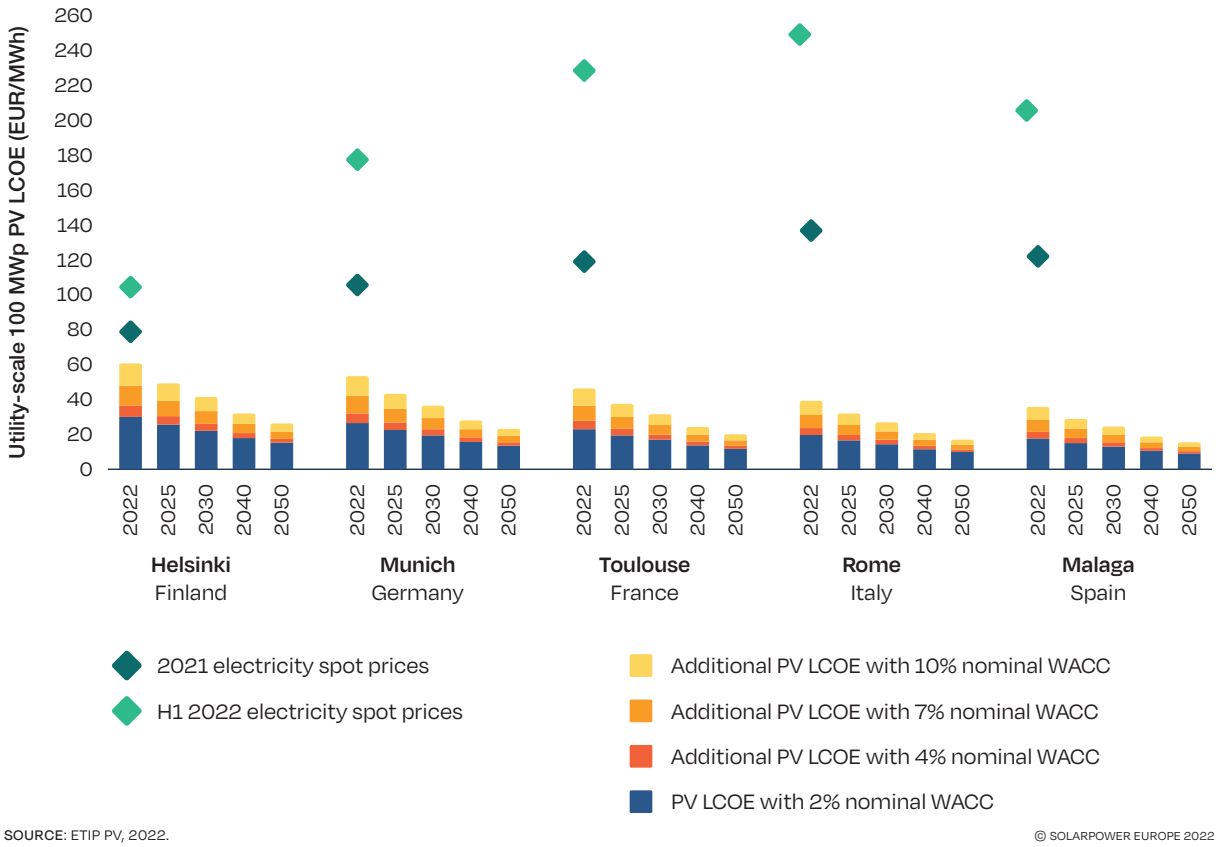
- Combiner boxes for connection, protection and combination of PV strings
- Monitoring and communication of string performance and component status
- Complete portfolio of installation accessories
- Global footprint but localised production

More information on our website:
www.weidmueller.com/pv-solutions

Weidmüller

If in the past few years, solar had already improved its business case but remained somewhat hindered by adverse exogenous conditions in Europe, 2022 has been the year when the true solar potential in the EU was acknowledged by top policy makers for the very first time. No longer hampered by COVID-19 restrictions and with its severe supply chain bottlenecks increasingly overcome, solar power in Europe demonstrated how easily this cost leading technology can be deployed at all scales under the right policy and investment conditions.

FIGURE 1 PV LEVELISED COST OF ELECTRICITY (LCOE) IN FIVE EU LOCATIONS, 2022-2050



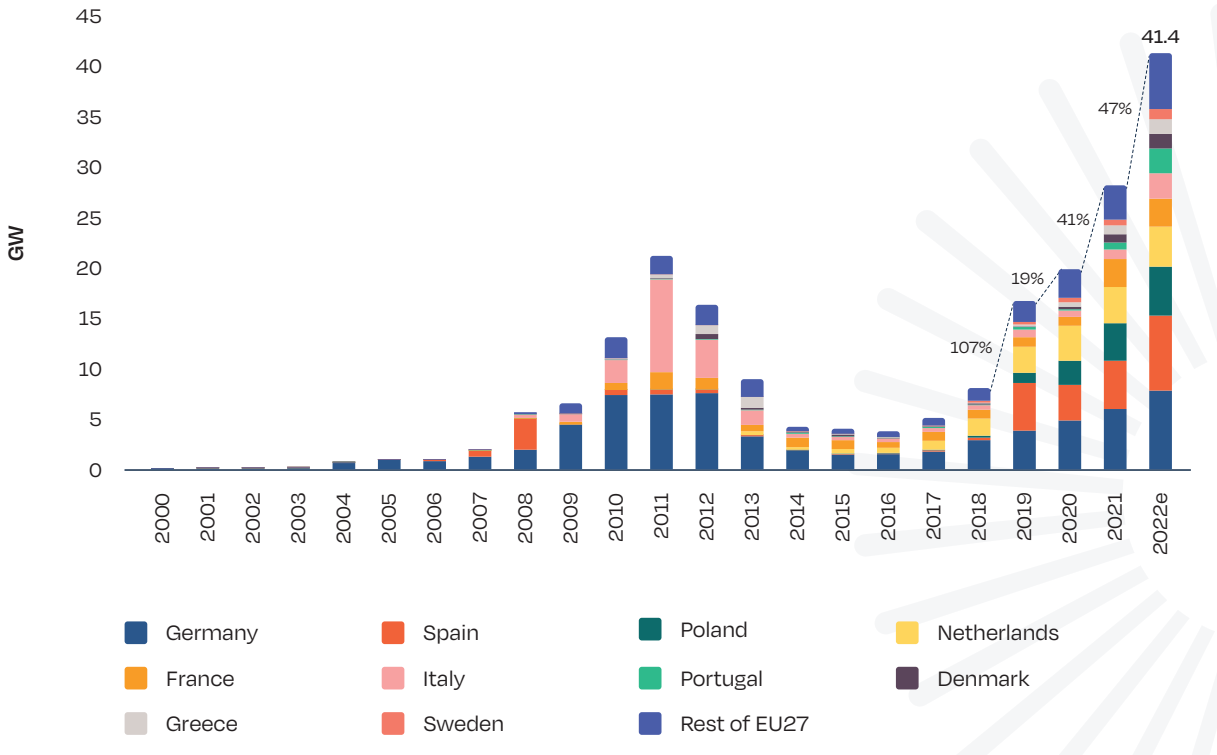
SOURCE: ETIP PV, 2022.

While electricity spot prices across Europe had already reached new heights in 2021, improving solar power's very attractive business case, it was the start of the Russian war against Ukraine in February 2022, and the following geopolitical tensions, that have resulted in record high energy prices, and big concerns of both companies and citizens about their energy security. Subsequently, solar investments are extremely attractive everywhere in Europe – even in a northern country like Finland – and also in high-interest rate environments (see Fig. 1).

In 2022, the 27 EU Member States saw 41.4 GW of new solar PV capacity connected to the grids, a 47% increase compared to 2021, which had also been a record-breaking year, when the solar market had already expanded by 41% to 28.1 GW, marking the best year in history (Fig. 2). But due to the Russian war and the energy price crisis, the role of solar in the EU has changed drastically, as both the European Commission and the Member States have identified in this technology a green, affordable and unmatched rapid solution to their urgent need to decrease their dependency on Russian energy imports.

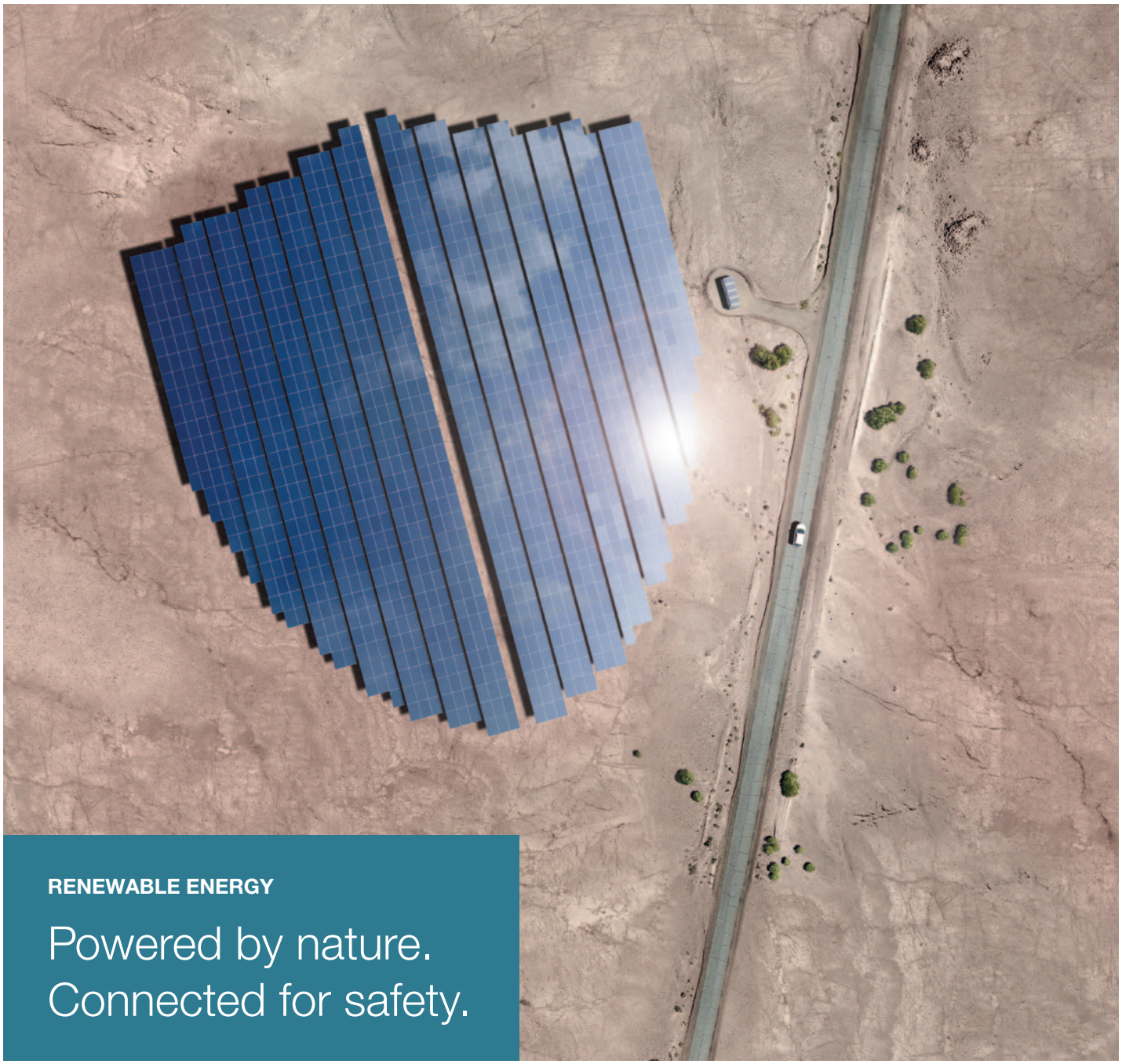
In the last edition of our EU Market Outlook 2021-2025, we anticipated a 16% growth to 30 GW under our Medium Scenario, and a 35.7 GW market under our High Scenario for 2022. Upon the publication of our latest Global Market Outlook from June 2022, our expectations were revised upwards to 33.6 GW for the Medium Scenario and 39.7 GW for the High Scenario. Even these higher expectations will be outdone in the end, as the market will comfortably surpass the 40 GW milestone this year – more than 10 GW higher than what we expected one year ago (see Box 1, p. 23).

FIGURE 2 EU27 ANNUAL SOLAR PV INSTALLED CAPACITY 2000-2022



FAST MOVING TECHNOLOGY

STÄUBLI



RENEWABLE ENERGY

Powered by nature. Connected for safety.

**The Original MC4 by Stäubli –
the world-leading connectors for PV systems.**

When it comes to photovoltaic power stations, measurable success depends on even the smallest details. Designed with Swiss precision craftsmanship, our connectors help you prevent unnecessary and costly downtime. To ensure longstanding performance, rely on the partner with a superior safety track record.

Stäubli – Connections for sustainable change

www.staubli-renewable-energy.com

1.1. Top 10 EU solar markets 2022 in brief

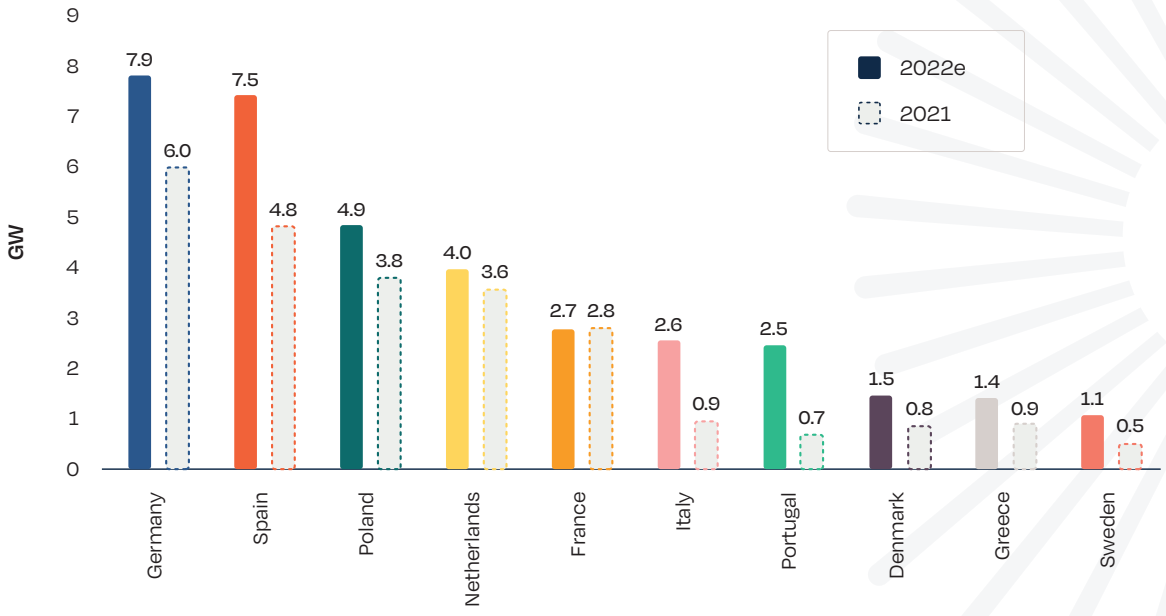
The top 5 markets in the EU are the same, though in a different order than in 2021. Amongst the top 10 markets, there are two newcomers, Portugal and Sweden, replacing Hungary and Austria. Hungary and Austria still improved their solar performance in 2022. For the first time ever, all top 10 EU solar markets reached the GW scale (Fig. 3).

Like last year, **Germany** is again Europe's major solar market in 2022. It connected 7.9 GW, compared to 6.0 GW the year before. The EU's largest economy has mostly held the no. 1 position since the early 2000s.

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. This is 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, in addition to solar's steadily improving cost competitiveness. With a new Green Party-led Economy Ministry, creating a new 2030 solar target of 215 GW installed capacity, another revision of the Feed-in Law (EEG) took place in July 2022, setting improved investment conditions for the rooftop segment: among others, the feed-in tariff for new systems has been increased; the monthly decreasing trajectory of feed-in rates for new systems is now frozen until 2024; and the technical limit to input only 70% of rated power output will be scrapped from January 2023. Furthermore, high electricity prices improved the business case for solar, in particular in combination with batteries.

Spain ranks 2nd in Europe, experiencing a remarkable increase bringing the market to 7.5 GW, up 55% from 4.8 GW in 2021. The utility-scale segment has been thriving for a while, surpassing 4 GW of additions this year, the first time since 2019. In contrast, the growth of rooftop solar has proven surprising. This is a newly developed segment in Spain which only emerged after a prohibitive tax was cancelled in 2019, receiving a real boost through the energy crisis. In 2022, the market more than doubled compared to 2021. The disappointing results of the auction that took place in November 2022, where no solar capacity was awarded despite 1.8 GW being initially allocated to solar, must not be seen as a signal of lowered performance for the sector. Under the current energy market conditions, developers are selecting projects which sell their power on the free market, as this option is more attractive than government-run tenders.

FIGURE 3 EU27 TOP 10 SOLAR PV MARKETS 2021-2022

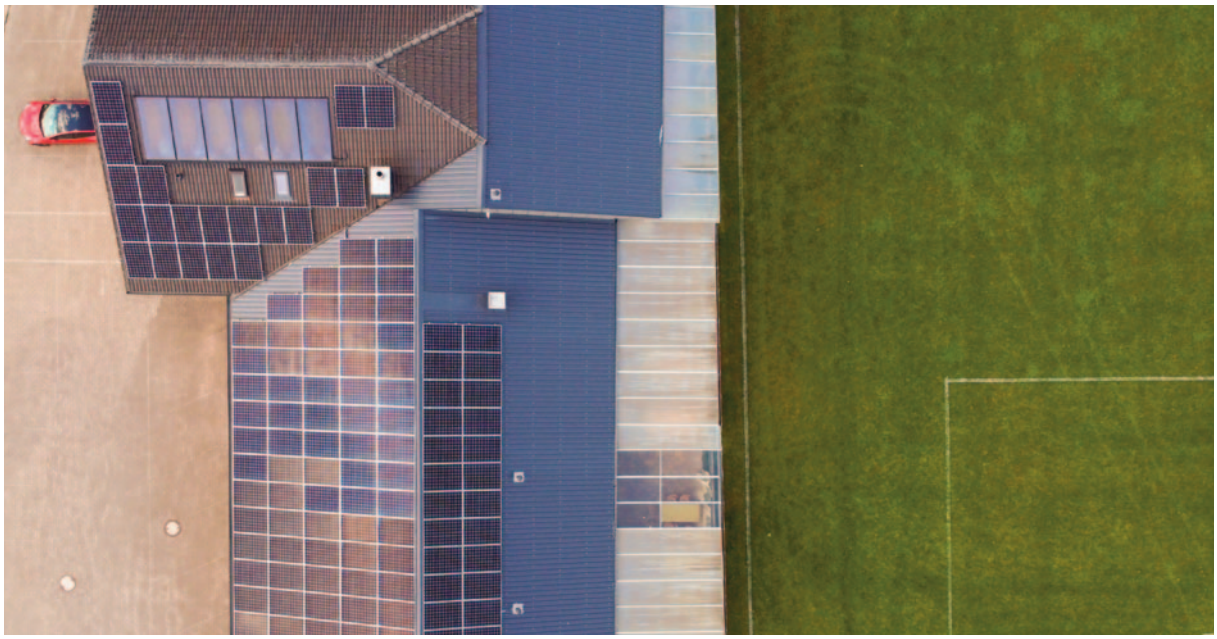


Rounding out the top 3 positions, **Poland's** solar performance has been remarkable, the country increased its annual solar additions again – this time by 29% to 4.9 GW, from 3.8 GW added in 2021. The shift from net-metering to net-billing since April 2022 led to a rush of installations in the first quarter of the year in the small-scale rooftop segment. Even with a somewhat less attractive support framework for small-scale solar, high electricity prices and severe energy security concerns from Russia's war have ensured a sustained pace of installations throughout the year. In parallel, the utility-scale segment keeps growing at a rapid pace as the country tries to limit its dependency on fossil sources.

The **Netherlands**, ranks 4th, continuing on its upward solar path. The country installed 4 GW in 2022, up 11% from the previous year. Driven by a continuous attractive net-metering policy, the residential segment contributed the lion's share of this growth, with 1.8 GW of capacity additions. By contrast, the C&I segment, facing decreasing subsidies from the SDE++ scheme coupled with increased technology and logistics costs, has lost some traction. Nonetheless, the Dutch market retains a good balance between its different segments, a factor that contributes to its 1st spot in Europe when it comes to solar capacity per capita. In a country where space availability is a challenge, the industry is increasingly looking into multi-functional PV applications such as floating solar or solar carports, as well as local participation in renewable energy projects to improve social acceptance.

France remains the EU's 5th largest PV market in 2022, with 2.7 GW of annual additions. A marginal decrease of 2% has been observed after the record-breaking 2021 performance, when the market grew 218% year-on-year. The increase in solar prices and difficulties in access to land observed in 2022 has led many developers to put projects on hold until economic and regulatory conditions improve. The commercial self-consumption segment, on the other hand, has increased its size, thanks to a revision of the policy framework in autumn 2021, when the threshold for rooftop tenders increased from 100 to 500 kW, making more systems eligible for feed-in tariffs. Though still small compared to its European peers, residential solar is also gaining traction in the country.

Solar in **Italy** is finally back to the annual GW size for the first time since 2013, granting the Mediterranean country the 6th place in the EU. With an estimated 2.6 GW added capacity and a 174% year-on-year growth, the Italian market is flourishing. The small-scale PV segment has bolstered the market, thanks to the country's favourable Superbonus 110% incentive scheme, and high electricity prices which have improved the attractiveness of self-consumption business models. While permitting and identification of suitable land remains a key challenge for larger PV projects, positive steps towards simplified procedures are already being implemented.



© Tesla

One of the two new entries in this year's top 10 is **Portugal**, which is also joining the GW market club for the first time. The country, ranked 7th, is poised to grow 251% to 2.5 GW this year, primarily due to the large increase in utility-scale solar. A large number of projects, including those stemming from the auctions in 2019 and 2020, have been granted permits until the end of 2022, meaning they will most likely be completed by the end of 2022. The self-consumption segment, which played a marginal role in the past, is also quickly gaining pace.

The 8th position is taken by **Denmark**. With 1.5 GW installed and a 75% annual growth, the Nordic country became a GW market in 2022, after missing this milestone in 2021. While subsidy-free solar PV parks provide the lion's share of new installations, thanks to well-functioning and transparent regulations for permitting and grid connection procedures, notable growth is also taking place in the rooftop segment.

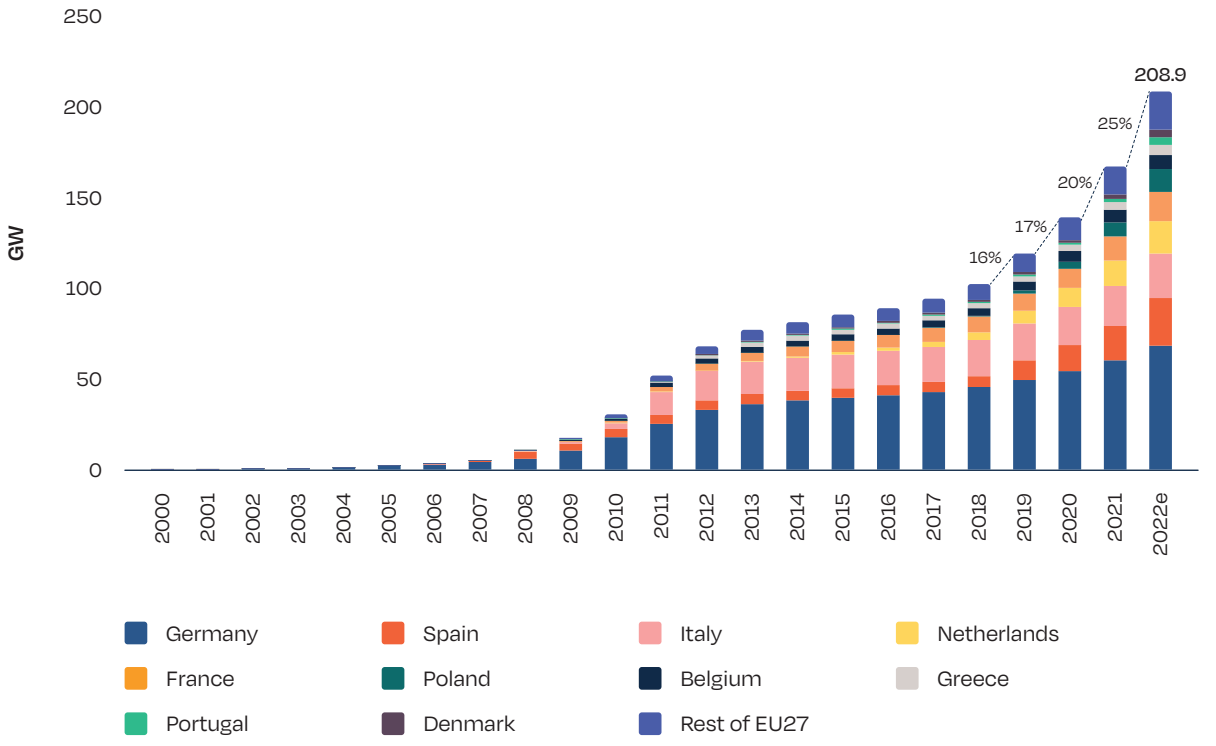
Another country that was expected to become a GW market in 2021 but only reached this goal in 2022 is **Greece**. The Greek market has grown by 62% to 1.4 GW, driven mostly by small ground-mounted PV projects up to 500 kW for which a feed-in premium is available until the end of 2022. In parallel, the utility-scale and the residential segments are also experiencing growth – the former supported by an auction scheme and simplified authorisation procedures, the latter driven by the energy crisis. However, Greece dropped 2 places to rank 9th in Europe in 2022.

In **Sweden**, rounding out the top 10, solar demand keeps being driven by tax incentives and grants. Residential PV systems, whose demand was fuelled by soaring energy prices, provided about half of the country's annual installed capacity. The country reached the GW level for the first time with 1.1 GW and a striking 98% growth.

The EU's top 10 solar markets were responsible for 87% of total installations in 2022, decreasing their share by 3 percentage points from 90% in 2021. This is based on new additions of 35.9 GW, compared to 25.2 GW in 2021, reflecting a decreasing market concentration. In the meantime, the share of the top 5 solar markets has continued its downward trend, claiming 65% of the market in comparison to 75% in 2021, and 78% in 2020. This reflects a more balanced and diversified distribution of new installations. This is also seen in the increased number of countries installing more solar than the year before. In 2022, almost all EU Member States deployed more solar than the year before – with only one exception, France, whose market decreased marginally by 47 MW. In 2021, 25 EU countries experienced increased annual growth.

From reviewing Members States' National Energy Climate Plans (NECPs) published in 2019, it is apparent that most European policymakers have severely underestimated their electorates' interest in solar. By now, several countries have already met their 2030 NECP targets, and 21 of the 27 EU Member States will meet their 2030 targets by end of 2025 (see Chapter

FIGURE 4 EU27 CUMULATIVE SOLAR PV INSTALLED CAPACITY 2000-2022



3). For this reason, the revision of NECPs starting in 2023 is a crucial opportunity for EU countries to improve their solar ambitions.

In 2022, the EU-27 Member States' total installed solar capacity of the major markets has followed the trend observed for annual additions. The EU's solar power generation fleet increased by 25% to 208.9 GW, from 167.5 GW in 2021 (see Fig. 4). Total solar capacity across the EU has exceeded 200 GW, only four years after it passed the 100 GW milestone in 2018.

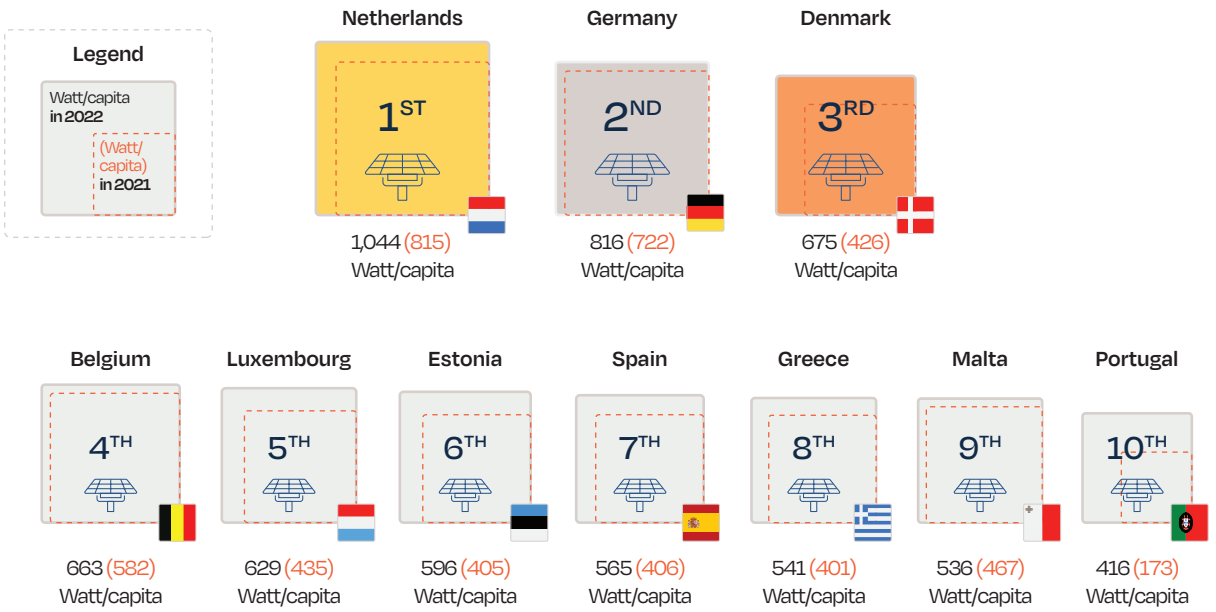
When looking at the developments of the EU markets' cumulative PV capacities at the end of 2021, a few changes can be observed compared to the year before. **Germany** maintains its role as the largest operator of solar power plants in the EU. With new annual additions of 7.9 GW to around 68.5 GW cumulative installed capacity by the end of 2022, the spread with the second largest market has widened once more.

Thanks to its extraordinary growth, **Spain** ranked 2nd in the EU in 2022, reaching a total of 26.4 GW. It takes this spot from Italy, which was in control of the EU's second largest solar fleet for over a decade since 2011. Italy installed around 2.6 GW in 2022 – a good performance, but not enough to overcome the many years it was lagging behind in European solar developments.

For the first time, a country exceeding 10 GW of operating capacity is positioned outside the top 5 – that is Poland, with a solar fleet of 12.5 GW. The remaining top 10 countries stay below this level: Belgium at 7.7 GW, Greece at 5.6 GW, Portugal at 4.2 GW, and Denmark at 3.9 GW. Hungary, which is also at 3.9 GW, stays out of the top 10 in 2022 because of a few MW difference.

Other GW-level EU solar fleets at the end of 2022 were Austria (3.8 GW) , Sweden (2.7 GW), Czech Republic (2.6 GW), Romania (1.8 GW) and Bulgaria (1.5 GW), the same number as in the previous year.

FIGURE 5 EU27 TOP 10 COUNTRIES SOLAR CAPACITY PER CAPITA 2022



Despite its absolute solar growth and outstanding position in the EU, Germany now holds 33% of the installed capacity in Europe; it held 36% in 2021. Other countries are catching up. Spain's installed capacity improved by 2 percentage points to 13%, while Italy's capacity decreased by 1 percentage point to 12%. Together, the EU's largest solar operators, now Germany and Spain, claim a total installed capacity of 45%. This is 4 percentage points less than 2021, when Germany and Italy combined controlled 49% of the total EU fleet. The share of the top 5 cumulative markets also keeps decreasing, standing at 74% in 2022, 77% in 2021 and 80% in 2020. At the same time, the top 10 markets now claim a 90% share of installed capacity, 1 percentage point less than the year before.

When it comes to solar power per capita, Europe's long-time solar leader Germany does not hold the first position. For the second year in a row, Netherlands ranks first, reaching the remarkable milestone of more than 1,000 watt per inhabitant in 2022, 28% up from 815 W/capita in 2021. Germany's average installed solar power per person increased to 816 W/capita, 13% growth 722 W/capita in 2021. Denmark takes third place with 675 W/capita, up from 426 W/capita in the previous year, leaving behind Belgium, now standing at 663 W/capita in fourth place. Besides Luxembourg, at 629 W/capita, all other top 10 EU solar markets per capita control capacities below the 600 W/capita level, although the level for joining this group (this time, Portugal) was lifted to 416 W/capita, compared to 364 W/capita in 2021 (then, Italy).

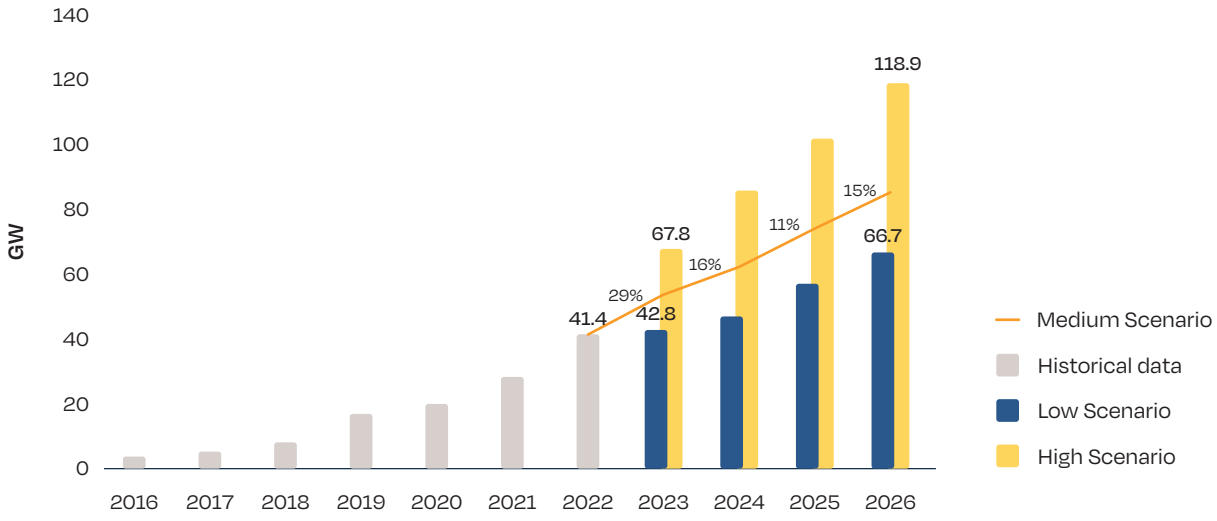
In summary, in 2022, solar displayed yet another stellar performance, sustained by high energy prices and increased policy support. The EU grid-connected capacity stood at 41.4 GW in 2022, 47% more than the year before and 38% higher than our forecast from the previous EU Market Outlook published in December 2021. The same pattern applies to cumulative installed capacities, which increased by 25% to 208.9 GW. Demand in Germany continues to dominate the EU solar market, both in terms of annual and total solar installations at 7.9 GW and 68.5 GW respectively, but the strong growth in Spain allowed the country to get closer to Germany in annual additions, and to surpass Italy in cumulative capacity. On installed PV capacity per capita, the Netherlands remains unbeaten again, breaking the impressive 1,000 W/capita threshold for the first time in Europe, way ahead of the second ranking country Germany with 816 W/capita.

1.2. Prospects 2023-2026

2022 has been an impressive year for the European solar sector. 2023-2026 will be characterised by further strong growth, according to our Medium Scenario (see Fig 6). Module prices have remained generally high over the course of 2022 but recently started to ease as availability has significantly improved in Europe. Issues still exist at the supply chain level. The shortage of polysilicon production capacity, which was a major reason for higher module prices, is coming to an end, while the market continues to experience a shortage of inverters. The scarcity of inverters can be attributed to the global semiconductor chips shortage, ongoing since 2020. The COVID-19 pandemic has impacted the leading manufacturers of chips in Asia which has subsequently impacted a range of industries. The worst bottleneck in the extended solar segment can be seen for battery energy storage systems, which severely limited the growth for the residential BESS segment in 2022, as shown in our recently published European Market Outlook for Residential Battery Storage 2022-2026.

Nonetheless, at a 29% annual growth rate, 2023 is set to be another record year for solar in the EU. It will be the first time that the 50 GW threshold is reached. The new EU ambitions set under the REPowerEU plan, along with the need to tackle the current high electricity prices, will drive the solar sector to 53.6 GW in 2023. It will also be the year when two countries, Germany and Spain, are expected to exceed 10 GW annual market size for the first time. This would break the record for annual PV grid-connections in a year by a single European country. Currently, Italy holds this title from when it added 9.3 GW in 2011 with the help of uncapped feed-in tariffs. In 2024, our Medium Scenario anticipates a 16% growth rate to 62.3 GW in the EU. The Medium Scenario growth rates will remain in the same range in the following two years – 19% in 2025 and 15% in 2026 – which will result in annual solar deployment volumes of 74.1 GW in 2025 and 85.2 GW in 2026.

FIGURE 6 EU27 ANNUAL SOLAR PV MARKET SCENARIOS 2023-2026

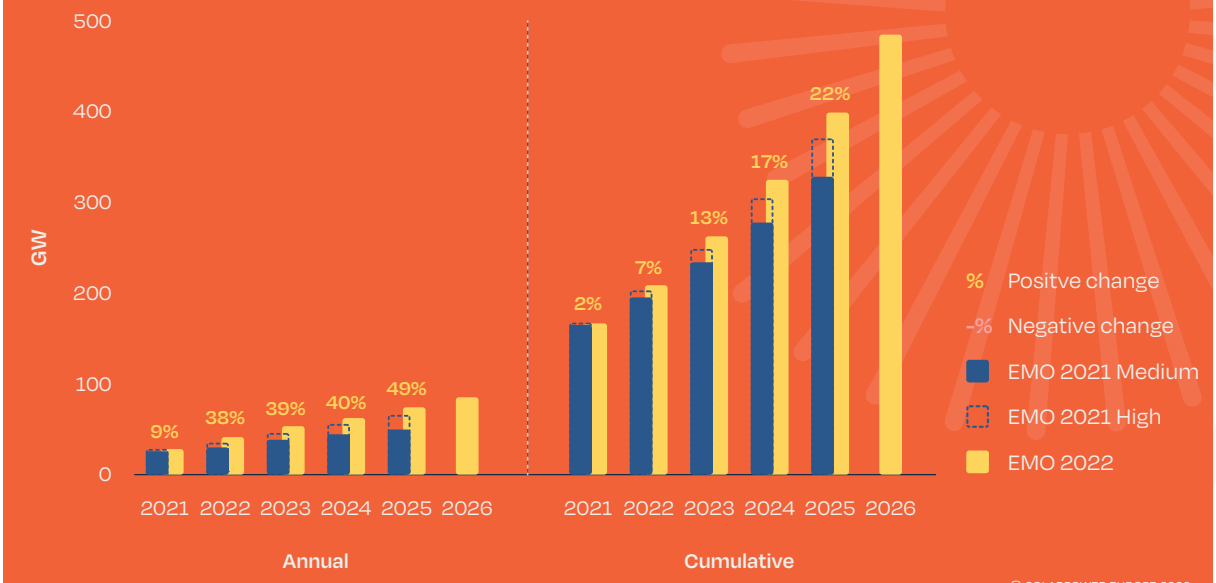


Box 1: Looking back and forth

When we published our previous EU Market Outlook, we registered a strong market growth (+34%) to 25.9 GW, an all-time high for the EU, beating the previous 21.3 GW record from a decade ago. While several factors pointed to an improved business case for solar in the EU, some crucial barriers remained. These included policymakers' lack of recognition of solar's important role to reduce fossil fuel dependency and facilitate the green energy transition across Europe. One year later, solar is at the core of the EU energy strategy. On 18 May 2022, the European Commission published the REPowerEU package setting out the roadmap for ending reliance on imported Russian fossil fuels. The package of announcements included a first-of-its-kind EU Solar Strategy increasing solar ambition in Europe by 43% and uncovering several steps to speed up solar deployment: new guidance on permitting, a Solar Rooftops Initiative, an EU Solar PV Industry Alliance and a Solar Skills Partnership. This reflects the increasing trust that EU policymakers have in the potential of solar power.

Due to these dramatic changes, in this year's edition we have significantly increased our forecast for all years. We revised our country statistics for 2021 and found that 28.1 GW of new solar PV capacity was connected to the grids for this year, 9% more than what we had estimated previously. Between 2022 and 2025, our Medium Scenario forecasts higher annual markets with differences ranging from 38% to 49% (see graph, left part). Our revised 41.4 GW outlook for 2022 is 38% higher than the 30 GW we expected one year ago, fuelled by strong solar demand to curb extremely high energy prices across the continent. In fact, it is even 16% higher than our High Scenario from last year. We are very optimistic for 2023, 2024 (+39% and 40% respectively) and 2025 in particular, where our Medium Scenario expectations have grown by 49%, with an increase of 24 GW compared to last year. Our expectation for total installed capacity in 2022 is 7 percentage points higher compared to our previous EU Market Outlook; in 2025, this is 22 percentage points higher, with 71 GW more than we expected last year (see graph, right part).

FIGURE 7 COMPARISON MEDIUM SCENARIO EU MARKET OUTLOOK 2022 VS 2021



The drivers for solar in Europe are much stronger than before, accelerating growth in the coming years:

- The energy crisis and the underlying current geopolitical context has led to EU policymakers prioritising the acceleration of renewables' deployment. In the short term, emergency measures are being taken to ease permitting procedures and accelerate the rollout of solar projects. In the medium term, the Commission is proposing to raise the EU RES target to 45% for 2030. The European Commission's REPowerEU pledge to end Europe's dependence on Russian fossil fuels also includes a new EU solar target of 750 GW_{DC} by 2030.
- As a consequence of skyrocketing electricity prices, the demand for residential and C&I solar PV is booming. Households and businesses are turning to solar to find a way to shield themselves against rising energy bills. In countries like Germany, there is an advanced battery storage market, as consumers want to increase self-consumption rates and create individual energy security in case of blackouts.
- High wholesale market prices also means that the business case for subsidy-free solar systems has improved considerably across Europe. In Denmark and Spain, corporate solar sourcing has already evolved into a key driver for the strong growth of the countries' solar sectors, while subsidy-free projects have been quickly developing in several other markets as well. Depending on how the upcoming EU discussions on price caps aiming to eliminate windfall profits from the energy crisis proceed, investor confidence could be severely damaged and impact financing.
- The versatility of solar remains unparalleled, enabling various multi-purpose applications which match increasing interest thanks to increased cost-competitiveness. Rooftop solar for carparks allowing direct EV charging and other technical

solutions enabling dual use of space, such as floating solar or Agri-PV, are more frequently seen, and attract the interest of policymakers. For instance, in France, a new proposed measure requires the installation of rooftop solar on carparks over 80 parking slots – this measure alone could add up to 11 GW of new solar PV in the country, enabling direct EV charging.

- As part of its Rooftop Solar Initiative, the European Commission has also proposed a solar rooftop mandate for all commercial and public buildings by 2027, and for new residential buildings from 2029. A first rooftop solar mandate was implemented in the German State of Baden-Wurttemberg in 2022. With solar mandates turning the technology into a standard for new buildings, architects will integrate solar PV into their building practices. 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 and should support the deployment of building-integrated photovoltaic (BIPV) in Europe.
- SolarPower Europe has listed several policy asks in this EU Market Outlook to accelerate the deployment of solar and to help the EU reach its climate goals. (see p. 8).

While the annual additions for the coming 4 years forecasted in the Medium Scenario appear high, there is a possibility that the market will grow even faster, which it will need to if the EU wants to meet the 1.5°C Paris target. Our **High Scenario** projects 67.8 GW already in 2023, and up to 118.9 GW new solar additions in 2026. This seems very ambitious, but in the past, stakeholder predictions have turned out to be much too conservative. The EU annual deployment in 2022 (41.4 GW) has even slightly outpaced our June released Global Market Outlook 2022 High Scenario (39.7 GW). In this year's High Scenario, we assumed that the central role of solar in EU energy policy will remain, and most importantly, that most issues related to product availability will be resolved. In contrast, our Low Scenario anticipates the 2023 demand to remain slightly above 2022 levels at 42.8 GW, and to grow to 66.7 GW in 2026. This scenario was modelled assuming severe supply shortages of inverters and modules, amid global trade conflicts leading to import bans. It also accounted for the EU not establishing relevant solar manufacturing capacities along the value chain. This scenario is more than unlikely when observing the current shipment flows towards Europe, which received more than 70 GW of modules from China in the first nine months of 2022.

© ABO Wind

The implementation of revenue caps as extraordinary measures across several EU Member States remains an unknown. An inappropriate implementation of poorly designed measures would bring catastrophic consequences to solar projects and their bankability, harming in particular mid-size companies.

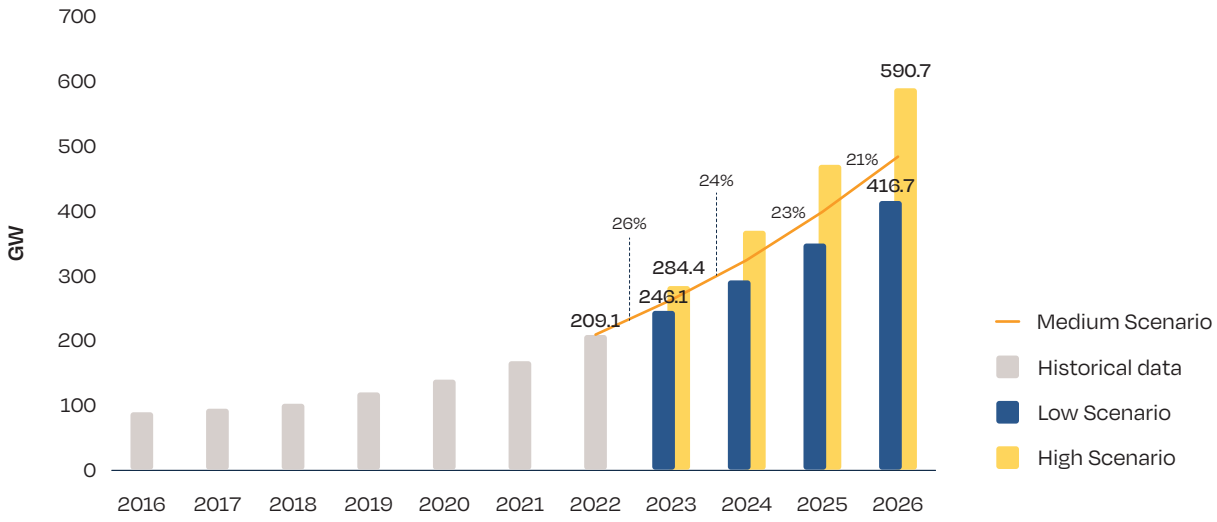
Finally, a potential key bottleneck will be the capacity of installers to cope with the ever-increasing demand. A lack of workers will reduce the growth prospects, but will not decrease the overall installations as they theoretically have at minimum the capacity to install as much a what has been installed the previous year.

This year's EU cumulative PV capacity scenarios 2023 to 2026 show continuous, two-digit annual growth rates, characterised by a strong uptake in 2023 and 2024 as the energy crisis is fuelling solar demand (see Fig. 8). The Medium Scenario forecasts 26% and 24% growth rates for 2023 and 2024 respectively, compared to 20% and 19% in last year's analysis. Under the Medium Scenario, total capacities continue to expand considerably in 2025 and 2026, at 23% and 21% respectively. After a strong growth in 2023-2024 following Russia's war, this momentum will eventually plateau. Secondly, as the EU solar fleet grows larger, its yearly variation in percentage is decreasing. Under our Medium Scenario, during the years 2023 to 2026, new additions will bring around 275.2 GW to reach 484.1 GW of total installed capacity by the end of 2026. This means that the EU solar power generation fleet will more than double within four years from the 209 GW in operation today. This will reflect the REPowerEU interim target of 400 GW (320 GW_{AC}) by 2025, a target some considered overly ambitious at the time of publication in May 2022.

The High Scenario assumes new solar additions of 374.1 GW between 2023-2026, leading to a total solar capacity of 590.5 GW in 2026, or nearly 50% above the REPowerEU interim target. But even our pessimistic Low Scenario assumes that the EU's total PV power generation will reach 416.7 GW by the end of 2026.

SolarPower Europe's growth forecasts are largely surpassing the aggregate national solar targets for 2030 formulated by EU Member States in their NECPs. These targets must be updated in the revision process, beginning in 2023. Our Medium Scenario outlook to 2030 suggests that total installed solar capacity in the EU will quadruple and reach over 920 GW, outperforming the EU Commission's REPowerEU target of 750 GW by 2030 (see Chapter 3).

FIGURE 8 EU27 CUMULATIVE SOLAR PV MARKET SCENARIOS 2023-2026



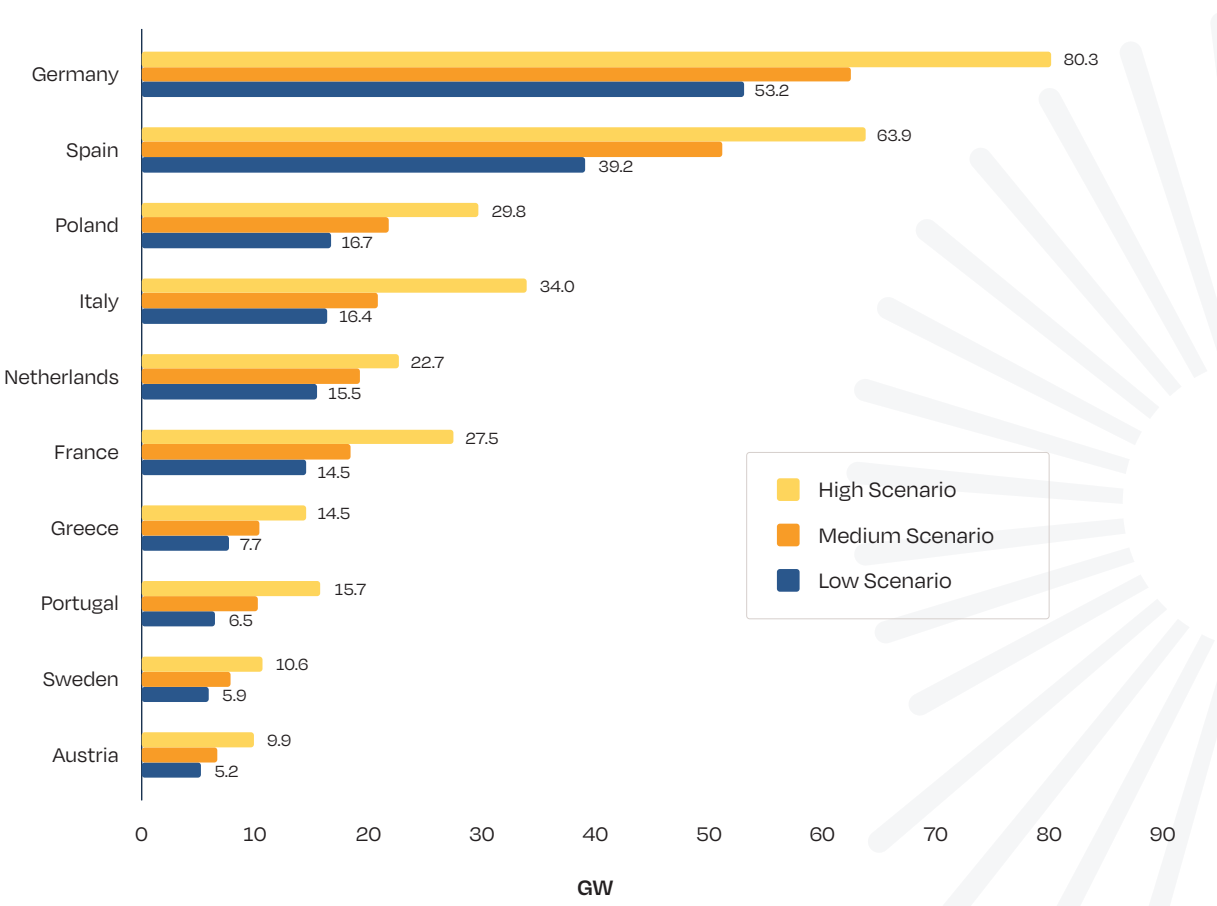
We are very optimistic on the solar developments in the top 10 EU markets over the coming years (see Fig. 9). For most Member States, the 4-year installation forecasts from 2023 to 2026 expect significantly more power additions compared to our last EU Market Outlook.

The expectations for the EU market leader **Germany** have been raised once again. With the government targeting 215 GW of solar installed by 2030, we expect the country to grid-connect 62.6 GW between 2023 and 2026 in our Medium Scenario, which is 5 GW more compared to what we had anticipated in last edition's High Scenario. We anticipate that Germany will double its current solar fleet in just four years. Even our Low Scenario forecast, under which the country adds 53.2 GW, is 12% higher than our Medium Scenario 4-year additions last year. On the upper end, the very ambitious High Scenario predicts that 80 GW will be installed in Germany.

Second on the list, **Spain's** solar prospects have increased the most from 2021. The gigantic Power Purchase Agreement (PPA) project development pipeline, the quickly growing self-consumption rooftop segment, and the development of hydrogen projects are pushing the Iberian market to unprecedent levels. Under our Medium Scenario, it is now expected to add 51.2 GW over the next four years, a spectacular increase from the 18.9 GW forecasted last year.

Consistently on the rise and now entering the top 3, **Poland** is confirming its position as a well-established solar market in the EU. The small rooftop segment, which constituted the backbone of the market thanks to a supporting net-metering scheme, remains strong despite the change to a less remunerative net-billing scheme, while utility-scale projects will become the second pillar of growth. The Polish market adds 21.8 GW over the next four years under the Medium Scenario, and up to 29.8 GW under the High Scenario.

FIGURE 9 EU27 TOP 10 SOLAR PV MARKETS ADDITIONS 2023-2026



Italy is finally starting to unleash its solar potential again. New permitting rules for commercial and industrial sites taken in 2022 are already having positive effects on those segments, while utility-scale is expected to be a key driver in the coming years. We see 20.9 GW of new solar connected to the Italian grid by 2026.

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 forecasted before, resulting in 19.3 GW of new installations in the next four years.

In 2021, **France** tripled its annual solar installations and went close to the 3 GW level for the first time. Installation levels in 2022 are in the same range, indicating that a multiple-GW market will be the new normal. Our increased forecast sees France grid-connecting 18.4 GW solar until 2026, as more favourable economic and regulatory conditions are available for both the utility-scale and rooftop segments.

A very positive trend is also observed in **Greece**, where the utility-scale and residential segments are displaying noteworthy growth for the first time. PV is expected to win most of the renewable auctions from 2022 to 2025. The government is also supporting the PPA market through a new scheme. Between 2023 and 2026, the country is now expected to add 10.4 GW.

Following closely, **Portugal** is on track to meet its 2026 target. While rooftop solar continues to expand, the utility-scale market will continue to provide the bulk of new installed capacity. In total, Portugal will see about 10.3 GW of new PV additions between 2023 and 2026 under our Medium Scenario. On the upper end, our High Scenario anticipates increased subsidy-free solar activity and new renewable hydrogen projects, which could push the additional capacity to 15.7 GW.

Rising one spot from its first entry last year, **Sweden** is benefiting from the development of the residential and large industrial solar PV systems. Helped by different tax rebates, the residential sector will remain the key pillar of new additions for the coming years. Moreover, the utility-scale segment is likely to become a notable contributor to the growth of the market as several large PV parks are being planned on top of small ground-mounted systems of which a number already produce power.

The only newcomer to the listing of the top 10 solar markets in the next four years is **Austria**, where several subsidy schemes are fuelling the residential sector, and larger ground-mounted systems are matching increasing interest.

Our analysis sees the top 10 EU solar markets install 229 GW from 2023 until 2026 in the most likely Medium Scenario (+65% from last year), 181 GW in the Low Scenario (+97%), and 309 GW in the High Scenario (+78%).

Valencia, Spain. © TrinaSolar

FIGURE 10 EU27 TOP SOLAR PV MARKETS PROSPECTS

Country	2022 Total capacity (GW)	By 2026 Total capacity medium scenario (GW)	2023-2026 New capacity (GW)	2023-2026 Compound annual growth rate (%)	Political support prospects
Germany	68,5	131,0	62,6	18%	
Spain	26,4	77,7	51,2	31%	
Poland	12,5	34,4	21,8	29%	
Italy	24,7	45,5	20,9	17%	
Netherlands	18,0	37,2	19,3	20%	
France	16,1	34,6	18,4	21%	
Greece	5,6	15,9	10,4	30%	
Portugal	4,2	14,5	10,3	36%	
Sweden	2,7	10,5	7,8	41%	
Austria	3,8	10,4	6,7	29%	
Romania	1,8	8,0	6,1	44%	
Ireland	0,5	6,5	6,0	90%	
Denmark	3,9	9,5	5,6	25%	
Belgium	7,9	13,1	5,1	13%	
Hungary	3,9	9,0	5,1	23%	

Even if more capacity will be added in absolute terms, our updated 4-year weather forecast for the 15 largest EU solar markets has somewhat become cloudier than the year before (see Fig. 10). Last year, we witnessed a very sunny political support climate for solar power in all but one EU country, Italy. This year, we see clouds on the horizon of three countries, but are not very concerned about growth prospects for now as each of them is expected to grow over 20% CAGR until 2026, and one even over 40%. In **Romania**, large PV projects planned on agricultural lands are facing difficulties as the Ministry of Agriculture and Rural Development (MARD) recently rejected most requests for installations over 50 hectares. The decision followed an interpretation of the legislation changes from June 2022, which were initially implemented to ease the deployment of such systems. Those larger projects are now at risk of losing their grid-connection right as those agreements are only valid for 18 months, during which the building permits must be obtained.

Another country facing difficulties in the utility-scale segment is **Denmark**. Though the large-scale, subsidy-free projects are the largest contributors to the annual market, the increase in grid connection fees expected from January 2023 will hamper the financial viability

of many projects. Our Medium Scenario expects that the issue will be resolved. Nevertheless, there will likely be a reduction of large-scale deployment in 2023, 2024 and beyond.

Finally, the recent announcement by the **Hungarian** government to suspend the possibility for new solar installations to feed their electricity to the grid is putting the sector on high alert. The length of this suspension, which targets systems that are planned but not yet licensed, is uncertain at present. The decision is damaging the solar PV deployment in a country that needs to reduce its high dependency on electricity imports. As the decree has still not been officially published, the situation remains uncertain as of today.

Beyond those countries, there are still a number of issues that need to be fixed within the EU to fully realise solar's potential, as outlined in our chapters on policy recommendations (see p. 8) and our updated table on the status of NECP target achievement (see p. 36). However, we still expect double digit annual growth rates in Romania, Denmark and Hungary.

Overall, the outlook for solar is only getting brighter. We anticipate the largest 15 EU solar markets to grid-connect 257.3 GW of new PV capacity in the coming 4 years based on our most probable Medium Scenario. This is in comparison to 152.4 GW forecasted in our 2021 published EU Market Outlook.

By 2026, the EU solar market is expected to double compared to today – 85.2 GW vs. 41.4 GW. Carried by its ambitious long-term solar targets, **Germany** will still deploy more solar than any other EU Member State; its share will be a bit larger than in 2022 – 23% vs. 19%. In the previous edition of our EU Market Outlook, we had assumed that Germany's share would be 31% in 2025. The differences observed demonstrate the rise of smaller EU markets that remain outside of the top 10, whose share will increase from 13% to 18%.

The top 3 markets will retain the same market share in 2022 and 2026, at 49%, but with one notable change: the large expansion of Italy is propelling it from 6th in 2022 to 3rd in 2026, relegating Poland to 4th position. These four countries plus France will compose the top 5 in 2026, reflecting the increased relevance of utility-scale solar in larger countries. For the top 5, the annual market share will only marginally decrease from 65% to 63%, while the top 10 market share will reduce from 87% to 82%, indicating a diversification of solar demand in more EU Member States.

FIGURE 11 EU27 SHARES OF TOP 10 SOLAR MARKETS IN 2022 AND 2026

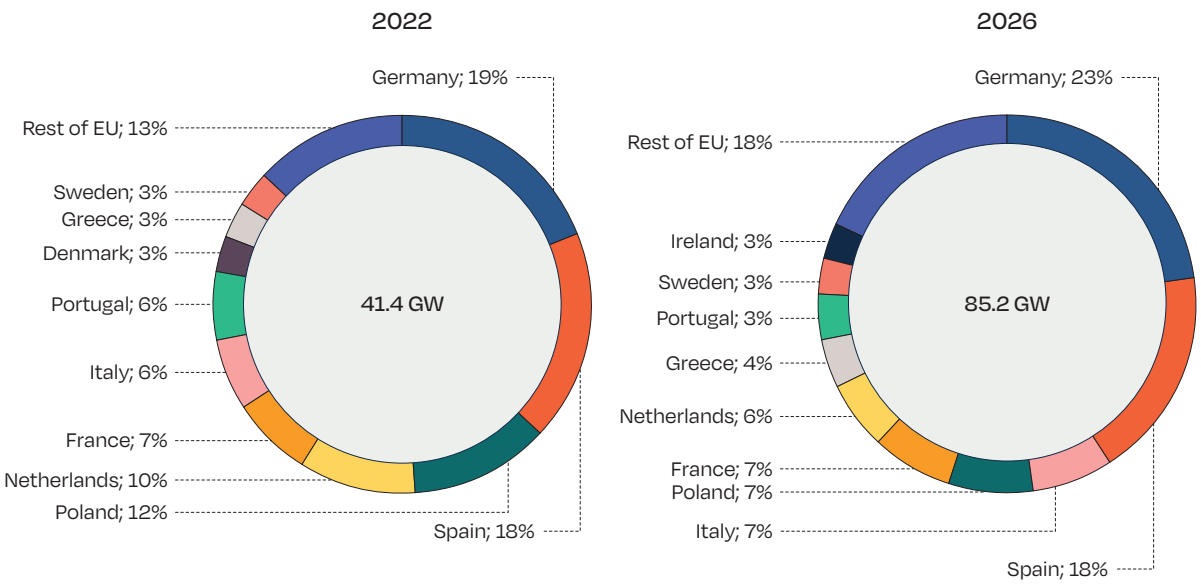
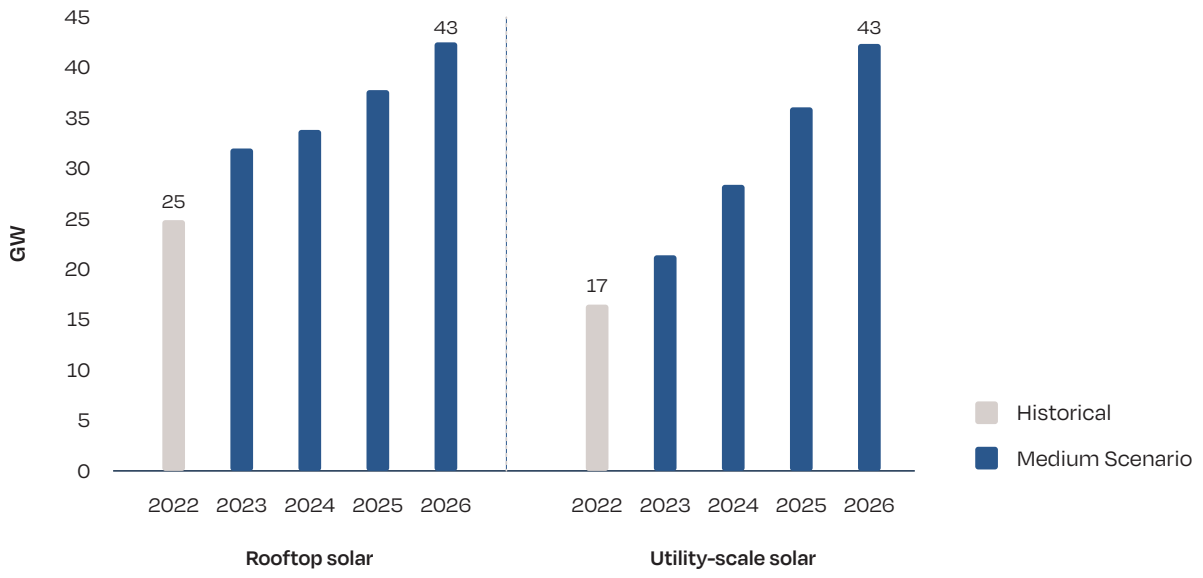


FIGURE 12 EU SOLAR PV ROOFTOP AND UTILITY-SCALE SEGMENTS SCENARIOS 2022-2026



1.3. Segments 2022-2026

Both the rooftop and the utility-scale segments grew significantly with the increase of the total annual market in 2022. But as in previous years, rooftop has remained the largest source of solar installations in the EU. The current energy crises obviously has been playing a large role in increasing demand for rooftop PV, as the technology promises a hedge against rising retail power prices. Moreover, system sizes are often increasing as consumers prepare for individual electrification of transport and heat. Rooftop solar added 25 GW in 2022, 8 GW more than in 2021. There was a strong increase on the residential and small commercial segment, as such investment decisions can be quickly made, and such small systems sizes rather quickly built. At the same time, as several governments are increasingly looking into solar to reach their climate ambitions, they are creating demand for large volumes of utility-scale solar via auctions and tenders. On top comes a quickly increasing volume of systems outside government schemes as companies now even more look into renewable power procurement through PPAs – to source green and at lower cost than from fossil fuels; this includes both on-site and off-site PV power plants. A total of 17 GW of ground-mount solar power plant capacity was added in 2022, compared to 11 GW in 2021. However, throughout the year, the market share of rooftop vs. utility barely changed from 2021 to 2022, decreasing slightly its total share from 61% in 2021 to 60% in 2022, while utility-scale grew from 40% to 41%.

Although the rooftop segment grew faster than anticipated due to the energy crises, the 2022 growth rate of rooftops in the EU was lower than for utility-scale, at 45% and 51% respectively. Many projects – merchant, PPA and tender-based – have been under construction and finished over the course of the year. However, looking across all segments, the commercial sector (10 kW-250 kW) increased most, at a rate of 55% from last year.

Compared to our previous European Market Outlook, the speed at which rooftops are expected to lose market share to utility-scale has slowed down. Earlier, we were expecting annual utility installations to surpass annual rooftop installations in 2023 with a 52% share. The energy crisis has strongly altered the playground for PV. While rooftop solar is primarily limited by installers' capacities, permitting issues, which affect much more the large-scale systems, are yet to be fixed in most member states and on local levels, as government market interventions are starting to cause insecurity among investors and lending institutions. We are now seeing rooftop to defend its leading position in the EU at least until 2026, when annual additions might break even with new utility-scale capacities.

When looking at cumulative installed capacities, rooftop PV represents 66% of the 209 GW installed across the EU at the end of 2022. With the slower than earlier expected increase of large-scale solar, the total rooftop share is expected to decrease only slightly to 59% by 2026.

2 The European Solar Manufacturing landscape in 2022

2.1. Policy developments

The political context for reshoring solar manufacturing to Europe changed dramatically in 2022. There is now a strong political awareness around the need for clean tech industrial strategies. Subsequently, more open discussions are taking place on Europe's competition rules and State Aid policy.

The US Inflation Reduction Act (IRA), which was signed into law in August, has been the catalyst for this changed approach. The US IRA is the latest – and probably most impactful - in a series of assertive industrial strategies on solar manufacturing proliferating around the world, following developments in India, Turkey, and of course the most successful example, China.

In response, the European Commission launched the Clean Tech Europe Platform in December 2022 to assess the challenges facing Europe's clean tech industry. Solar is one of the five key technologies for a "decarbonised and largely electrified continent by 2050" which is being prioritised under the platform.

In December 2022, the EU launched the European Solar PV Industry Alliance (ESIA) as a funnel for solar manufacturing financing. This alliance will promote investment in large-scale factories, aiming for 30 GW of manufacturing of each key solar component, annually, by 2025 – more than six times the current average capacity of around 4.5 GW. The ESIA brings the Commission, the European Investment Bank, and all of the relevant solar industries together across the value chain. The ESIA's joint statement includes a commitment to prioritise the mobilisation of public and private finance for European solar PV for scaling up European solar PV manufacturing projects in the short-term. The Alliance will also look at the swift implementation of Ecodesign requirements for PV systems, advancing new rules for green public procurement of solar PV, in addition to creating a European PV Academy for manufacturing skills.

SolarPower Europe is closely involved in all of these initiatives and is on the Steering Committee of the ESIA. In a joint CEO letter in October 2022, SolarPower Europe urged the European Commission to take bold action to boost investment in Europe's solar PV industrial base, in order to reinforce the Commission's solar deployment and energy security ambitions. The letter welcomes the recent REPowerEU and EU Solar Strategy, while pointing to international measures, like the US IRA, which are accelerating the global competition for solar PV value chains outside of Europe. To ensure Europe's competitive participation within a globally diversified solar supply chain signatories called on the Commission to replicate the EU Chips Act's success for critical solar PV technology, and promote solar PV production in the National Resilience and Recovery Plans.

In 2023 we can expect concrete EU proposals on solar manufacturing. Commission President Ursula Von der Leyen has stated that "the EU will respond in an adequate and well calibrated manner to the IRA." Europe is now serious about clean tech industrial policy, and the integral role which solar PV will play in this policy.

2.2. Status of the manufacturing production capacity in EU27 + Norway

Building on last year practice, we have continued our survey on the European Union's solar PV manufacturing landscape. We are not only aiming at finding out the latest production capacities in the main segments along the value chain in the EU27 Member States plus Norway[2], we also want to get a comprehensive picture of the status and plans in solar manufacturing. The companies active in silicon, ingot/wafer, cell, module and inverter manufacturing and offering commercial products in 2022 are displayed on our solar map (see Fig. 13). In addition, we have started to include module component manufacturers in our online manufacturing map .

Inverter production remains by far the largest European solar manufacturing segment, with a production capacity reaching almost 70 GW, about 5 GW more than in 2021. Today, inverter manufacturers are still the backbone of solar employment in the EU, as shown in our latest *Solar Job Report 2022*. With at least 9 stakeholders employing nearly half of all manufacturing jobs, several of these companies are also international leaders, among them Europe's No. 1, SMA from Germany, and Fronius from Austria. While European inverter manufacturers still suffer from sourcing chips, which has been severely limiting output, the companies are preparing their expansion. In June, SMA announced its ambition to reach 40 GW of production capacity by 2024 in Germany, nearly doubling its current size.

When looking into the European Union's solar module value chain, the largest manufacturer is active upstream, in the **solar silicon** segment. Wacker Chemie is the only EU company to operate polysilicon production facilities with a capacity of around 60,000 metric tons in Germany, which translates into over 20 GW of cell/module products. Looking just outside the EU, REC Solar Norway produces solar silicon using a metallurgical purification method rather than the traditional chemical route to polysilicon based on the Siemens process.

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

© Meyer Burger

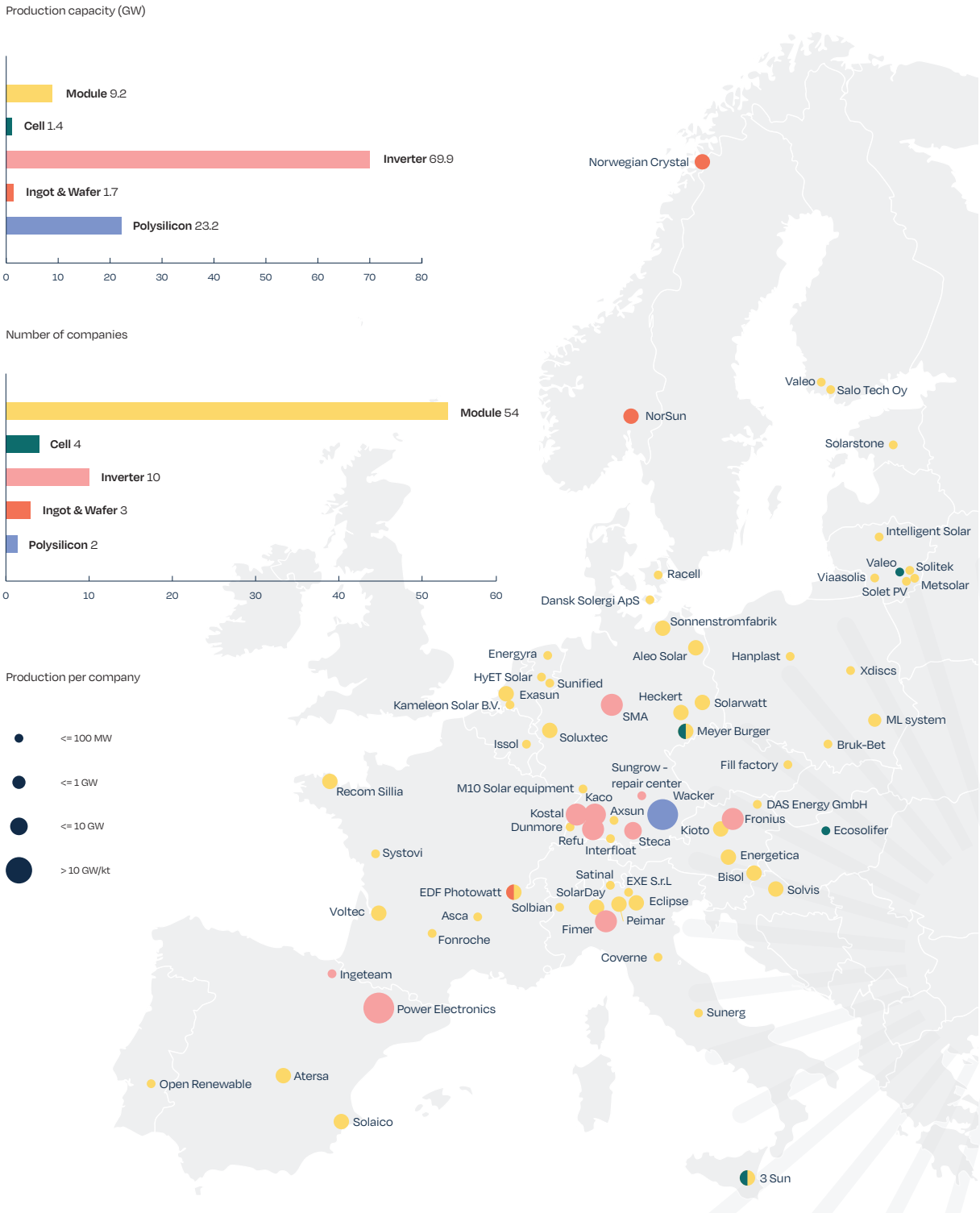
2 Though not a EU member, we also included Norway in the map due to its importance in Ingots & Wafers segments. Beyond the EU-27, there are a number of other existing and planned solar manufacturing projects in Europe.

ingot/wafer capacities, while most of Europe's 1.7 GW wafer capacity is located in Norway, where low-cost hydro power enables production at competitive cost and low carbon footprint. One of the main actors, Norwegian Crystal, revealed in September 2022 that it has secured all permits to expand its production of ingots from around 1 GW today, to 3.6 GW by 2026, and eventually 6 GW at a later stage. Also, promising next-generation wafering start-up, NexWafe is still active; in April 2022, it announced it finally closed its Series C financing round with a total of 39 million EUR and is now working on completing product and technology development for its PV products on prototype lines in Freiburg, Germany. More funding from a projected Series D round is planned to advance construction of NexWafe's pilot facility scheduled to break ground in 2023, the company said in June.

The EU's **solar cell** production capacity increased slightly to 1.4 GW in 2022, from around 0.8 GW last year, reflecting several companies' plans to expand or enter that segment. The EU's largest solar cell manufacturer is Meyer Burger, which currently operates 400 MW of cell production in Thalheim, Germany, and an equivalent large module line Freiberg, Germany. The Swiss company started to ramp up a second module production line for its high-efficiency heterojunction solar cells in September 2022 and targets to reach 1.4 GW of production capacity in Germany by end of 2024. The other ambitious module producer with internal cell capacities is Enel's 3Sun, which built a 200 MW HJT cell/module line in Catania, Sicily in 2019/2020, that is now the base for a 3 GW capacity cell/module project. Enel was the first to win a grant for a solar manufacturing plant in the first round for large-scale projects of the EU Innovation Fund in November 2021, which is being used to increase production to 400 MW in 2023, and 3 GW in 2024. At the same time, attracted by the US Inflation Reduction Act, both Meyer Burger and Enel are expanding their production activities into the US, where Enel announced to install 3 to 6 GW production capacity. In the meantime, in early December, REC Solar, which won a grant in the second round of the large-scale EU Innovation Fund tender to build a 4 GW heterojunction module factory in France, has announced to put its plans on hold 'due to various changes in market conditions' without providing further details.

© Fronius

FIGURE 13 EU27 AND NORWAY SOLAR MANUFACTURING MAP



Beyond the two EU-based cell/module manufacturers, which produce the cells for internal use, there are many **module manufacturers** that don't make their own cells but import them from Asia. As pure solar module manufacturing requires the lowest investment cost among the different stages of the solar module manufacturing 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 2022, at least 49 module manufacturers have operated factories in the European Union.

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

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

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, among others.

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

3 NECP and EU 2030 market outlook

5.9 MW, Gard, France: © Akuo

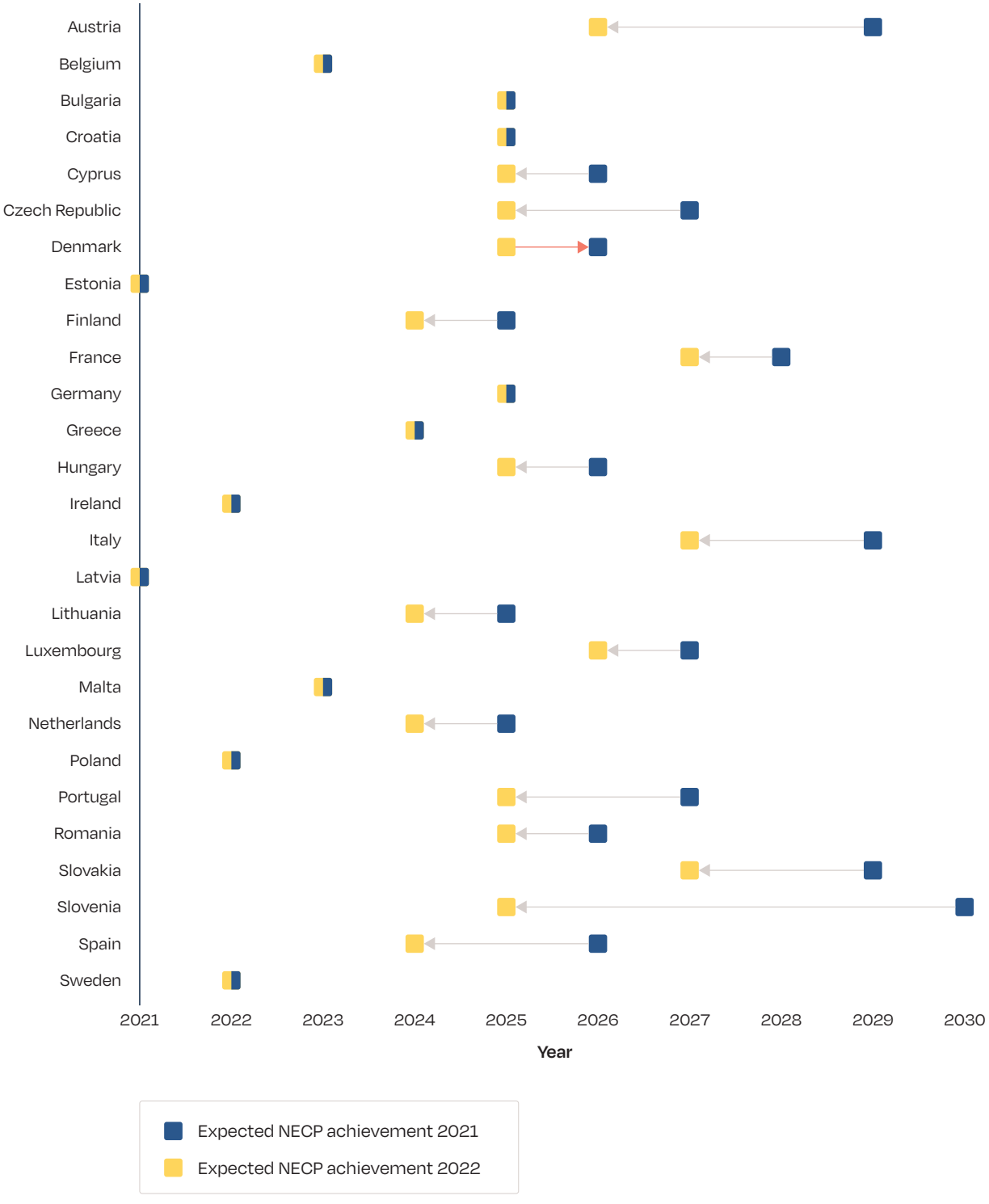
We have carried out an updated review of all EU Member States on their progress towards the achievement of their 2030 solar targets as indicated in their National Energy and Climate Plans (NECPs). The analysis builds on an assessment we had published in our 2021 EU Market Outlook, looking at the measures that are key for solar deployment of a country, such as the level of ambition of solar targets; the policy framework for prosumers; actions to ease administrative procedures, amongst others.

The new review is based on the latest market information available, and our most-likely scenario projections until the end of the decade. For each Member State, we include information on its national solar target's level of ambition compared to the current state of solar development, as well as outlining key challenges which are impacting further deployment.

Our market analysis has shown an improved outlook for solar across the EU, with most countries having more installed capacity than expected. In 2021, Estonia and Latvia already reached their 2030 goals.[3] By the end of 2022, Ireland, Poland and Sweden have reached their 2030 NECP solar targets as well (Poland's solar capacity was 8 years early even 72% higher than its 2030 target, an indication that the technology wasn't on the radar at the time of writing the NECP). In 2021, our analysis showed that all EU Member States were on track to reach their national solar targets by 2030 or earlier. According to our updated market development projections, 15 EU Member States will reach their NECP target earlier than what we predicted last year. Only Denmark is forecasted to achieve its goal later than we outlined in our previous EU Market Outlook, but still years ahead of the 2030 deadline (Figure 14). This demonstrates solar's exceptional deployment speed which is a consequence of quickly improving cost competitiveness and outstanding technological versatility. However, it also highlights the level of ambition of national solar targets has to be raised significantly now that energy policy makers are finally aware of solar's capabilities.

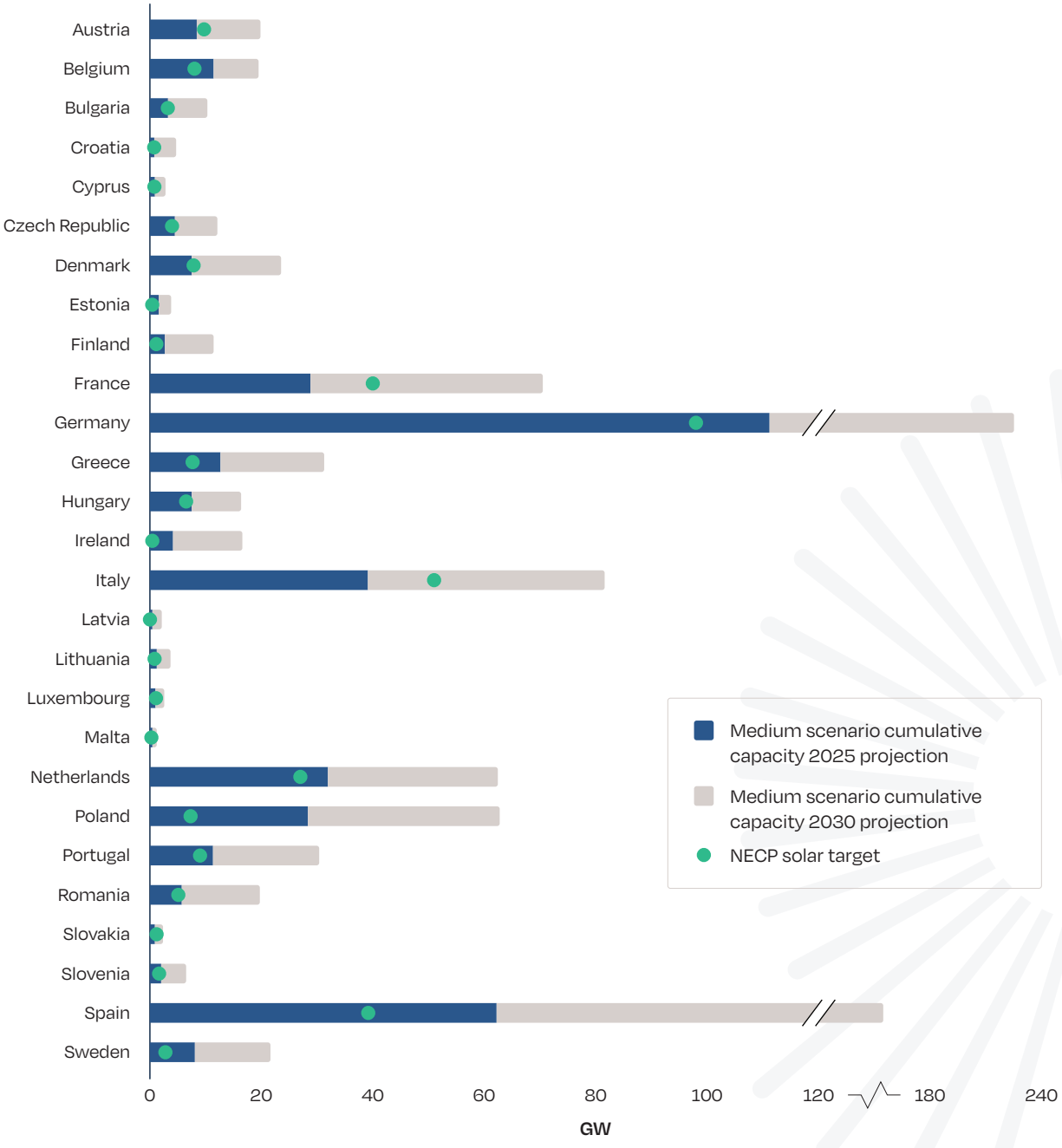
3 Latvia's NECP does not include a solar target.

FIGURE 14 TIMELINE OF EXPECTED NECP SOLAR TARGET ACHIEVEMENT



Our Medium Scenario projections indicate that 21 EU Member States will have already reached their 2030 goals no later than 2025. The remaining 6 Member States will do so no later than 2027 (see Figure 15). This is 3 years earlier than the last country was supposed to reach that target in the 2021 edition. Solar deployment will be sufficient to largely overachieve NECP targets in all EU countries, and even meet it in our Low Scenarios. Therefore, anything else other than a dramatic increase of each NECP solar target to a level that is at least in line with the EC's 2030 750 GW_{DC} (600 GW_{AC}) target (and which is our new Low Scenario), must be considered intentional disregard for the most clean, fast and cost-effective power technology.

FIGURE 15 EU27 SOLAR PV CUMULATIVE CAPACITY IN 2025 AND 2030 COMPARED TO NECP TARGET

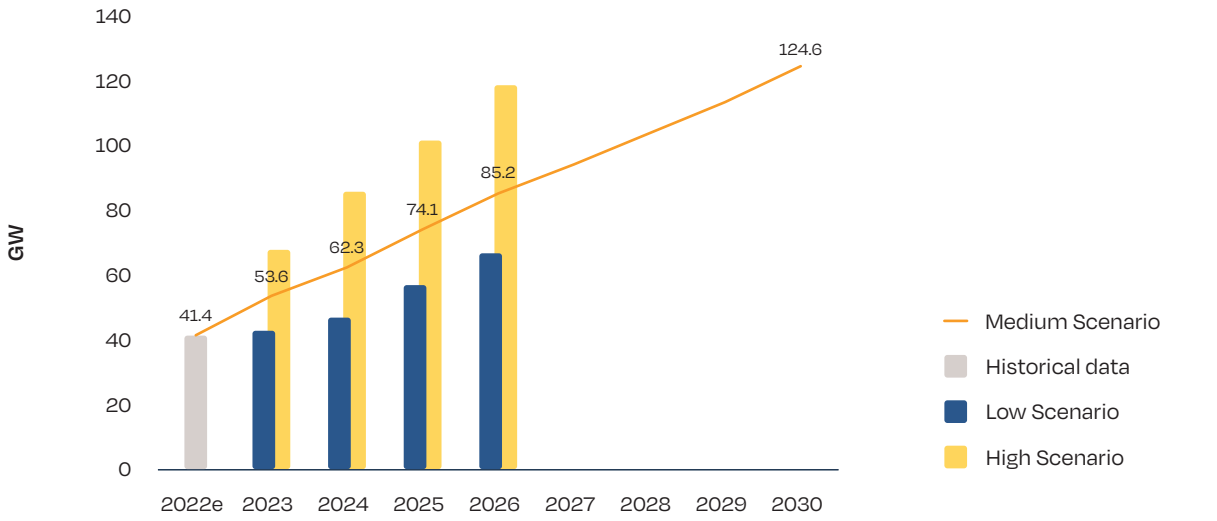


3 NECP and EU 2030 market outlook

/ continued

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 more than double from 41.4 GW installed in 2022 to 85.2 GW in 2026. For the period 2027-2030, we expect that additional annual growth will take place thanks to improved policy conditions and further technology cost reductions. In our Medium Scenario projections, we foresee a 125 GW annual solar market in 2030, increasing 46% from 2026 levels and 201% compared to 2022 (Figure 16).

FIGURE 16 EU27 ANNUAL SOLAR PV MARKET SCENARIOS 2022-2030



Such an expansion in the annual market will be reflected in cumulative installed capacities. According to our Medium Scenario long-term outlook, the total solar fleet in the EU will increase from 209 GW installed end of 2022, to about 400 GW in 2025, and 920 GW in 2030 (see Figure 17).

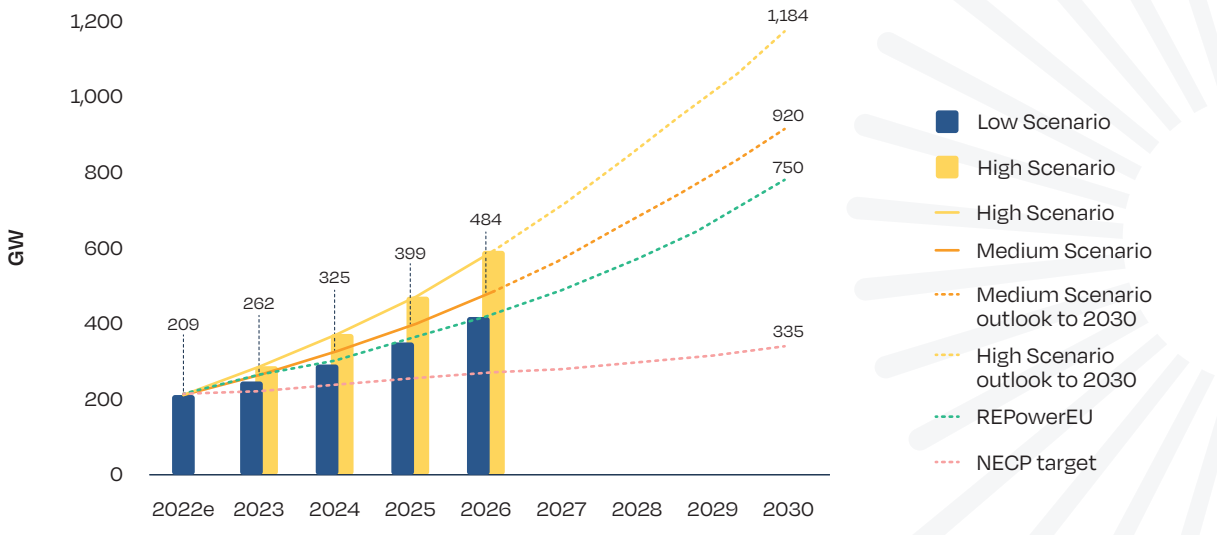
It is no surprise that our Medium Scenario 2030 outlook is almost three times higher than the 335 GW aggregate PV capacity goal from NECPs. This is another reason why Member States must revise their NECP solar targets. According to our updated forecast, the NECP aggregate target will be already met by 2025.

What is more striking is that the 920 GW total market size in our new Medium Scenario 2030 has improved so much that it now overshoots the EU Commission's REPowerEU strategy's 750 GW solar target by 170 GW; the previous 2030 projection was expecting 672 GW in 2030. According to our model, the improved policy and investment conditions will enable the EU to meet its REPowerEU solar target already in 2029, and surpass the target by 24% by the end of the decade.

While this is very positive news for the sector, and for the entire EU, it also indicates that the ambition could be raised even further. In fact, for the EU to remain on track to deliver on a 1.5 °C Paris Agreement scenario, ambition on renewable energy deployment must be raised. Our High Scenario 2030 outlook illustrates that if the remaining obstacles to solar development are lifted, and all Member States set appropriate levels of ambition and enabling policy frameworks, the EU could run a 1,184 GW solar power fleet by end of the decade, which is 58% higher than the REPowerEU goal. Reaching the TW-level milestone by end of the decade would pave the way for a multi-TW solar development towards 2050 which is needed for the EU to remain on its clean electrification track to deliver on its climate ambitions.

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, and the corresponding level of solar capacity per capita in 2030. In a few cases, when national governments have set out a higher solar target than what was indicated in the NECP, we have included this information in the charts. This explains the 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 existing NECP targets for all Member States.

FIGURE 17 EU27 TOTAL SOLAR PV MARKET SCENARIOS 2022 - 2030



DMEGC SOLAR

The World's Leading Manufacture of

High efficient PV Modules

- Low Carbon Footprint
- High Efficiency and Durability
- Up to 30-Years Warranty
- Global Customer Service Network
- Leading Financial Health in Global PV Industry
- 26GW PV Procucts (wafer, cell, module) Cumulative Shipments

Tier 1 Bloomberg NEF

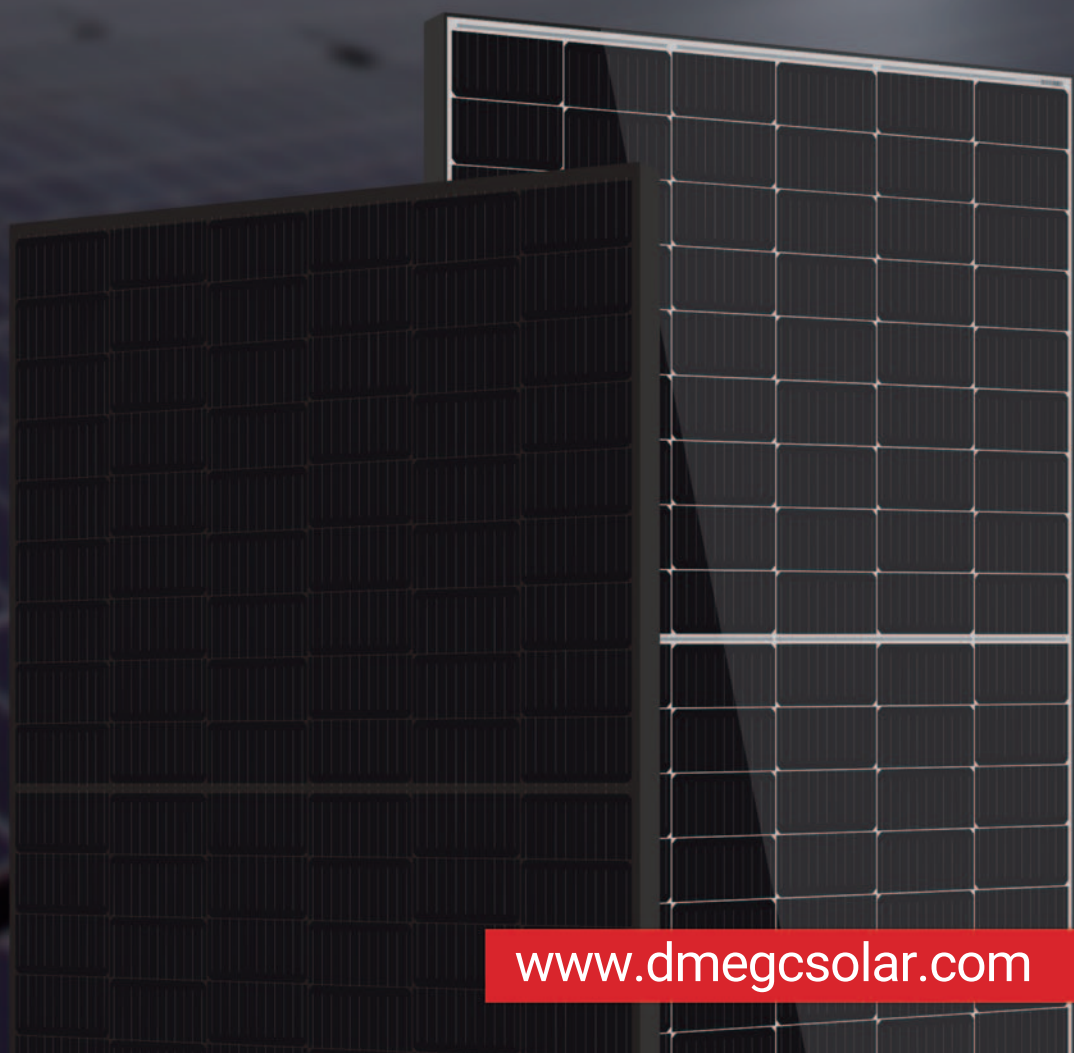
Certisolis Carbon Footprint

EUPD RESEARCH TOP BRAND PV MODULES NETHERLANDS 2022

TOP PERFORMER 2022 PVEL PV MODULE RELIABILITY SCORECARD

SOCIAL ACCOUNTABILITY ACCREDITATION SERVICES SA 8000

SILVER 2020 ecovadis CSR Rating

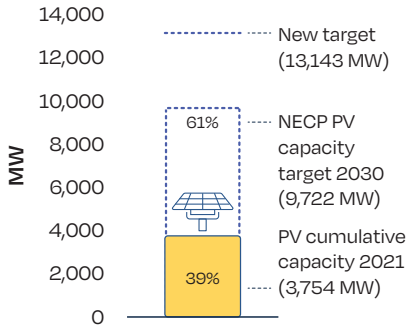


A Member of SolarPower Europe

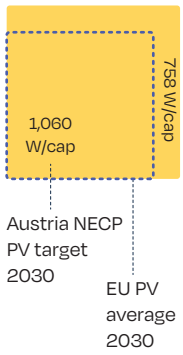
www.dmegcsolar.com

NECP AUSTRIA

Solar PV target 2030 achievement rate



Solar PV capacity 2030 Watt /capita

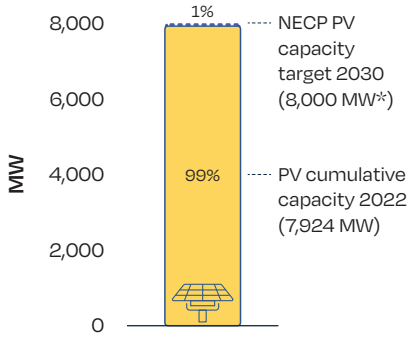


Key market and NECP challenges:

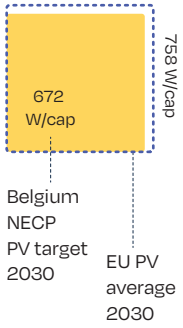
- **Workers availability.** The main bottleneck in the country remains the avialability of skilled workforce. For the connection of inverters and modules, in particular, electricians are needed. A lack of training and certification of workers is flagged as a key issue.
- **Grid congestion.** The Austrian grid needs upgrading in order to keep solar development at a sustained pace. Works on the transition and distribution grid are known to take a long time. At present, plans for grid-development are under preparation. However, this currently poses a challenge in Austria's solar deployment.
- **Administrative procedures.** Permitting times are identified as a bottleneck in the timely deployment of solar PV. Additionally, administrative requirements can differ among the nine states.

NECP BELGIUM

Solar PV target 2030 achievement rate



Solar PV capacity 2030 Watt /capita



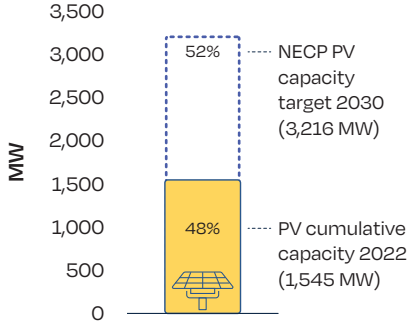
*: Average between low and high targets.

Key market and NECP challenges:

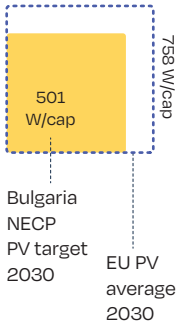
- **PV target.** Lack of ambition in the NECP solar target could limit growth in a country with good solar potential. The study "Towards 100% renewable energy in 2050" shows a potential of 170 GW, which is several magnitudes higher than the 8GW target set in the Belgian NECP. The 2030 target is expected to be reached already by 2023.
- **Administrative procedures.** The fragmentation of responsibilities among the regions creates uncertainty and hurdles for larger solar PV projects in particular. Auctions are regionally organised and are historically known to lack vital information, discouraging investors.
- **Grid integration and flexibility.** Despite the high share of prosumers in the country, the NECP does not include distribution grid modernisation. The fragmentation of governments creates additional complexity, with Wallonia and Flanders focusing on different aspects in their flexibility frameworks. Grids in the more rural parts of Wallonia remain vastly underequipped to handle ground-mounted PV projects, while the Flemish grid needs to integrate offshore renawables as well as a large amount of rooftop PV.

NECP BULGARIA

Solar PV target 2030 achievement rate



Solar PV capacity 2030 Watt /capita



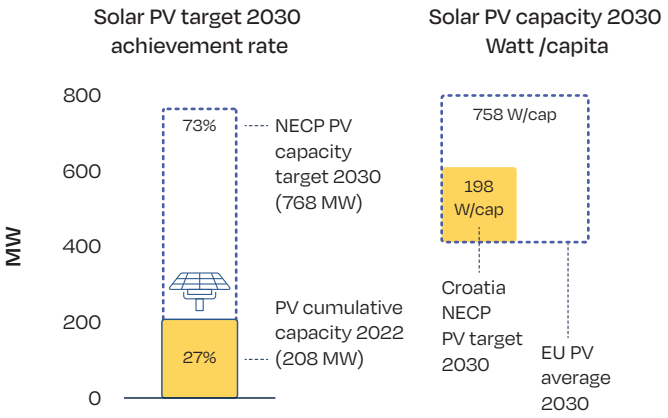
Key market and NECP challenges:

- **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.
- **Poor financial landscape.** Electricity prices are kept artificially low, lowering the attractivity of solar PV. Additionally, the current government favours fossil fuels over solar and renewables.

3 NECP and EU 2030 market outlook

/ continued

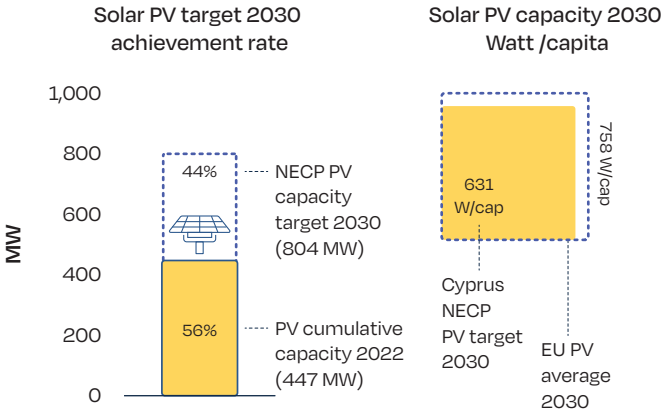
NECP CROATIA



Key market and NECP challenges:

- **PV target.** Croatia has shown an important willingness to support solar development. Yet, although the NECP 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.

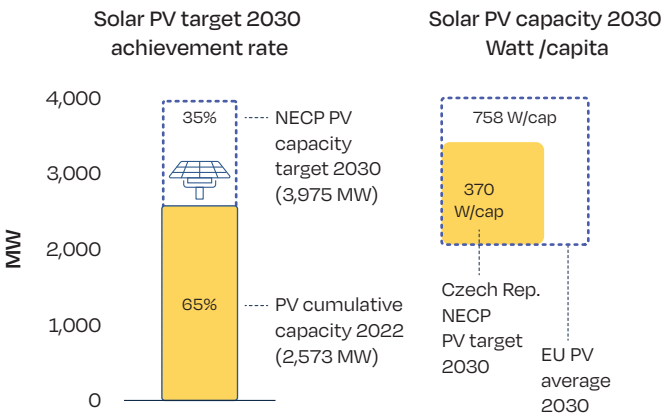
NECP CYPRUS



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 should be operative by 2023.
- **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.

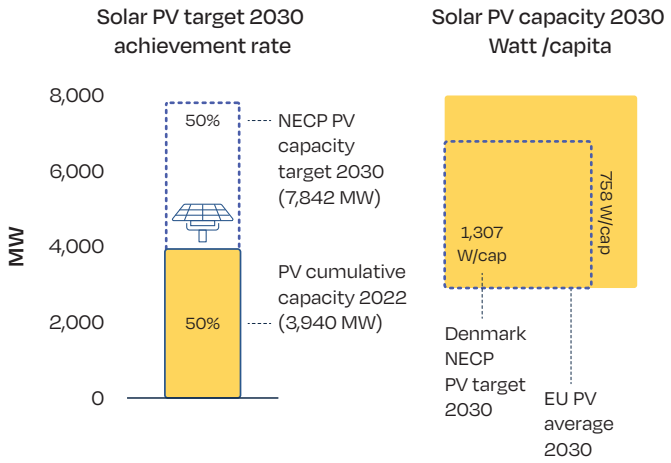
NECP CZECH REPUBLIC



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. While this already forms a bottleneck for installers, recently grid connection became a problem as well. DSOs face manpower shortages and grid connections can take multiple months.

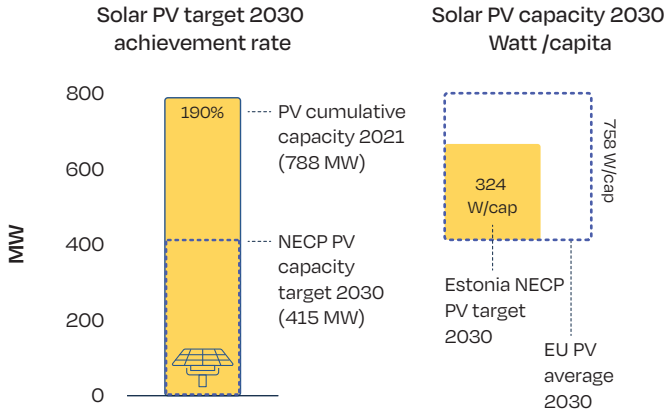
NECP DENMARK



Key market and NECP challenges:

- **New tariff regime.** Unfavorable new grid connection tarrifs implemented in January 2023 slow the development of larger projects. Specifically, the higher connection tariffs are expected to hurt the business case significantly.
- **Grid development.** Denmark has developed a vision for the future of its grid, also addressing an expected growth of renewable energies. However, the new grid connection tariffs push the costs of grid development towards project developers. There is some debate about who needs to carry those costs, but currently, the new tariffs scare away international investors. This "chicken-and-egg" problem of grid capacity persists.
- **Prosumers.** Recent developments for self-consumption segments show positive market signals, supported by high electricity prices. This sector, however, remains limited compared to its potential. This is partly due to the fact that small-scale PV is not supported by incentive schemes.

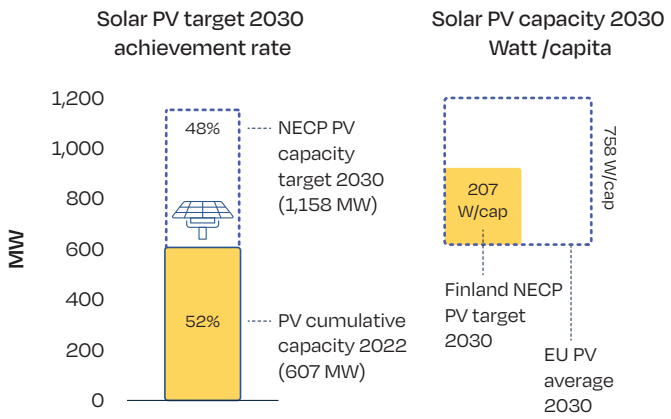
NECP ESTONIA



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



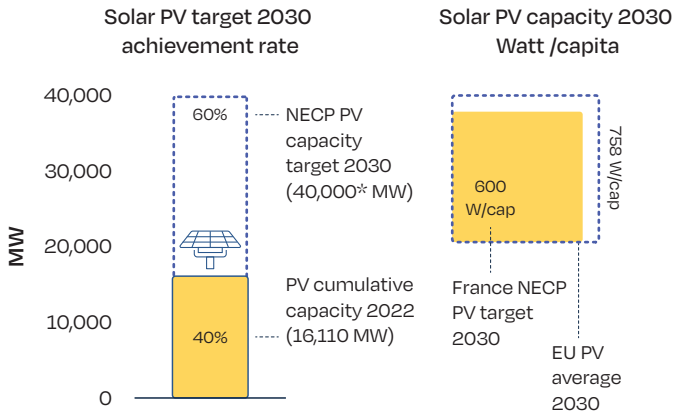
Key market and NECP challenges:

- **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.

3 NECP and EU 2030 market outlook

/ continued

NECP FRANCE

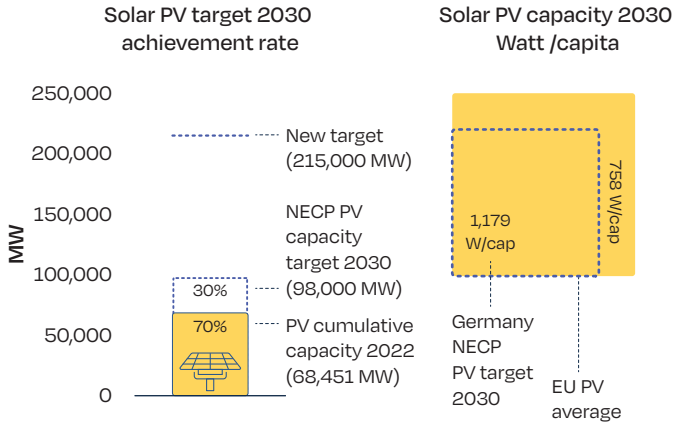


Key market and NECP challenges:

- **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.** The self-consumption segment is still far beneath the country's potential. The support mechanisms for self-consumption projects need to be improved to fully recognise its value.

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

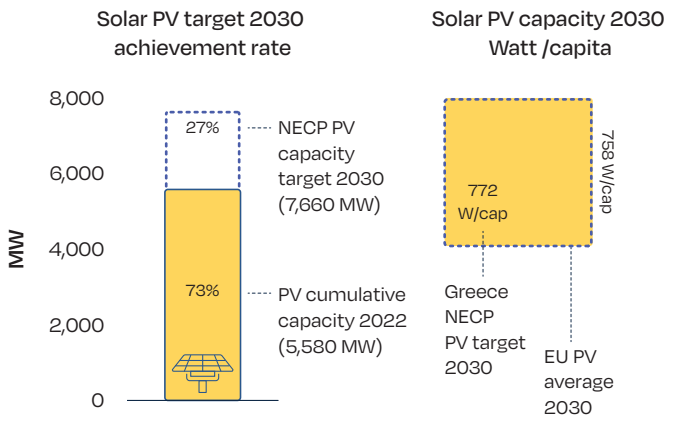
NECP GERMANY



Key market and NECP challenges:

- **Workforce and supply chain shortages.** A shortage of electricians and a lack of availability of inverters is limiting market growth and caused a significant raise on the costs of smaller installations. While the backlog in inverter supply is expected to be resolved in the mid-term, it is essential that the bottleneck of installers is resolved as soon as possible through accessible trainings and campaigns.
- **Revenue cap.** As in several other EU countries, the proposed revenue cap is creating market uncertainty and might have a significant impact on Europe's largest PV market.

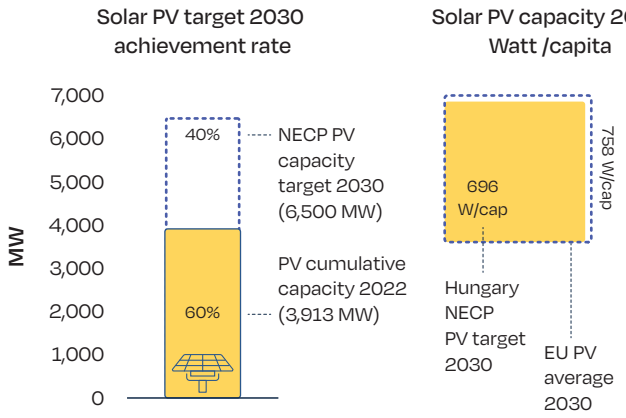
NECP GREECE



Key market and NECP challenges:

- **Grid development.** Currently, grid capacity is the main bottleneck for larger PV projects. Additionally, the responsible authorities have been criticised for the untransparant decision process that results in exclusion of some projects.
- **Administrative procedures.** Despite mandatory deadlines, the organisations responsible for the issuance of environmental permits often fail to deliver them in time. This causes unpredictability and delays that decreases the attractibility of Greece for international investors.
- **Prosumers.** Although data suggests that this segment is also gaining traction, the lack of support measures hamper small-scale PV deployment.

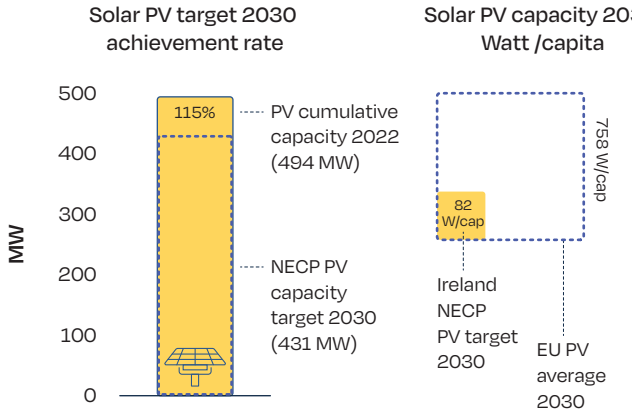
NECP HUNGARY



Key market and NECP challenges:

- **Prosumers.** The prosumer business case was severely hit by the phaseout of the net-metering scheme. Aditionally, a sudden abolition of the FIT scheme for an undetermined period has frozen the market. Besides this, the regulation of electricity prices is harmful for the attractiveness of residential solar, although the recent, sudden rise of government-regulated prices has revived its business case.
- **Auctions.** Auctions have brought disappointing results so far, mainly because of too stringent deadlines and excessively low prices. A revision of auction frameworks should be considered.
- **Grid development.** New larger PV plants have been unable to connect to the grid, due to grid congestion concerns. It is uncertain when the grid might open up again. This creates a clear bottleneck that should be resolved urgently.

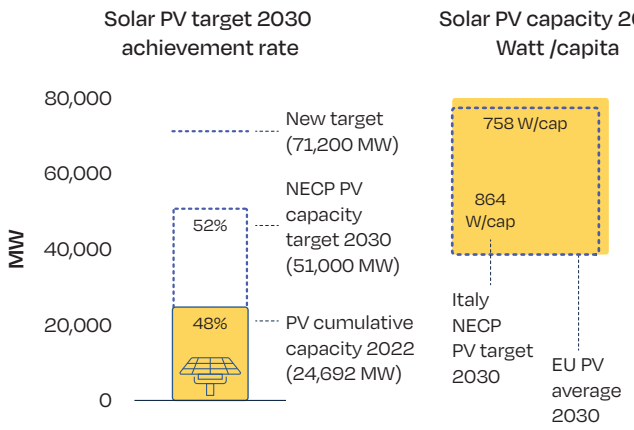
NECP IRELAND



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.
- **Lack of resources and workforce.** As large EU countries with more advanced solar markets step up their solar markets, Ireland might face fierce competition to grow its workforce and ensure access to solar components.

NECP ITALY



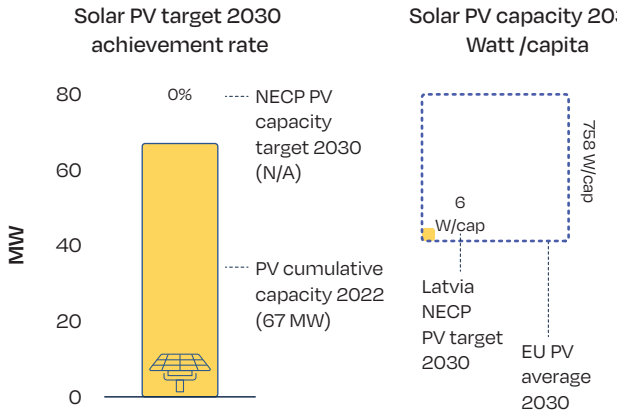
Key market and NECP challenges:

- **Permitting procedures.** Despite positive legislative developments, the authorisation of projects remains a challenge. Permitting can take long times, depending on the region.
- **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

/ continued

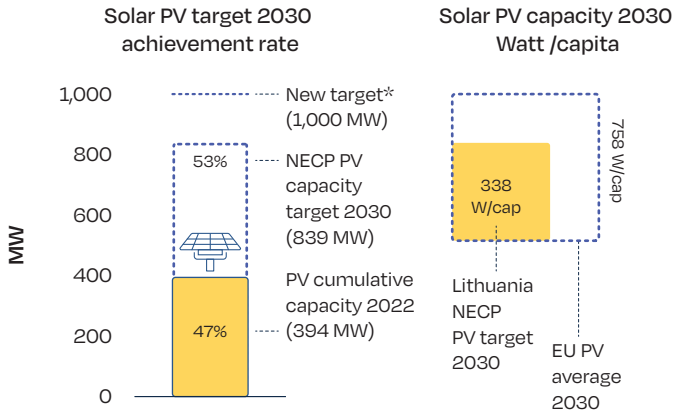
NECP LATVIA



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

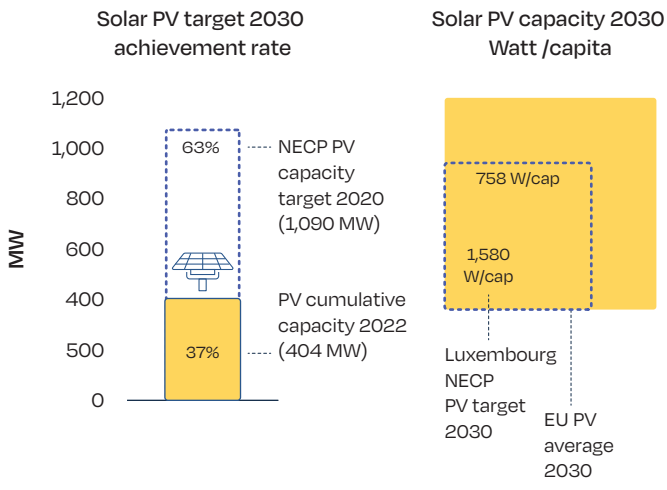


*to be reached by 2025.

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.
- **PPAs.** While the plan includes extensive information on different measures supporting PV deployment, a framework for Power Purchase Agreements still needs to be developed.

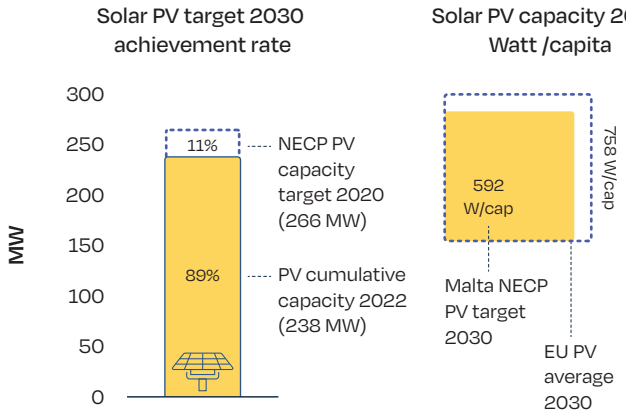
NECP LUXEMBOURG



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.

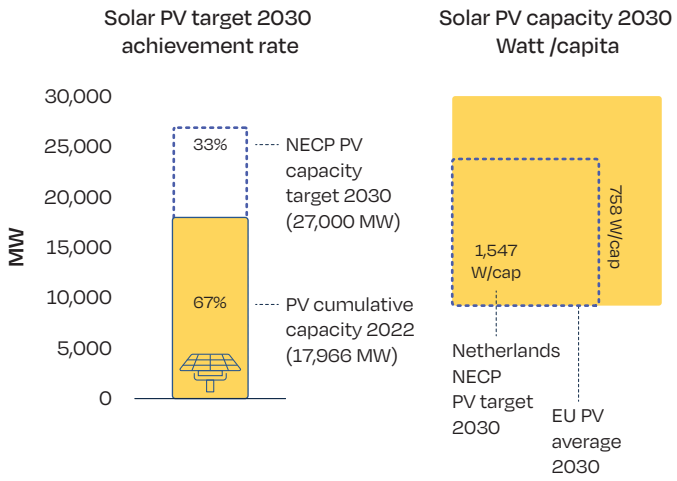
NECP MALTA



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.

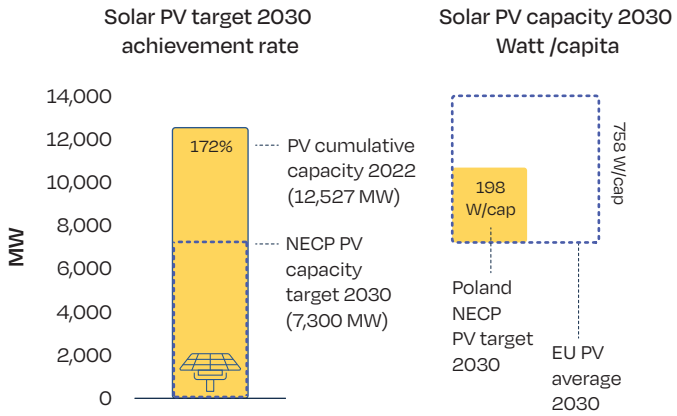
NECP THE NETHERLANDS



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



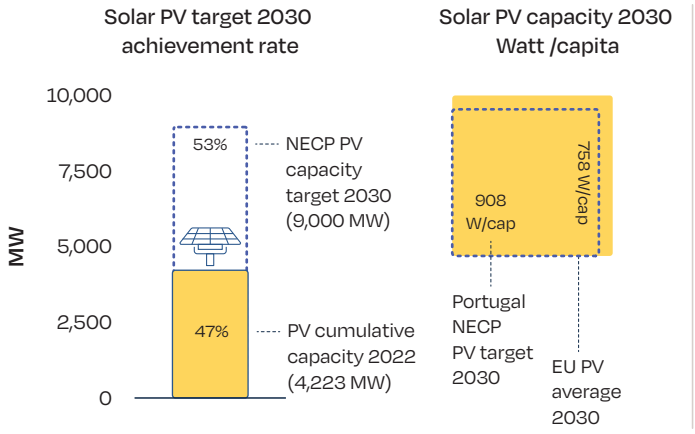
Key market and NECP challenges:

- **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.** As Poland continues to outdo predictions, it is time to set ambitious targets. After years under strong coal dependency, the public perception towards solar is shifting and the usage of this momentum is crucial to capture the true potential of solar PV in Poland. This is not reflected in the current NECP target, which has already been surpassed.
- **Price cap.** The recent introduction of an energy price cap creates uncertainty on the future of solar PV, altough the impact on PV deployment is difficult to assess at present.

3 NECP and EU 2030 market outlook

/ continued

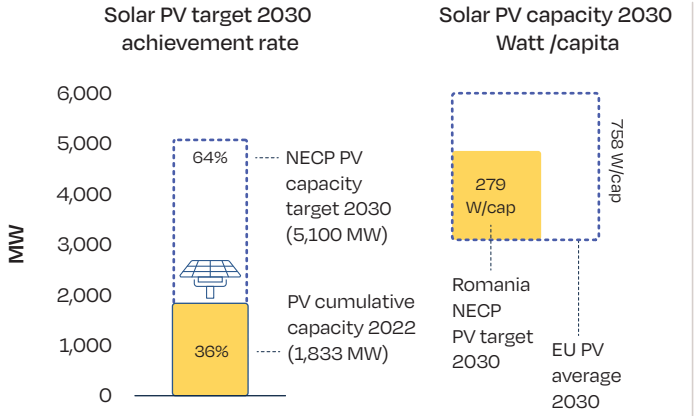
NECP PORTUGAL



Key market and NECP challenges:

- **Permitting procedures.** Though notable developments have been made on the previously long-lasting environmental impact assessment study, a number of permitting hurdles remain. In particular, it takes a long time before the relevant entities answer. This is largely due to a lack of digitalisation and inter-organisational communication. The whole process needs streamlining.
- **Grid development.** A lack of grid capacity creates uncertainty for bigger solar projects. The large solar PV potential of Portugal might not be met if grid development does not speed up.
- **Prosumers.** Self-consumption remains a limited market in Portugal, due to limited attractiveness of the support framework. Furhter, the online portal for self-consumption has suffered numerous bugs, which discourages potential investors.

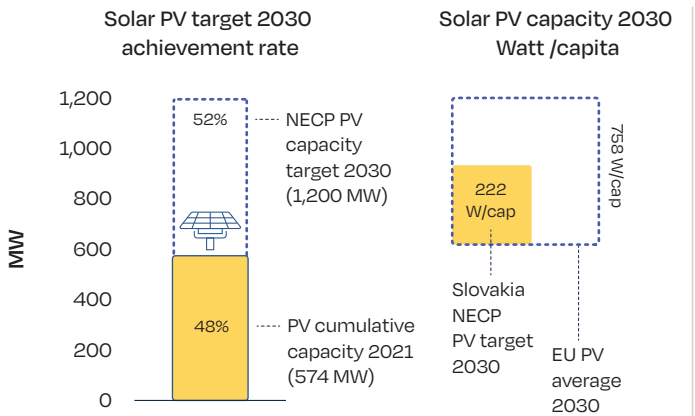
NECP ROMANIA



Key market and NECP challenges:

- **PV target.** The NECP target does 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 NECP for prosumer support schemes. At the same time, the plan should be more ambitious on prosumer development.

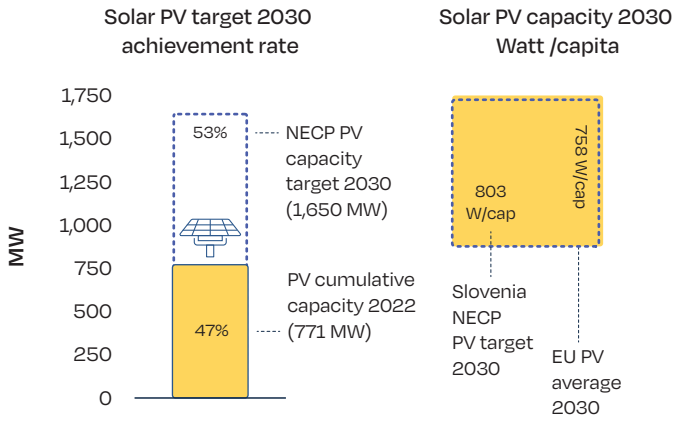
NECP SLOVAKIA



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. 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.

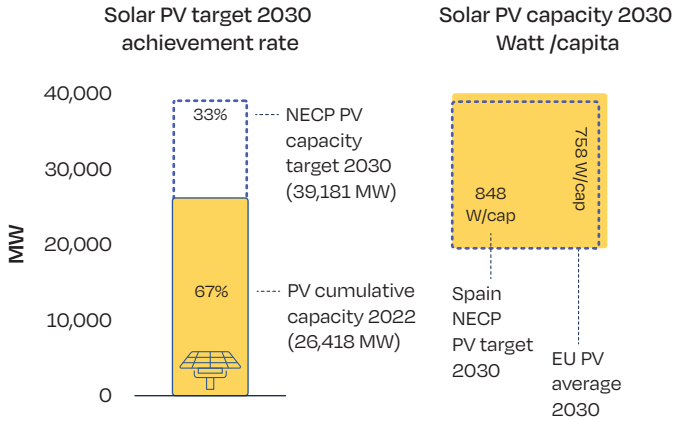
NECP SLOVENIA



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.

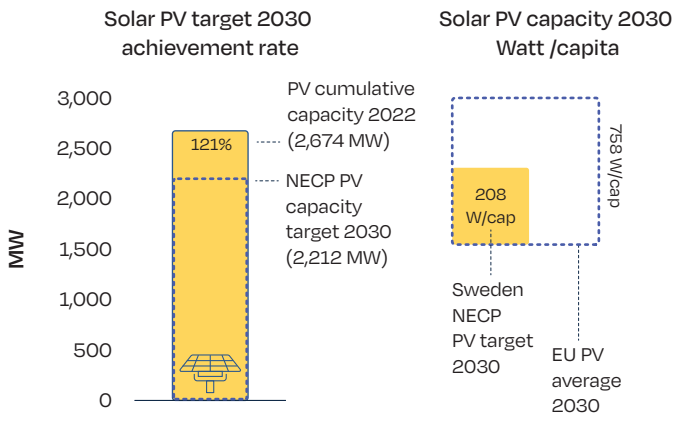
NECP SPAIN



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.** Public perception of solar is becoming more polarised, as a NIMBY attitude is growing strong among local communities. The industry needs to curb this trend by showcasing the positive impacts of large solar projects on local communities and the natural environment.
- **Prosumers.** Requirements for solar PV installations differ per municipality. Processes are not standardised and often not digitalised. This results in long waiting times for prosumers and might discourage investors.

NECP SWEDEN



Key market and NECP challenges:

- **PV target.** Given the recent enormous growth in solar PV, the plan shows low ambition for solar energy before 2030. As a matter of fact, the 2030 target has already been surpassed.
- **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.

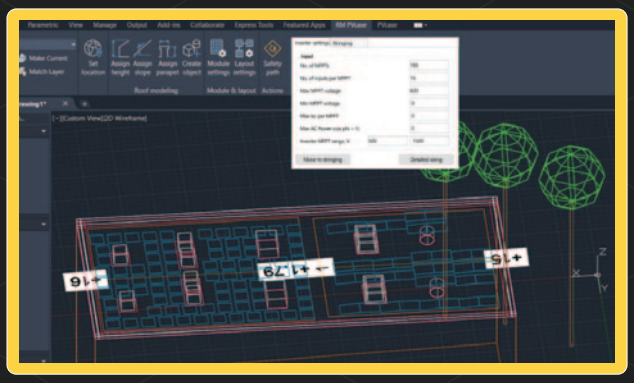
PVcase

SOLAR SOFTWARE SUITE FOR DESIGN & YIELD

BY ENGINEERS FOR ENGINEERS

PVcase GROUND MOUNT

AutoCAD-based solar design software for **utility-scale ground mount** solar projects. Enables solar engineers to reduce project costs, boost reliability and improve asset performance.



PVcase ROOF MOUNT

AutoCAD-based solar design software for **commercial & industrial rooftop** PV projects. All-in-one tool for greater automation, and a higher level of precision. Intelligent algorithms improve design efficiency, accuracy, and quality.

PVcase YIELD

Energy modelling software for solar PV systems. Estimate the performance and assess the economic potential with the power of **ray tracing** and **cloud computing**.

PVcase.com

/PVcase

/WeArePVcase

/WeArePVcase

LEARN MORE

4 GW-scale solar markets

15 MW, Ourbans, France. © Akuo

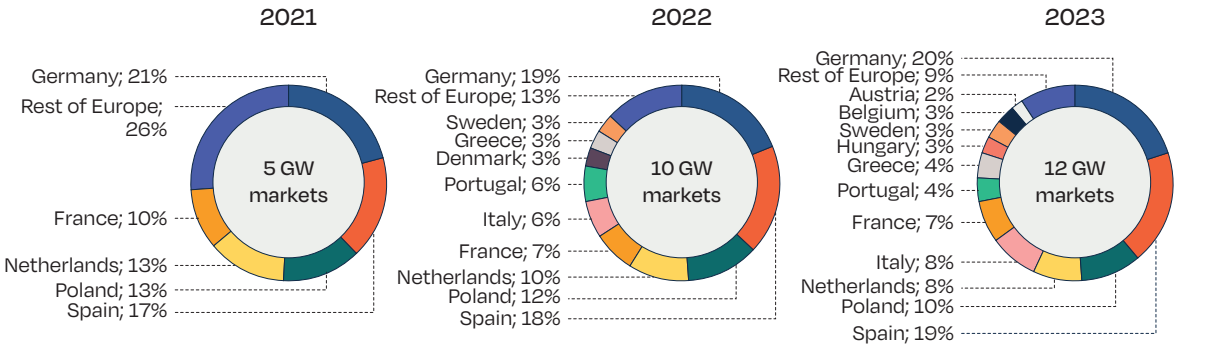
For the first time, a double-digit number of EU solar markets installed more than 1 GW of solar in a year. According to our Medium Scenario for 2022, these 10 markets include Germany, Spain, Poland, Netherlands, France, Italy, Portugal, Denmark, Greece and Sweden (see Figure 18).

The number of GW-scale markets has doubled compared to the 5 candidates from last year. In our previous EU Market Outlook 2021 edition, we had assumed that 7 markets would have reached the GW-scale in 2021, but it turned out Greece and Denmark finally did not reach to that mark.

The five GW-level markets in 2021 – Germany, Spain, Poland, the Netherlands and France – have all secured their spot in 2022 again, while five new entrants have filled the remaining slots. Italy, ranked sixth, largely surpassed 2 GW of annual installations, after several years of poor performance. At 7th position we see Portugal, which installed around 700 MW in the first three quarters of 2022, but should cross that threshold as many large-scale plants are supposed to come online by the end of the year. Denmark and Greece, which have both missed the GW target by a small margin in 2021, follow at 8th and 9th. The two countries are expected to comfortably cross the threshold this year with 1.5 GW and 1.4 GW of grid-connected capacity respectively. Closing the list, a positive and unexpected surprise comes from Sweden. The Nordic country joins the GW club for the first time ever with 1.1 GW of annual installations.

1.	GERMANY SolarPower Europe	SolarPower Europe
2.	SPAIN Unión Española Fotovoltaica (UNEF)	UNEF
3.	POLAND PSF & PV Poland	PV POLSKA
4.	THE NETHERLANDS Holland Solar	Holland Solar
5.	FRANCE Syndicat des Énergies Renouvelables (SER)	SYNDICAT DES ÉNERGIES RENOUVELABLES
6.	ITALY ANIE Rinnovabili, Elettricità Futura, Italia Solare	ANIE Rinnovabili ELETTRICITÀ FUTURA ITALIA SOLARE
7.	PORTUGAL APREN	APREN
8.	DENMARK Danish Solar Power & the Danish PV Association	dansk solkraft Dansk Solcelleforening
9.	GREECE HELAPCO	HELAPCO
10.	SWEDEN Svensk Solenergi	SVENSK SOLENERGI

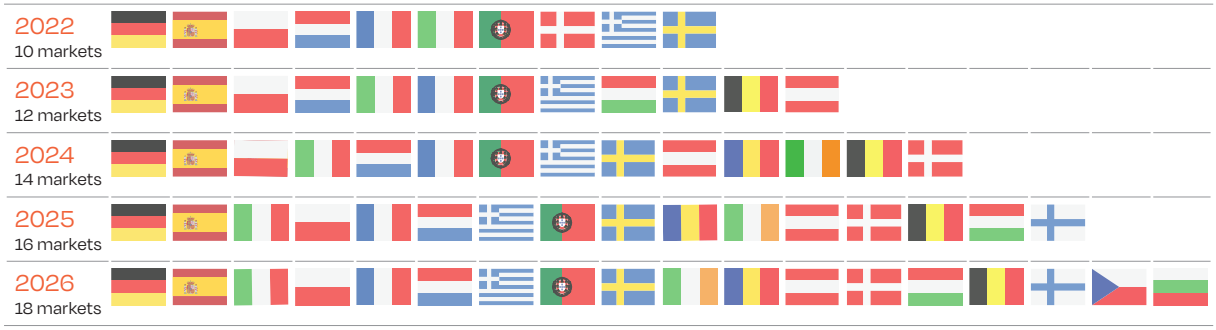
FIGURE 18 EU27 GW-SCALE SOLAR MARKETS 2021 - 2023



For 2023, we expect the group to broaden further. Even if Denmark is not expected to retain its size, Hungary, Belgium and Austria are anticipated to join the group, adding the total number to 12.

The expansion of solar technology in different geographies across the EU will continue over the next years, as countries identify solar as the safest, most versatile and most cost-competitive solution to their climate and energy needs. In 2024, we expect to reach 14 GW markets across the European Union, which will likely become 18 by 2026 – an impressive two third of the 27 EU Member States (Figure 19). In this GW-chapter, we traditionally invite our members, national solar/renewables associations to provide their local expert views on their home countries (which, however, sometimes differ from our estimates that are based on several sources). For those countries for which we did not receive contributions from national associations, we have written the overview based on our SolarPower Europe research, this time only for Germany.

FIGURE 19 NUMBER OF SOLAR GW MARKETS IN THE EU27



1. Germany

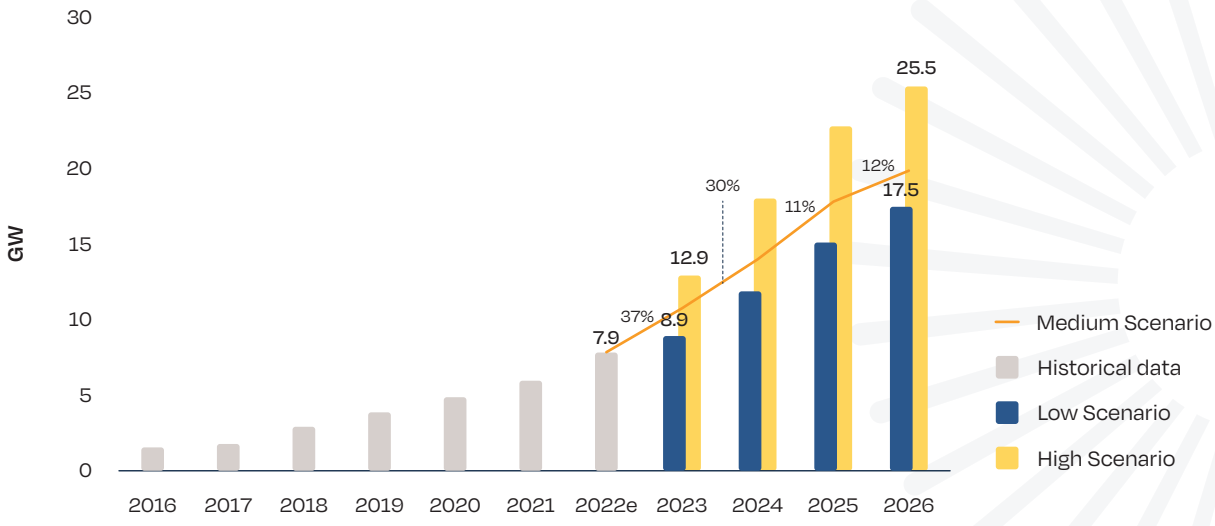
Towards A 2-Digit GW Market Soon

Overview of Solar PV Developments

For the first 10 months of 2022, the German Federal Network Agency (Bundesnetzagentur) reported that 5.5 GW of solar PV have been installed as part of the country's EEG renewables incentive programme. The country experienced a record-high monthly installation level of 730 MW in March 2022, and a monthly installation average rate of 550 MW for the period from January to October. Those numbers do not account yet for merchant PV projects and PPAs constructed outside the EEG scheme. For the whole year we are expecting Germany to install around 7.9 GW of solar PV capacity in 2022, a 31% growth compared to 2021, when 6 GW was added. This growth rate is 8 percentage points higher than the 23% between 2020 and 2021.

Germany continues to hold on to its top spot as both the largest solar market in Europe and the largest solar PV operator. The new government coalition, steering the country since the end of 2021, has been already committed from the start to make significant efforts to align the country on its 2030 targets by speeding up the development of renewables. The invasion of Ukraine by Russia and its consequences on the energy market has geared up the political agenda, encouraging the new combined Economy and Climate ministry to present amendments faster than originally planned. In July 2022, the government adopted its "Easter Package", which set a target of 215 GW of total installed PV capacity by 2030, including an annual break-down for annual solar installations of 7 GW in 2022, 9 GW in 2023, 13 GW in 2024, 18 GW in 2025, and 22 GW from 2026 onwards. The "Summer Package" that was planned for the summer 2022 has now been split into several individual proposals.

FIGURE GW 1 GERMANY ANNUAL SOLAR PV MARKET SCENARIOS 2023-2026



Solar PV Targets in Germany

The solar PV target in Germany has been raised twice in recent times. While the country's Renewable Energy Act 2021 (EEG 2021) had set a 100 GW total installed solar PV capacity target by 2030, this was first doubled to 200 GW by 2030, then was further raised in the 2022 Easter Package to 215 GW, in line with energy independence and security concerns caused by the Russian war on Ukraine. Therefore, starting from an installed capacity of 68.5 GW by the end of 2022, Germany is committed to grow its PV fleet almost fourfold by the end of this decade. Moreover, post 2030, the new measures outline solar installations of 22 GW per year on average, with an aim to reach about 400 GW by 2040.

As Germany has been facing a total gas supply meltdown from Russia over the course of a few months during 2022, dropping from over a third in April to 0% in September, the coalition compromised on extending the operation time for two its last three nuclear plants originally scheduled to be phased out end of year, until April 2023. On the other hand, whereas the coalition reaffirmed its plan to move forward the coal phaseout from 2038 to 2030, the country restarted old coal power plants in March to ensure continued electricity supply.

In June 2021, the new Climate Protection Act set a binding path to climate neutrality and brought forward the target year by 5 years to 2045. The interim GHG emission reduction targets were also raised to 65% by 2030 and to 88% by 2040.

The government is committed to meeting at least 80% of its electricity demand with renewable sources by 2030, up from the previous 65% target, and full decarbonisation by 2035. In January 2021, the former government introduced a national Emission Trading System (ETS) for heating and transport fuels, which expands the EU-wide ETS that currently does not cover fuels used in these sectors. Starting with a fixed and rather low CO_2 price of 25 EUR per tonne, the prices will increase each year to reach 55 EUR in 2025, followed by an auction system with minimum and maximum prices starting in 2026. 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 will implement price control measures if needed.

Drivers for Solar Growth

2022 brought massive changes for solar in Germany. A key point is the adoption of the EEG 2023 by the government coalition in July 2022, which includes many positive provisions for faster solar deployment in Germany.

As of July 30, 2022, **the EEG 2023 increased the excess solar power feed-in** for new systems to 0.086 EUR/kWh,

3 MW, Haltern am See, Germany.

from 0.0624 EUR/kWh in July 2022. The monthly decreasing trajectory of feed-in tariffs is also now frozen until 2024, after which it will re-start with levels of 1%, but only every 6 months. As the government is looking to increase accessible power volumes during the current energy crises, the technical limit to inject only 70% of a solar system's rated power output is ended as of January 2023. Moreover, households deciding to export all solar electricity to the grid will benefit from a bonus of 0.048 EUR/kWh, raising total remuneration to 0.134 EUR/kWh. The full feed-in is also aimed at investors whose properties have little or no self-consumption needs and encourages maximum usage of available roof space. The EEG 2023 also revoked the limitation to sell electricity to the grid for mid-size rooftop PV systems, implemented by the earlier government, which had resulted a steep drop of installations in this segment.

The new coalition also reached an agreement to abolish the **renewable energy surcharge (the so-called EEG surcharge)** as of July 2022. This comes after the government's decision in October 2021 to decrease this levy by 43%, from 6.5 EUR cents down to 3.7 EUR cent per kWh of consumed power. Starting from July 2022, operators of small commercial systems from 10-30 kW no longer have to pay the feed-in tariff (FIT) surcharge for self-consumed solar power. The EEG remuneration will be financed solely by the Federal Energy and Climate Fund. In the future, the government will be counting on the revenues from the Emission Trading Scheme to offset the financial loss of the EEG surcharge to develop renewables. While the ending of the EEG surcharge was initially aimed at lowering electricity prices to stimulate investments on EVs and heating, it will now mainly act as a social measure to relieve consumers from high electricity prices.

While the new government agreed to make **solar installations mandatory on all new commercial buildings**, it also intends to establish solar as a 'common feature' for residential homes, a political phrase for dissent on this topic among the coalition partners. The solar obligation for commercial buildings stems from several German states deciding 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 m2 as of 2023. Since May 2022, Baden-Wurttemberg is the first state to start with mandatory solar installations on residential buildings.

Tenders and auctions

The legislative package approved in July 2022 also brings winds of change on the tendering scheme landscape. Starting from 2023, **installations below 1 MW no longer need to participate in a tender**. The previous thresholds under which systems needed to participate in a tender process was 300 kW for rooftops and 750 kW for ground-mounted projects.

As a response to the current energy crisis, the German authorities have announced in September 2022 a plan to launch an extra tender to add 1.5 GW of solar capacity. The deadline for submitting bids is set on 15 January 2023, and the tender is open for projects not exceeding 100 MW. As the government is looking to quickly increase the installed capacity, selected PV projects will have to reach completion within 9 months, starting from the date they secured feed-in premium tariffs.

In 2022, still in the normal context of **large-scale auctions**, Germany had two types of tenders that involve solar: a technology-specific tender for **ground-mounted** projects between 750 kW and 20 MW and a **solar rooftop tender** for systems between 300 kW and 750 kW.

Specific to ground-mounted projects, three tenders took place in 2022, for a volume of 1,083 MW (March), 696 MW (June) and 609 MW (November); the latest round was concluded with an average price of 0.0580 EUR/kWh, slightly higher than the 0.0510 EUR/kWh for the same round last year. All three rounds were undersubscribed – in March, still almost all of the tender volume, 98% of 1,108 MW was allocated; in June, it dropped significantly to 62% of 1,126 MW; and stayed at a similar low level of 68% of 890 MW in November. The German authorities justify this undersubscription as a result of the large increase in the tendered capacity, over 3 GW in 2022, compared to 1.9 GW in 2021, blaming module procurement challenges for the large number of new projects.

The current funding conditions of the EEG are also being criticised, as they are not reflecting the increase in system costs. In addition, the debate over taxing windfall profits, which limits the profit made by solar generation, is holding back investments, according to industry stakeholders. The next round of ground-mounted auctions are planned for March 2023. The revision of the EEG is also supporting the development of Agri-PV as the technology now falls under the "large-scale auction" instead of the innovation tenders, which widens the available areas.

On the solar rooftop side, three rounds of auctions were held in 2022. The first tender, held in April 2022, was undersubscribed; a total of 204 MW of bids were accepted against the initially tendered 767 MW. The second tender for rooftops concluded in August 2022 with a total of 201 MW being awarded at an average price of 0.0884 EUR/kWh. This second tender was also undersubscribed, the initial tendered capacity was again 767 MW. A third and last round was organised and bids were accepted until 1st December 2022. The results are not yet published at the time of writing this article, but the tendered capacity decreased to 203 MW.

In addition to ground-mounted and rooftop tender types, two **innovative solar tenders** took place in 2022. The first round was held in April 2022 and was oversubscribed as the Federal Network Agency awarded 403 MW, out of the 397 MW tendered. The amount of capacity won by each solar technology is not specified. The second round concluded in December 2022 with a tendered capacity of 397 MW. This type of tenders are carried out two times per year.

7.27 MW, Pfaffenweiler, Germany.

Starting from 2023, tenders for solar are planned to stay around 2 GW per year. However, with the 2022 Easter Package increasing the 2030 solar target to 215 GW, there has also been an increase in tender volumes announced for the period up to 2028-2029.

The 2021 EEG revision also brought some positive changes for **community solar systems**, a segment that has lagged expectations for years. Among others, operators do not have to supply power directly to the tenant, but also via third parties, like utilities, a change that is expected to make the scheme more useful. In the most recent EEG 2023 from July 2022, the government announced that community solar projects below 6 MW can be built without participating in auctions.

As shown in SolarPower Europe's recent European Market Outlook for Residential Battery Storage 2022–2026, Germany continues to be the **key European market for home batteries**, with an estimated 147,000 units installed in 2021, which is equivalent to a storage capacity over 1.3 GWh. The latest amendments to the Energy Industry Act in June 2021 included the removal of double charges and levies to battery systems, enabling better utilisation 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 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.

Next to capacity generated by the self-consumption regime and auctions, **PPA-based projects** are the third pillar of solar development in Germany. Large-scale merchant solar is an emerging trend in the German market. 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 approved regulatory changes in the Easter Package have lifted several barriers to the deployment of solar in Germany. With the threshold for auctions now raised to 1 MW, the removal of the EEG surcharge and the increased FIT rates, the rooftop segment can become a major contributor to the country's climate and energy independence ambitions.

A key challenge in the market is linked to the current debate over the revenue cap. The proposal to limit the margins made by solar generation is creating uncertainty on the market and is disincentivising investments in the sector at a time when they are most needed.

Identifying suitable areas and receiving permits to develop large utility-scale volumes remains a challenge. Even if Agri-PV is now part of the large-scale tender scheme – instead of the innovation tender – the bonus allocated for agrivoltaics is currently insufficient. Floating PV is also still not recognised enough in the EEG 2023 as it must be installed at least 40 meters away from the shore and cannot cover more than 15% of the water surface.

The key action is the same as last year: getting the pieces of the puzzle all together — incentivise investors for rooftop and power plant segments to fully allocate the tendered capacity, smooth the permitting process, educate a sizeable number of installers, and create local acceptance for 147 GW to be installed over the next 8 years.

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

2. Spain

The challenges of our ambition

If most analysts described the Spanish solar market as being at a mature stage during 2019-2021, the market has now entered a completely different league in 2022. At least 6.4 GW are expected to be brought online throughout the whole year, a 33% increase from the 4.8 GW installed in 2021, which was an all-time record for the Iberian country. The leadership of Spain in the renewable PPA market and the growth of distributed PV have laid 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

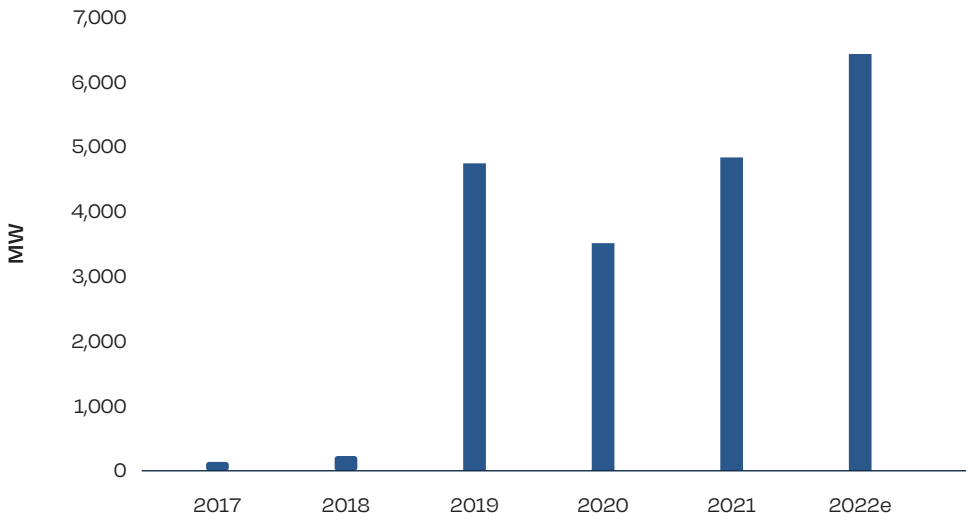
Following a process that lasted several years, the Spanish Parliament approved the Climate Change Act in May 2021 fixing a dual target for renewables in 2030: a 42% share in final energy consumption and a 74% share in electricity generation. The law also includes a clause to revise (only upwards) the 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.**

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 and gas sector, IPPs, solar developers, investment funds, etc.

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 to the good prospects of Spanish solar companies.

FIGURE GW 2 SPAIN ANNUAL PV MARKET 2017-2022, BY UNEF



SOURCE: UNEF.

The pillar behind the impressive development of the previous years has been Power Purchase Agreements **(PPAs)**. All large-scale solar capacity commissioned during 2020 (2.9 GW) and 2021 (3.4 GW) has been developed without any type of public aid or regulatory scheme, and all through 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 corporate renewable energy sourcing platform RE-Source.

The rooftop PV market is getting increasingly attractive. After the removal of the Sun tax on self-consumption in 2018, the current framework was achieved in 2020, with the introduction of automatic surplus remuneration, plus collective and through-the-network facilities. Both companies and the end-consumer market have been gradually gaining pace since then.

Although installed rooftop power had already been increasing quickly in the previous years (+715 MW in 2020, +1.4 GW in 2021), in 2022 this segment expanded much further and installed more than 2.4 GW. It is no surprise that the current energy crisis and the rise of electricity prices has led to a rush of new rooftop installations to increase self-consumption and to reduce electricity bills. The growth has also been supported by new measures approved in October 2022 aiming at simplifying processes for residential systems and for apartment blocks, an important measure in a country where nearly two-thirds of the population live in flats.

On the policy side, the main driver for the development of the sector is the **Roadmap of Self-Consumption, approved in December 2021**. The document includes measures to foster this segment and estimates the potential of self-consumption in 2030 between 9 and 14 GW.

In addition to policy, it has to be remarked that the Spanish **National Recovery Plan** considers rooftop PV to be one of the main measures to realise the energy transition. In fact, in June 2021 the government approved Royal Decree 477/2021, authorising the transfer of 450 million EUR to Spain's autonomous communities with the aim of 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

41.7 MW, Tordesillas, Spain.

The programme will support self-consumption 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.

As mentioned, the main driving force for rooftop PV is the high wholesale electricity prices we are seeing since mid-2021, which serves as a **wake-up call** for industrial and commercial players as well as for households. All these segments are looking at solar as a means to decrease their energy bills through the use of affordable and green, self-consumed electricity.

Adding to all the above, as a response to the ongoing war in Ukraine, the government introduced a set of measures in April 2022 to decrease fossil fuel dependency, curb energy prices and hasten renewable energy deployment. The package of measures includes, among others, a regulatory framework for Floating PV, accelerated procedures for PV parks below 150 MW with low environmental impact, strengthened distribution grid capacity to absorb 7 GW of self-consumption systems, and regulations for the pipelines of renewable gases, including renewable hydrogen.

In terms of **outlook**, expectations are very positive, with some remaining question marks that need to be followed closely to evaluate their impact. In the utility-scale segment, we expect the newly installed capacity to surpass 4 GW in 2022. The two auctions carried out in 2021 (January and October), allocating 2.9 GW of new solar PV capacity, will support the figures of deployment also in 2023. High expectations are also coming from the rooftop PV segment, after a very positive 2022. Moreover, the gigantic pipeline of utility-scale projects will eventually come to realisation rather soon as the Ministry of Ecological Transition and the Demographic Challenge (MITECO) is expected to grant environmental and other permits to up to 100 GW of large scale renewable energy capacity before the 25 January 2023 deadline. And finally, the development of hydrogen in the region will further boost the deployment of PV in the longer term.

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 before end 2022**. This deadline is obliging companies to rapidly advance on their permitting procedures and is putting strong pressure

200 MW, Alcalá de Guadaira, Seville, Spain. © Statkraft

on the administrative authorities, who are struggling to process the volume of files. As of today, the permitting journey for solar projects can take up to 3 years and administrative institutions have been swamped with requests. As a result, the pipeline of projects is stacking up and government is pressured to fast-track it. The country also has to improve the design of its auction scheme, which showed very disappointing results in the last exercise from November 2022, in which no solar PV was allocated, while the Ministry expected 1.8 GW of solar PV.

On the local communities' side, the sheer volume of projects going through local permitting (amounting to 2-3 times the NECP targets), has started to generate a **NIMBY**[4] effect in recent months. Certain local associations are opposing utility-scale renewable energy 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 spreading negative misunderstandings.

An overarching challenge that the Spanish market will have to face in 2023 and beyond is the rising cost of capital. Solar PV is a CAPEX intensive industry, and the rise of interest rates could hamper the capability of developers to raise capital for their projects or will make them less financially viable.

Conclusions

The high targets of the 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. However, driven by the energy crisis, the strong rooftop solar boom will continue, while the expected upcoming environmental permitting approvals for up to 100 GW will result in an unseen volume of PV power plant capacity coming online in the coming years.

Authors: *José Donoso*, Director General, Unión Española Fotovoltaica (UNEF).

Valladolid, Spain.

© Iberdrola

4 NIMBY - Not In My BackYard.

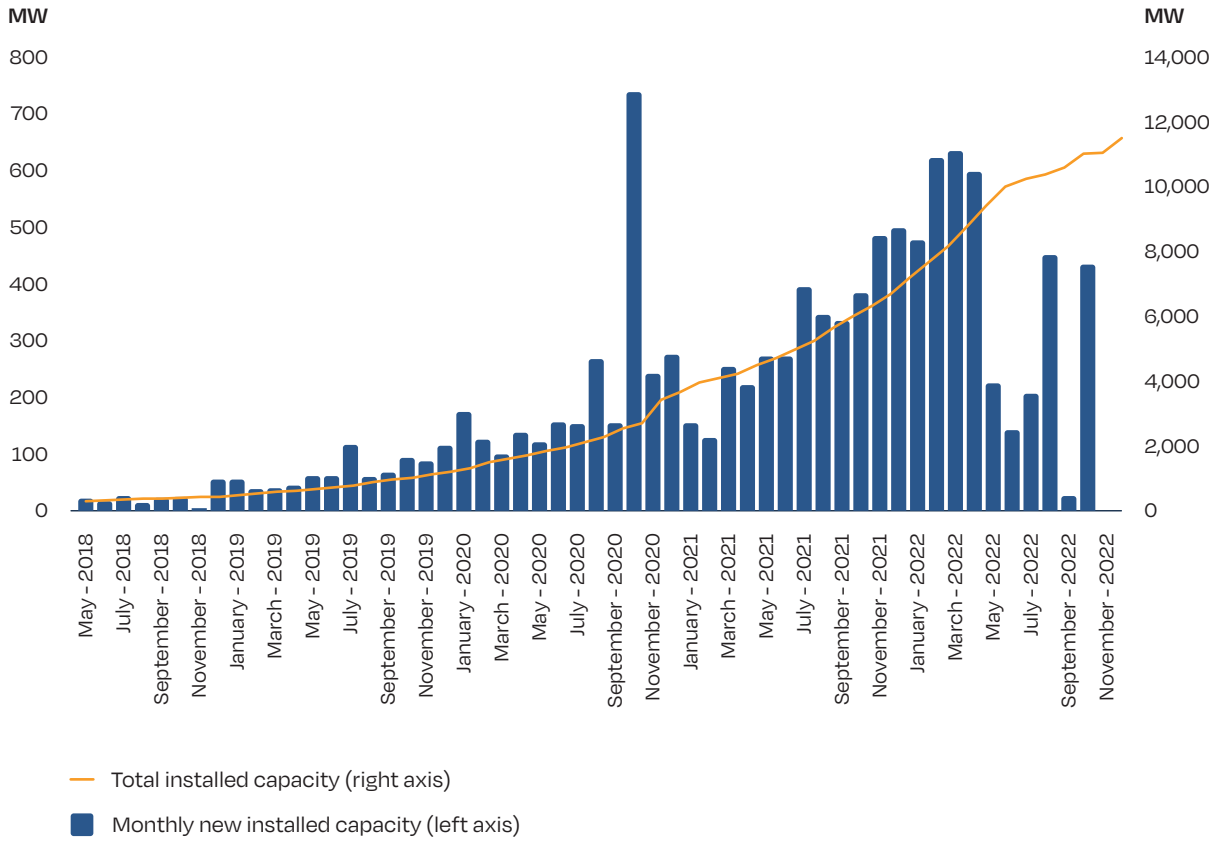
3. Poland

Overview of the solar market

At the end of August 2022, over 20 GW of renewable energy was installed in Poland, of which 11 GW came from solar PV installations. That's an over 80% year-on-year growth from the end of August 2021, when total solar capacity amounted to 6 GW. It is also almost four times more PV than the 2.9 GW installed at the end of August 2020. This growth is well reflected in the overall Polish electricity mix: solar PV will cover almost 10% of the country's final demand for electricity in 2022. Just three years ago, it covered less than 1% of the demand.

The success of solar energy in Poland is mostly due to the popularity of home prosumer installations. According to the data of the Energy Market Agency, by end of August 2022 Poland already had 1,131,973 photovoltaic micro-installations under 50 kW. Such high popularity of home installations is mainly the result of very favourable financial conditions for prosumers, which were in force until recently. Specifically, the country's net-metering scheme allowed prosumers with systems up to 10 kW to feed 1 kWh into the grid, and receive 0.8 kWh for free. For larger installations above 10 kW this ratio was 1 to 0.7. Moreover, prosumers did not pay the distribution fees for using the grid.

FIGURE GW 3.1 MONTHLY AND CUMULATIVE SOLAR PV INSTALLATION IN POLAND 2018-2022



SOURCE: PSE.

The large growth in the number of micro-installations in Poland turned out to be challenging for distribution networks and led to changes in the policy framework. On 1 April 2022, the net-metering system was replaced by a net-billing system, whereby the amount of electricity injected and retrieved from the grid is balanced in an hourly settlement using a metering system. Under the new scheme, prosumers are rewarded for surplus energy fed into the grid at the wholesale price, and they pay for the consumed energy just like other electricity consumers. After this change, the popularity of micro-installations somewhat decreased, although solar PV remains an attractive investment for households considering current electricity prices.

A public opinion survey carried out in May 2022, commissioned by the Polish Photovoltaic Association, shows the continued high public support for solar energy. The survey highlights that renewable energy sources (RES) rank best in all aspects when compared to any other energy source. Among renewable sources, solar PV obtains the best results and is the technology that Poles are the most willing to have in their neighborhood (51% of responses). Nearly 2 in 5 respondents also think that the requirement to install PV systems on all new buildings is a very good idea.

Public solar PV targets

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

Key drivers for the solar market

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

18 MW, Warńińsko-Mazurskie, Poland.

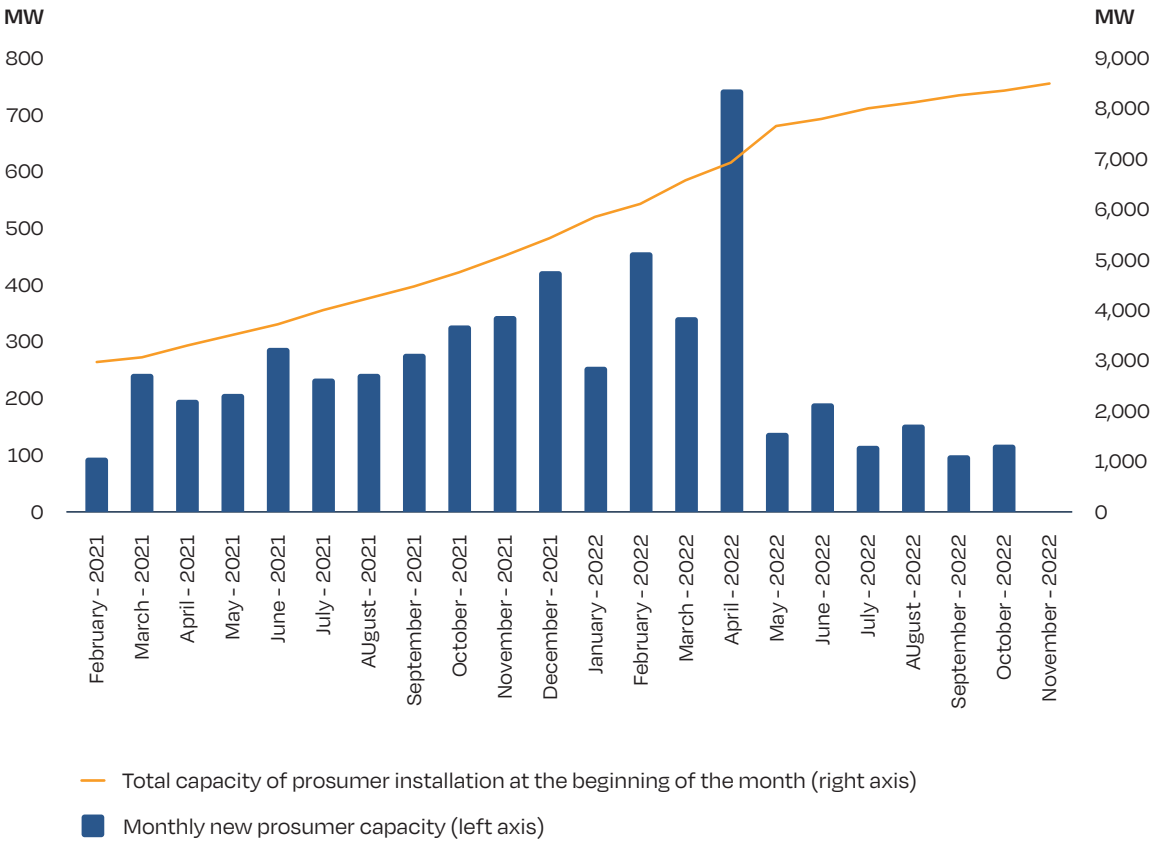
In the small-scale segment, in addition to the change from the previous net-metering framework to the new net-billing scheme, the popular Mój Prąd (My Electricity) scheme is also being revised. From mid-December until the end of March 2023, the subsidies towards residential solar are being increased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

Key challenges for the solar market

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

The act limiting electricity prices recently adopted by the Parliament is very relevant for the PV sector – and the entire Polish energy market. The act implements the European Council Regulation No. 2022/1854 and aims to protect the most vulnerable consumers against uncontrolled price increases. It contains a

FIGURE GW 3.2 MONTHLY AND TOTAL PROSUMER CAPACITY IN POLAND, 2021-2022



SOURCE: ARE.

mechanism that limits the market income of energy producers and energy companies to the amount specified in a separate regulation. While physical PPAs are exempted, virtual PPAs are negatively affected by the cap. The reduction in energy prices is applied until the end of 2023.

Prospect for the solar market 2022-2026

Despite these challenges, we anticipate further stable development of solar energy. The self-consumption segment is expected to grow, whereas for the development of large-scale PV farms, large investments in power grids will be necessary. Recently, a draft amendment to the Act on the Transmission Grid has been published, aiming to accelerate the construction of power grids. Poland is already experiencing a shortage in energy production capacity, and this trend is set to become even stronger. Against this background, PV is currently the only technology that can deliver new energy production capacity within a short timeframe.

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

4. The Netherlands

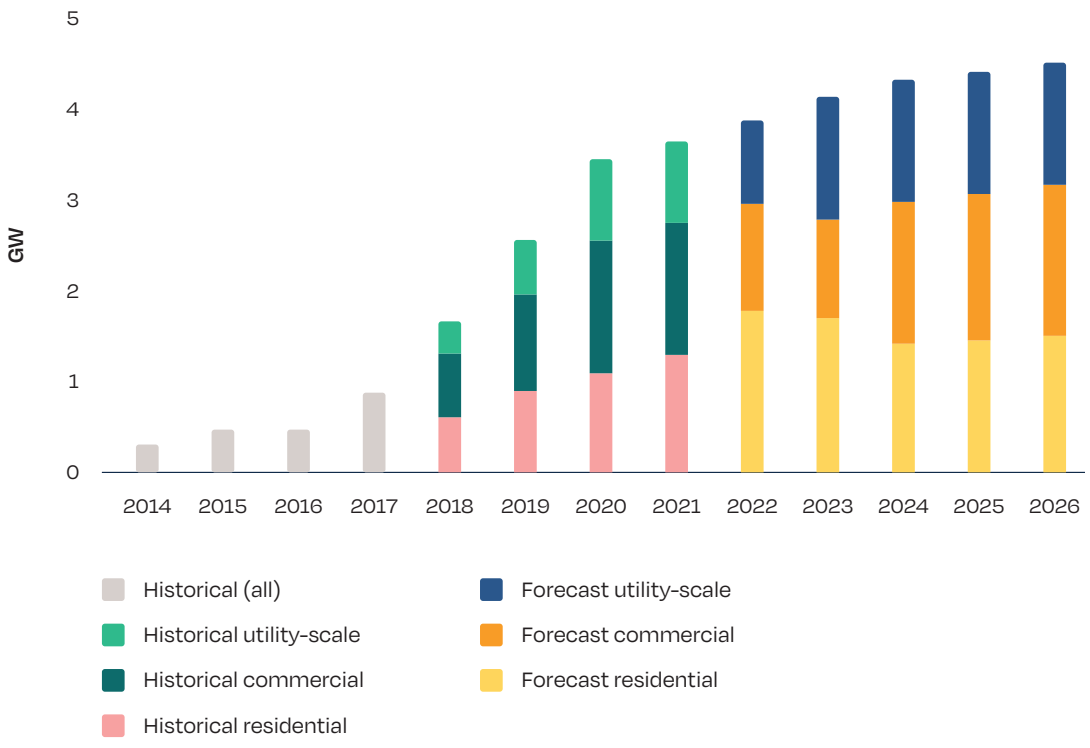
11 GW project pipeline, the game towards 75% clean electricity in 2030 is on

The market in the Netherlands is still developing strongly, with a capacity addition of 3.9 GW in 2022 that has brought the total Dutch PV fleet to 18.2 GW. This includes surprisingly high growth from the residential sector, which added 1.8 GW in 2022. The country also holds a project pipeline of 11 GW from SDE++ subsidy-awarded projects, with even shares of rooftop commercial and ground-mounted projects.

The main challenge now is to ensure that the projects in the pipeline are built. Currently, around 65% of proposed solar projects reach completion, including a timely grid connection. This percentage will decrease in the next years mainly due to the increase of project costs, such as material and labour costs. Rooftop projects face an expected completion percentage of only 40% or worse in the coming years. For ground-mounted, projects completion will fall from 90% to possibly 80%.

Due to new congestion management tools, extra grid capacity and peak shaving requirements, there has been an increase in solar connection capacity in some areas. Clearly, the capacity issues are still challenging for production and demand projects. Despite this challenge, it is expected that the Dutch solar energy market will continue to grow in 2023 and will surpass 4 GW a little earlier than expected a year ago (see Figure GW 4).

FIGURE GW 4 NETHERLANDS SOLAR PV MARKET SCENARIOS 2022-2026, BY HOLLAND SOLAR



SOURCE: Holland Solar.

New system-size records in 2022

In 2022, the biggest market segment in the Netherlands was the residential rooftop market, with a share of 46 % (approx. 1.8 GW) of the total market. The commercial rooftop market had a share of 30% (approx. 1.2 GW) while the market for ground-mounted and floating solar PV accounted for 24% (approx. 0.9 GW). The residential market has had an impressive year-on-year growth of 37% (from 1.3 GW to 1.8 GW) absolute and 10% market share increase due to the strong increase of electricity consumer price levels. This level is expected to be maintained in 2023 and to stabilise at a level of about 1.4 GW per year afterwards. Residential solar is considered an important market segment for the Netherlands and is the far most favourable option in policies as well as public opinion.

In 2022, the largest project with a new SDE subsidy grant is a 100% locally owned solar park in Haarlemmermeer. Its design and location were developed in co-creation with local citizens. This 136 MW project is expected to be finished in 2023.

A large utility company winning an offshore wind tender of a total capacity 760 MW recently announced to combine offshore wind with hydrogen production and battery storage. In addition, the offshore wind farm will be combined with floating solar panels to demonstrate a more efficient use of ocean space.

Dutch policy/RE targets

The Netherlands has a significant solar pipeline of over 11 GW. With this pipeline, and the successful completion of several wind projects, it appears that the 2030 National Climate Agreement target of 35 TWh/year renewable electricity production on land is almost met. However, the Dutch National Climate Agreement was agreed upon in 2019 and does not yet consider the higher national targets – being 55% but targeting 60% – related to the EU ambition of 55% GHG emissions reduction by 2030, nor the impact of the Russian invasion in Ukraine. On top of that, the target does not include forecasting for the increase in demand for renewable electricity from industry, buildings and mobility sectors. The government is now discussing what the new national ambitions for renewable energy production on land ought to be. Studies show that demand for green electricity will grow by 10-20 TWh by 2030. It is therefore foreseen that the tender scheme SDE++ will stay open for solar and wind projects in 2023-2025 and a formal decision will be published end of this year.

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. A new subsidy scheme, SCE (Subsidy Cooperative Energy production 2021), has been successfully supporting organised citizens in developing cooperative projects and will continue to do so adequately. This cooperative sector – 1 million organised citizens with hundreds of projects – takes however still a small, but growing, share of 1.5%. Other methods of participation – financial or otherwise – have been deployed as well and will be published in an addendum to the Code of Conduct of the solar sector. In this way Holland Solar intends to ensure a level-playing field for discussions between commercial project developers and local residents.

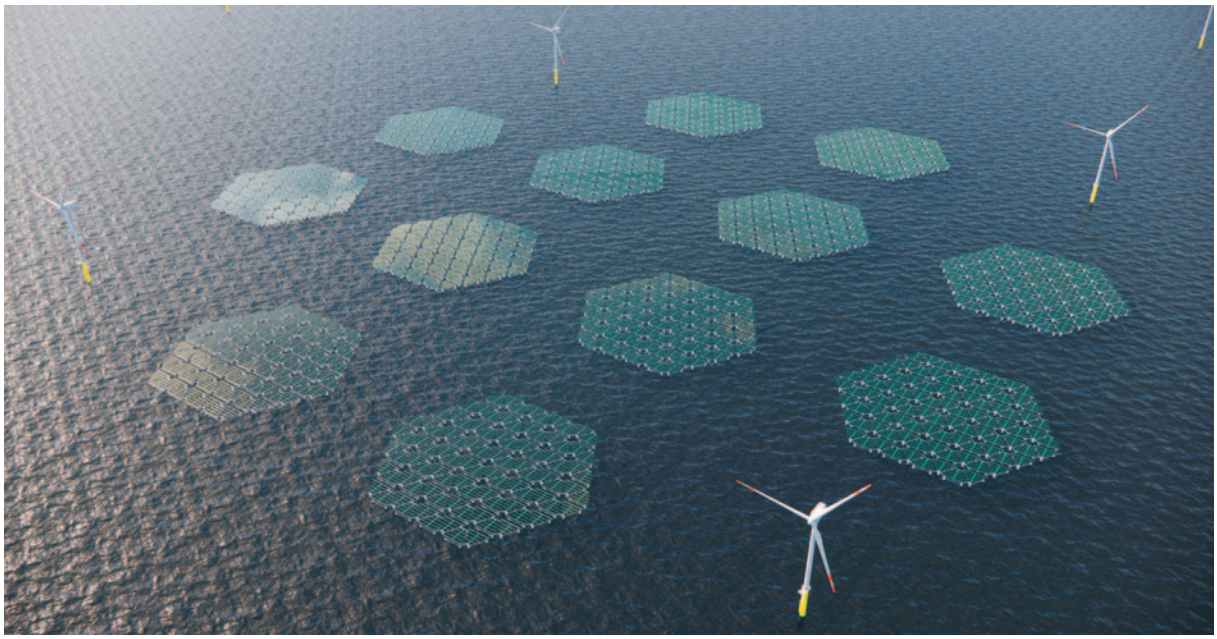
Reducing perceived risks of fire for rooftop solar

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 concerns sparked 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, which has now been in place for a whole year, has resulted in a higher insurability. It satisfies requirements from insurance companies and ensures that building owners can be confident their commercial solar installations are fire-safe.

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, is still pending a vote in the parliament. This degressive path is based on a seven-year payback time for the prosumer, assuming 30% self- consumption and optimal system conditions. In light of the new EU Fit for 55 discussions, 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 to incentivise more flexibility in the system. Nonetheless, this segment is and will remain an important driver for continuous growth in the Dutch solar sector, especially in the current context of extremely high electricity prices.

The commercial and utility-scale market in the Netherlands is driven by the SDE++ tendering scheme, whereby solar energy projects compete with other renewable energy projects and other CO_2 reducing technologies such as CCS. In this tendering scheme different maximum capacities are awarded, depending on technology (wind, biomass, solar), size, and application (ground-mounted, rooftop, floating). The ranking in the scheme is based on EUR per kt 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 and 2023 round, this decreasing subsidy level will need to be mitigated. In the 2022 round in June, a total of 2.3 GW solar projects applied for subsidy. There is a fair chance these projects will all be granted. About 1 GW are ground-mounted projects, 38 MW are floating and the other 1.3 GW are large rooftop solar projects. The next round, expected to be launched and closed before the summer 2023, will have at least a budget of € 5 billion. In this future round a budget of € 750 million will be reserved for projects producing "low temperatures, high temperatures, and molecules". Solar still needs to compete with CCS projects in the remaining budget.



© Solarduck and RWE

Challenges

The main challenges for the solar energy sector in the Netherlands are the current cost levels of project development and securing timely grid connections. For the coming years, the sector is still expecting to face serious delays and possibly a higher project non-realisation. Additional reserve capacity will be put into general use by the grid operators soon, and moreover, a recently published congestion management grid code will lead to an increase of connection capacity at the local level. Former legal limitations to cable pooling, which combines solar and wind projects in co-location with batteries, has been recently resolved. New projects applying for SDE subsidies (2022 and on) will have to comply to a maximum 50% connection, instead of peak capacity, to be eligible for applying to grid connection and to the subsidy scheme. The yearly loss is compensated in the subsidy level per kWh.

For the years 2023-2026, battery and flexibility solutions provided by the market will require more incentives from grid operators and the Dutch government. In Oosterwolde in March 2022, the first Dutch solar hydrogen plant was opened by GroenLeven through a pilot in cooperation with grid operator Alliander, under the Frisian name "Sinnewetterstof".

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. So far, it was announced that ground-mounted projects will need to include a multi-use component in order to receive permitting, but the nature of that component is still unclear.

The newly formed government has shown a good level of ambition in regard to climate change. New actions are being announced to support solar developments but are not yet in place. Examples include deploying additional support for solar on "unsuitable" rooftops and defining solar-prepared building standards. Local authorities are recently enforcing their assignment to locally stimulate rooftop owners to use their roofs for the energy transition.

Last but not least, the most important step in the near future will be to create effective policies on the electrification of industry, mobility, and space heating, which should go hand-in-hand with creating a level playing field for flexible green electricity production. The game is on.

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

© Groenleven, Bay.Wa r.e. and Alliander

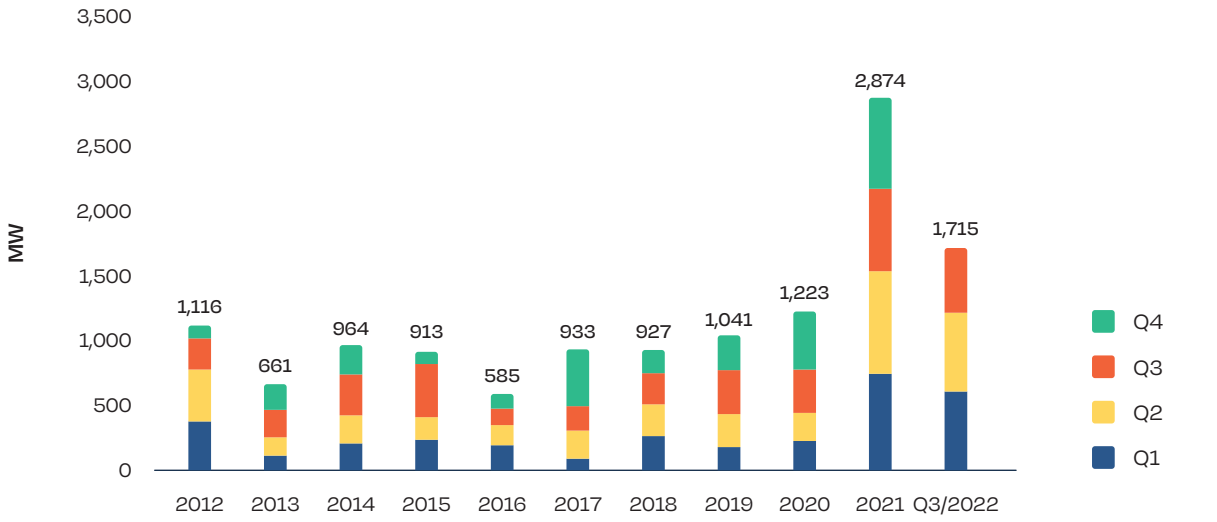
5. France

The 3 GW level within range

Overview of solar PV developments

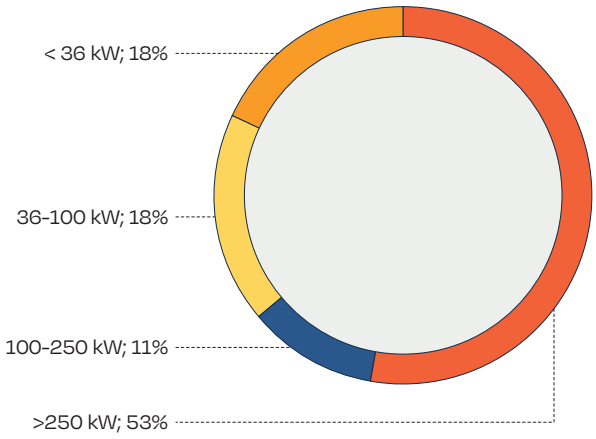
The French solar fleet is entering its acceleration phase: in 2021, for the first time, more than 2 GW was connected in less than a year. With an additional 1,715 MW connected during the first three quarters of 2022, the French solar fleet passed the 15 GW milestone at the end of September 2022. Electricity production from solar photovoltaic sources amounted to 9.6 TWh during the first half of 2022, up 32% compared to the first half of 2021. It represented 3.8% increase of French electricity consumption over this period. The capacity of projects in the queue has grown

FIGURE GW 5.1 FRANCE SOLAR PV MARKET INSTALLATIONS PER YEAR 2012-2022, BY MTE



SOURCE: MTE.

FIGURE GW 5.2 FRANCE CUMULATIVE SOLAR PV GRID CONNECTED CAPACITY Q3 2022, BY ENEDIS



SOURCE: ENEDIS.

by 31% since the beginning of the year. This amounts to about 15.1 GW of solar projects, including 3.2 GW projects which secured grid connection permits.

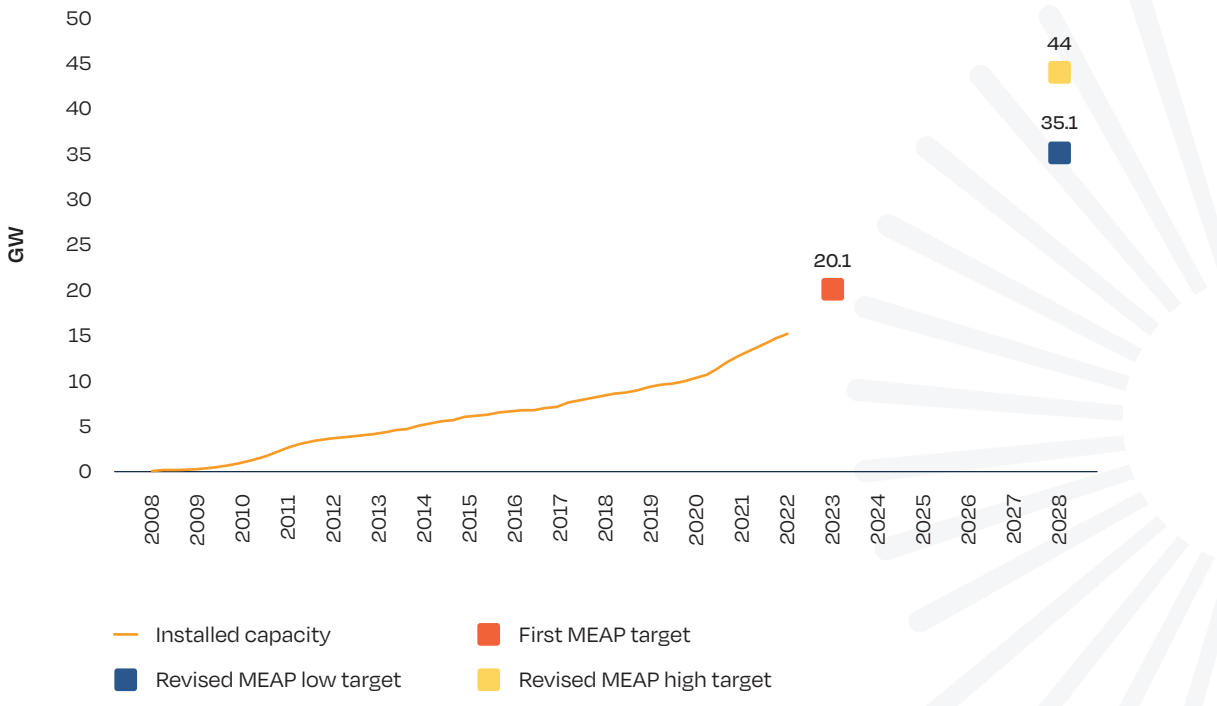
Solar PV targets in France

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 programme 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, currently stands at 75.6% completion.

A revised version of the first MAEP, adopted in spring 2020, confirmed the willingness to accelerate the development of a French 'solar park'. The new targets presented for 2028 lie between 35.1 GW and 44 GW in cumulative capacity. 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. These targets position solar as one of the most important contributors to the French energy transition.

Regarding the long-term strategy, French President Emmanuel Macron announced in February 2022 an objective of 120 GW of total solar installations by 2050. However, the MEAP targets for 2033 will be revised in 2023 and will set a trajectory that could be more ambitious. 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, predicts 70 to 208 GW of solar capacity installations in 2050.

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



SOURCE: MTE.

Drivers for solar growth

Calls for tenders are the main factors 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. The new threshold was implemented in Autumn 2021, raising the FIT threshold from 100 kW to 500 kW. This change is making things easier for the mid-size rooftop market segment, where projects were previously limited by tendering procedures. Immediate results from this legislative change have been observed on the market, as the number of installations lower than 500 kW continues to increase.

Many other measures allowing for a faster development of PV were adopted this year, or will be in the next months. Indeed, a new FIT scheme will start in 2023 for ground-mounted projects under 1 MW installed on degraded land. Moreover, an ad-hoc decree to be published by the end of the year will change the authorisation regime for ground-mounted PV projects. Specifically, according to the decree, only projects above 1 MW would require a building permit. Smaller projects should give prior declaration, but lengthy permitting can be avoided.

The calls for tenders have been modified this year to include Agri-PV projects, either in the form of agrivoltaic canopies above crops or ground-mounted projects, on uncultivated agricultural land of more than 5 years, or land that is hosting livestock.

A "renewable energy acceleration law " is also currently under discussion at the French Parliament to simplify procedures and reduce the deadlines applicable to renewable energies. Additionally, the self-consumption market, for which a dedicated framework has been put in place, is growing rapidly. In Q3/2022, 208,371 installations were self-consuming, representing 994 MW.

Challenges

Reaching the national target of 44 GW by 2028, compared to the 15.2 GW currently installed, would require average annual additions of around 5 GW. To achieve this, it will be necessary to implement regulatory changes that support the growth of all market segments.

15 MW, Curbans, France.

Firstly, the parameters should be wider for 'eligible land' in tenders for ground-mounted projects. Given the 2028 MEAP target and as the distribution of major projects remains stable, we can expect almost two-thirds of solar power to be installed on the ground. Assessing land use is crucial to incorporate 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.

Moreover, the development of photovoltaic projects is tightly regulated. Some administrative procedures and architectural planning issues must be clarified and simplified for all market segments. Some local services may have an ambiguous and debatable interpretation of the framework in place. This can sometimes go beyond current regulation, such as fire safety regulations. Additionally, administrative deadlines need to be shortened.

The promotion of France's low carbon footprint within its solar PV industry should also be recognised. The carbon criterion 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 $kgCO_2e/kW$ in the new call for tenders' specifications which were published in summer 2021. This criterion is now required to apply to the new FIT for rooftop installations. Thanks to the work of strong R&D centres (INES, IPVF, etc.), the French industry's innovation capacities and technological breakthroughs will also improve competitiveness. SER believes that manufacturers are interested in setting up solar wafer to module production capacities in France.

Finally, self-consumption rates are low within the French solar PV sector. The attachment rate of batteries with solar is also low – they are rarely used with PV systems. The support mechanisms for self-consumption projects must be adapted to enhance the value of all electricity produced, self-consumed, and injected into the grid. This would guarantee the financial security of projects. Another alternative is to encourage self-consumption, without penalising consumers who are not always able to consume all of their produced energy.

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

17 MW, Piolenc, France. © Akuo

6. Italy

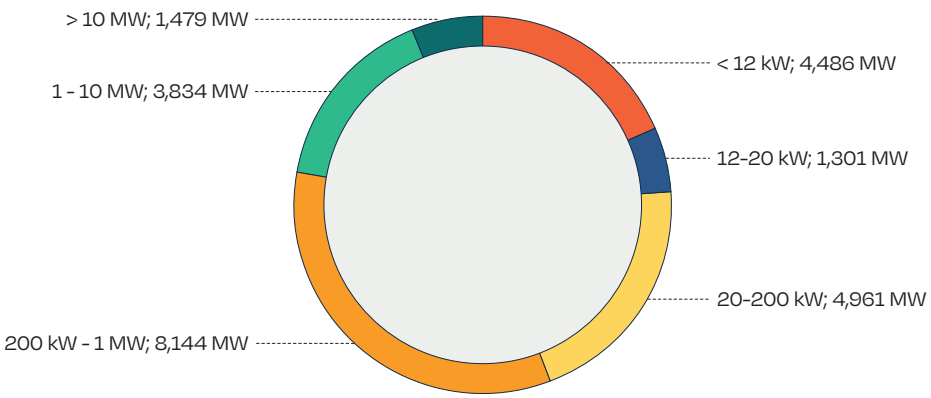
Overview of solar PV developments

The Italian solar market has had a slow growth in the last eight years, with on average 500 MW of capacity installed per year. After an improved performance in 2021, when 936 MW was added, the market is poised to grow significantly in 2022. At the end of Q3 2022, 1.6 GW of new PV power plants were installed, bringing the cumulative solar capacity level to 24.2 GW, with a total of 1,137,374 plants. The vast majority of these factories were small scale systems.

In Figure GW 6 you can see the specific distribution of installed PV power plants by size. PV systems sized between 200 kW and 999 kW make up the majority of Italy's installed solar PV capacity (8.1 GW).

The regions with the highest installed capacity are Puglia, Lombardia and Emilia-Romagna, while those with the lowest installed capacity are the Valle d'Aosta, Liguria and Molise.

FIGURE GW 6 ITALY CUMULATIVE SOLAR PV CAPACITY SEGMENTATION IN Q3/2022



SOURCE: Terna.

985 kW, Chiusi, Italy.

Public solar PV targets

The current NECP was drafted in 2018 and sets goals that are no longer relevant, given the current energy and climate crisises, and new European 2030 targets (Fit for 55 and the latest REPowerEU package). To reach 2030 targets, the deployment of renewables must be planned on a local scale. The so-called "Burden Sharing", already stated in the Italian Legislative Decree 199/2021 (embodiment of the RED II Directive in the Italian legislation), defines the distribution of installed power between regions, as well as the systems required for monitoring regional commitments. It also outlines the statistical processing of the collected data.

The Italian renewables energy associations, ANIE Rinnovabili, Elettricità Futura and Italia Solare agree that Italy must install at least 85 GW of new renewables capacity by 2030 to achieve their REPowerEU targets. They also believe that Italy must install 80 GWh of new large-scale storage capacity to effectively integrate new power into the grid. Solar PV represents 58 GW out of this 85 GW of new renewable energy sources. This scenario will require 309 billion EUR of overall investments in the electricity sector and associated supply chain. It will also lead to 345 billion EUR of overall economic benefits in terms of added value along the electricity sector supply chain, and an increase in domestic spending. This deployment of solar capacity will also lead to a reduction of 64 million tons of CO_2eq emissions, and almost 500,000 new jobs by 2030.

Key drivers and challenges for the solar market

To reach the 58 GW solar target, it is necessary to overcome some key obstacles. In particular, permitting for large-scale solar projects remains a crucial challenge. The identification of suitable areas for project construction should be supported by regional actors. The policy framework for PPAs and self-consumption must also be improved. The following actions should be urgently undertaken to cultivate further solar growth:

- Finalise the new NECP and the "Opportunity Sharing" planning between the regions;
- Secure a fair implementation of the recent Council Regulation (EU) 2022/1854;
- Define 'go-to areas' for PV project development;
- Continue simplifying the authorisation procedures of new plants and repowering projects;
- Plan the new RES auctions while adjusting auction bases to accomodate the LCOE increase as a consequence of increased PV prices; the contract tariffs should also be linked to inflation;
- Facilitate the transfer of the energy produced from PV and other RES plants to consumers;

986 kW, Anagni, Italy.

© Suncity

- Implement support measures for energy communities and self-consumption;
- Encourage the development of PPAs, especially long-term renewable energy purchase contracts;
- Increase support schemes for storage systems in all market segments;
- Avoid regulatory disruptions or sudden law changes which destabilise the market operators' plans; long-term planning is needed (see Ministerial Decree "FER 1" bis, Ministerial Decree "FER 2"; tax deductions for the residential segment; tax credit for businesses);
- Finalise the legislation for the development of Agri-PV systems;
- Review the connection regulations (TICA) to speed up process timing;
- Strengthen the European PV and BESS technological supply chain for improved energy resilience and decreased dependency from non-EU countries;
- Accelerate the reform of the electricity market rules to enable a greater penetration of RES, storage and demand-side response.

Solar market prospects 2022-2026

By 2026 Italy should install about 39 GW of new RES capacity, which for PV specifically means about 27 GW by 2026. This is equal to an average annual growth above 5 GW for the period 2022-2026. Considering that the market in 2022 will most likely stay below 3 GW, a growth in annual additions is expected for 2023-2026.

Author: *Michelangelo Lafronza,* Secretary, ANIE Rinnovabili; *Alessandro Scipioni,* Technical Affairs, Elettricità Futura; *Federico Brucciani,* General Secretary, Italia Solare.

7. Portugal

Overview of solar PV developments

Portugal started investing in solar PV in 2006, with the first solar power plant called "Hércules" which had an installed capacity of 11 MW. In the end of 2013, even though 8 years had gone by, Portugal had only 299 MW of solar PV capacity. This was due to several reasons but mainly because of the world economic crisis that affected Portugal enormously. Only after that year did the installed capacity start to increase at a good rate. From 2013 to 2022, the total installed capacity of solar PV went from 299 MW to 2.4 GW, almost a tenfold increase.

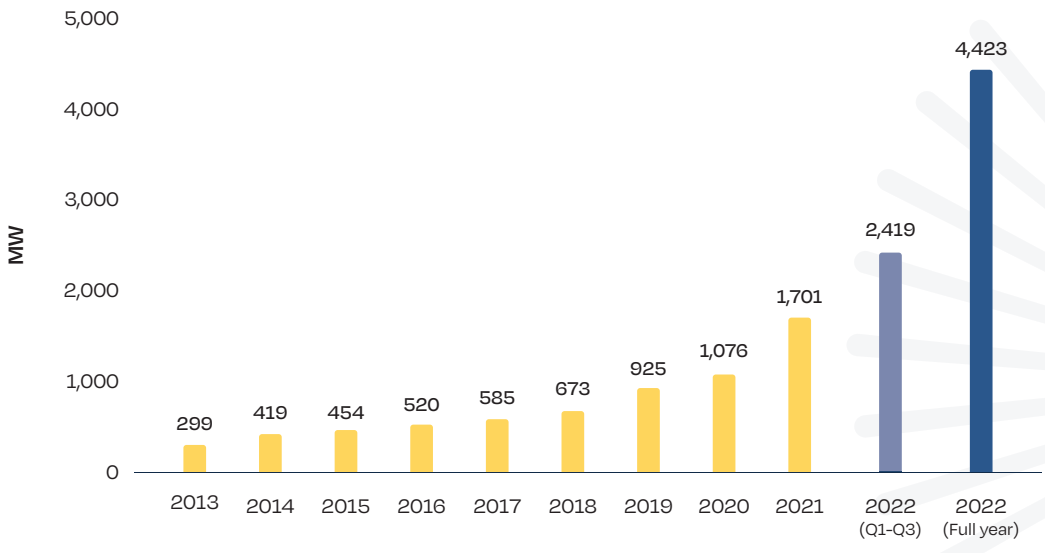
In the period from January to September 2022 alone, Portugal has installed roughly 700 MW of new solar PV capacity, has 1.14 GW of production permit requests (the permit needed to start the construction permitting procedure with the municipalities) and another 3.2 GW of solar PV waiting to get an operating permit (the permit needed to initiate generation).

Considering that all projects that obtained production permits by 2021 need to be operative by the end of 2022, Portugal might achieve 2.7 GW of yearly solar PV additions (installed between January and December 2022), which means 2 GW more than last year's additions. In cumulative terms, this would bring the total operating capacity in Portugal to 4.4 GW by year end (Fig GW 7.1).

As shown, Portugal has more capacity waiting for permits than actual installed capacity. This is due to the lengthy permitting process, even after the publication of new regulations, such as Decree-Law No. 15/2022, Decree-Law No. 30-A/2022 and Decree-Law No. 72/2022, which introduced different methods to speed up permitting.

Considering the goal of 9 GW solar capacity by 2026, Portugal is targeting an average of around 1 GW per year, from the beginning of next year until 2026.

FIGURE GW 7.1 PORTUGAL TOTAL SOLAR PV MARKET, 2013-2022



SOURCE: DGEG (2022).

Solar PV targets in Portugal

After the NECP targets have been brought forward from 2030 to 2026, Portugal now has a goal of reaching 9 GW of solar by 2026. On top of that, the hydrogen cluster expected for Portugal will require an even higher level of renewable energy sources and, for Portugal, the electricity that will be used for electrolysis will mostly come from wind and solar technologies. For that reason, the new NECP goal for wind and solar should be much higher than what was initially set.

Decentralised solar PV capacity, mainly self-consumption, has also been increasing at a promising rate. In 2015, Portugal had around 176 MW of decentralised solar PV capacity, and in 2019, the first big jump was noted when Portugal installed 110 MW, bringing the total to 429 MW. 2021 and 2022 were the best years for decentralised solar PV, with a rise of 210 MW and 296 MW respectively, summing up to a total of 1 GW (Fig. 2). In the years to come it is expected that decentralised solar PV follows the pattern of 2021 and 2022, at an average of 250 MW per year.

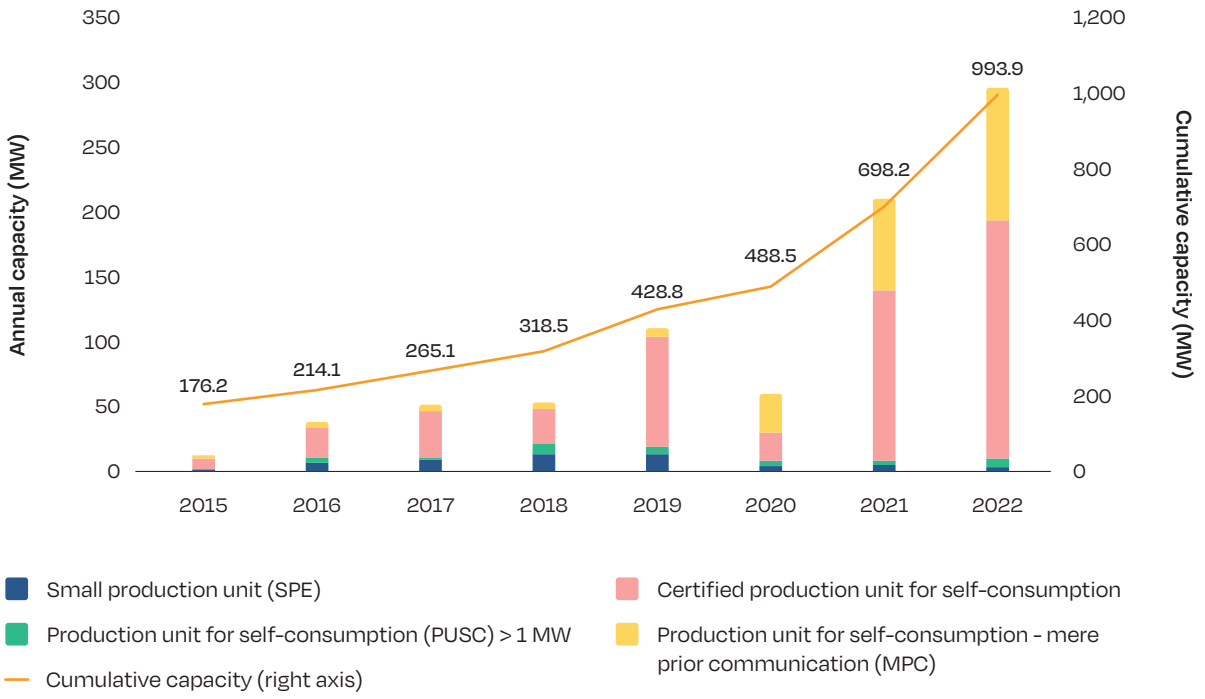
Drivers for the solar market

Due to the lack of grid availability, Portugal started with capacity auctions for grid connection points in 2019. This auction model was implemented to ensure compliance with the proposed targets in the most cost-effective manner. A total of 2.3 GW has already been auctioned for injection points to connect power plants where there is still grid availability or where its expansion is planned.[5]

Following the auctions of 2019 and 2020, which distributed, respectively, 1,400 MW and 700 MW of solar capacity, an auction for floating PV with a total capacity of 200 MW was carried out in 2022.

Besides that, the Decree-Law No. 15/2022 published at the beginning of the current year introduced two new modalities that will allow the optimisation of the connection point: repowering (until 20% of the injection capacity) and hybridisation. In the following years, it is expected that several wind farm operators will maximise the electricity input into the grid by installing a solar PV power plant.

FIGURE GW 7.2 EVOLUTION OF DECENTRALISED SOLAR PV CAPACITY IN PORTUGAL, 2015-2022



SOURCE: DGEG (2022).

5 SPU – Small Production Unit; PUSC – Production Unit for Self-Consumption.

Furthermore, given the proposal from the European Commission that pushes the implementation of solar PV in buildings by requiring all new and renovated buildings to have solar PV on rooftops and shortening the permitting process, Portugal could see a big rise in decentralised solar PV capacity.

To help with the deployment of decentralised solar PV, the Portuguese government has two financial incentive programmes for residential rooftop installations. One of them is the "Vale Eficiência" programme (efficiency voucher programme) which intends to deliver 100,000 "efficiency vouchers" of 1,300 EUR + VAT to economically vulnerable families by 2025, battling energy poverty and reinforcing the renovation of buildings, including the installation of PV panels. The other programme is the "Apoio Edifícios + Sustentáveis" (Support + Sustainable Buildings programme) which has a contribution rate of 85% up to 2,500 EUR for the installation of PV panels, with or without storage.

Challenges

Right now, the main challenge Portugal faces is the complex and bureaucratic process for permitting. For solar PV projects above 1 MW, the period between obtaining the production permit and the operating permit has increased significantly in recent years. Operating permits obtained in 2022 took, in average, 16 more months to be granted compared to those obtained in 2019.

There were several pieces of legislation weighing on the permitting process for this type of projects, as mentioned above. Following the release of the REPowerEU package, and to diminish the bureaucracy seen in the environmental permitting process, the Portuguese government took measures to simplify the process. It is therefore expected that, in the 2022-2023 period and in the years to follow, the duration of the permitting process will be significantly reduced, both for obtaining the production and operating permit.

However, it is extremely important that the official entities are provided with the required skills including human and digital resources, such as a one-stop-shop. This will enable the streamlining of permitting processes in accordance with the new measures and help to deal with the increase in permitting requests. Without such support, the implementation of the new legislative acts will not bring the necessary tools to ensure the development of the renewables sector.

Another big issue, as mentioned before, is the shortage of grid connection points. The local auction approach was introduced to address this shortage, and now brings to the market connection points that are available or that will be expanded.

14 MW, Coruche, Santarém, Portugal.

Prospects for 2022-2026

Portugal is on a good path to achieve the targets set for 2026. With the revision of the target deadline, we consider these targets might be ambitious considering the current challenges. However, it is important to adjust those targets to the development of the hydrogen sector and the possibility of hybridisation.

Decentralised solar PV will aid in this needed development. The Commission's proposal to introduce a maximum one-month permit-granting process for the installation of solar energy equipment, in existing or future artificial structures, will help raise the decentralised solar PV capacity of Portugal.

Authors: *Susana Serôdio, Gonçalo Martins & Mariana Carvalho*, Technical Department, Associação Portuguesa de Energias Renováveis (APREN).

8. Denmark

Overview of PV developments

In 2022, Denmark expects to become a GW-scale market, after missing this target in 2021. This crucial milestone has been driven by the utility-scale solar, which has demonstrated steady growth in recent years because of subsidy-free projects. Besides the large-scale solar segment, rooftop PV of all sizes also demonstrates significant growth with a nice potential for continued expansion in the future. The residential market peaked in 2012 and, except for a small decrease into 2013, has only regained growth momentum in the last three years.

Drivers for solar growth

As of November 2022, the accumulated utility-scale capacity in Denmark is 1.7 GW_{AC} (1.9 GW_{DC})[6] distributed into 57 parks, including 656 MW_{AC} (722 MW_{DC}) already registered as installed this year. Based on information collected from 8 major solar developers, an additional capacity of 556 MW_{AC} (612 MW_{DC}) is expected to be grid-connected during the last two months of 2022.

This brings the accumulated year-end utility-scale project volume to a record 2.27 GW_{AC} (2.50 GW_{DC}).

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. Danish mmunicipalities and utility providers have reputation for efficiency, which expedites the process.

Another driver behind the high volume of utility-scale installations, but only for this year, is a new tariff scheme for grid connection that will significantly increase grid connection costs in the near future. The new scheme will introduce a per-MW_{AC} grid connection charge between 17,600 EUR and 329,000 EUR depending on connection voltage (from 10 kV at DSO level to 400 kV at TSO level) and geographic zone (production dominated vs. consumption dominated), which presumably will be in force already from January 1st, 2023.

Thus, as the new connection charge may increase the overall grid cost by well over 50%, it is becoming challenging for most PV projects in the pipeline to stay competitive, since these pipeline projects have had no chance to plan for these charges and adapt the site location according to the new geographic zoning principle.

The 304 MWp Kassø PV plant was grid connected in 2022 to the 165 kV side of one of the main TSO transformer stations in the southern part of Denmark. It is constructed with half a million bifacial modules. In 2023 it will be connected to a 50 MW electrolyser and the world's largest e-methanol plant capable of producing 30.000 tons of green shipping fuels per year.

6 AC to DC conversion rate in Denmark is assumed to be 1.1.

The residential, commercial, and industrial market segments have also seen significant growth during the year, with growth rates close to 300%, 200% and 130% respectively for these sectors. This is largely because of the overall interest in supporting the green transition, and realisation of energy independence through a high degree of self-consumption.

Challenges

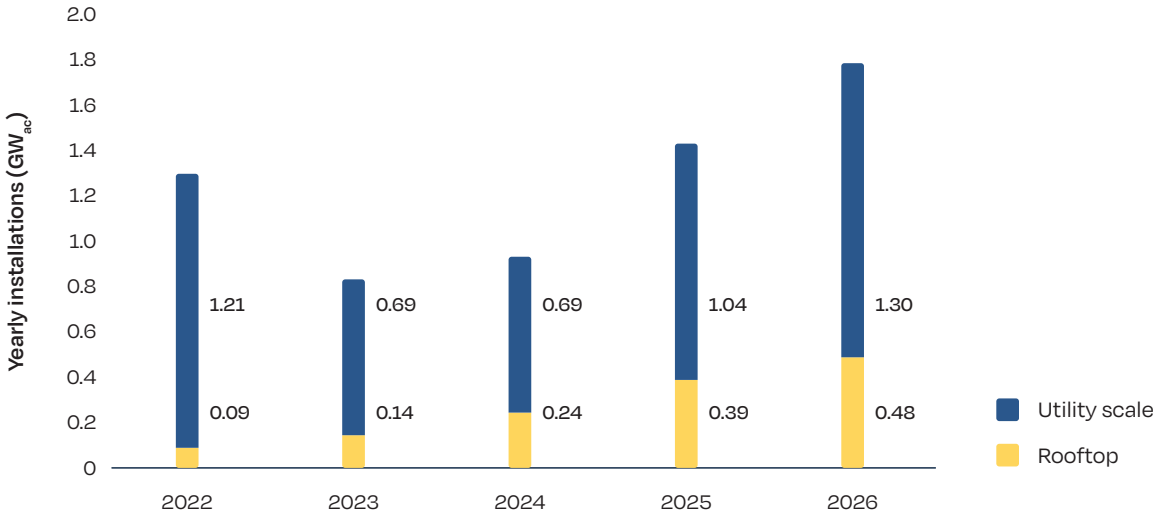
For the utility-scale market, it will take several years to adapt to the new grid-connection tariff regime. Based on feedback from the major developers, the total volume of projects expected to become grid-connected in 2023 accounts to 692 MWAC (761 MW_{DC}), which represents a 43% drop in installations compared to 2022. This significant installation reduction comes at a critical moment, with the calls for extraordinary measures to speed up the deployment of renewable energy sources. However, since it takes time for project developers to adapt to the new geographic zoning principles, 2024 installation rates will likely replicate 2023 installation rates. After two years of low utility-scale installations, 50% and 25% yearly growth rates are forecasted for 2025 and 2026 respectively, reflecting improved business cases, and more pipeline projects in "green" zones becoming ready-to-build. Steady growth in rooftop installations is anticipated to continue. This will be limited mostly by the availability of skilled installers.

Outlook

While 2022 is expected to be the first year when solar reached the GW scale in Denmark, this status will not be maintained due to the new grid-connection tariff scheme. Our five-year outlook foresees that the market will reach 0.84 GW_{AC} (0.924 GW_{DC}) in 2023, and will surpass the 1 GW_{AC} (1.1 GW_{DC}) mark again from 2025 and onwards, driven by the large demand for utility-scale solar (Fig. GW 8). If the bulk of installed capacity will keep belonging to the utility-scale segment, rooftop installations are also on a strong growth path. The annual market of residential and C&I solar combined, will grow from 90 MW_{AC} (99 MW_{DC}) in 2022, to almost 400 MW_{AC} (440 MW_{DC}) by 2025.

Authors: *Jacob Klivager Vestergaard*, Department Head, Green Power Denmark; *Flemming Kristensen*, Chairman of the Board, Danish PV Association.

FIGURE GW 8 DENMARK SOLAR PV MARKET 2022-2026



SOURCE:

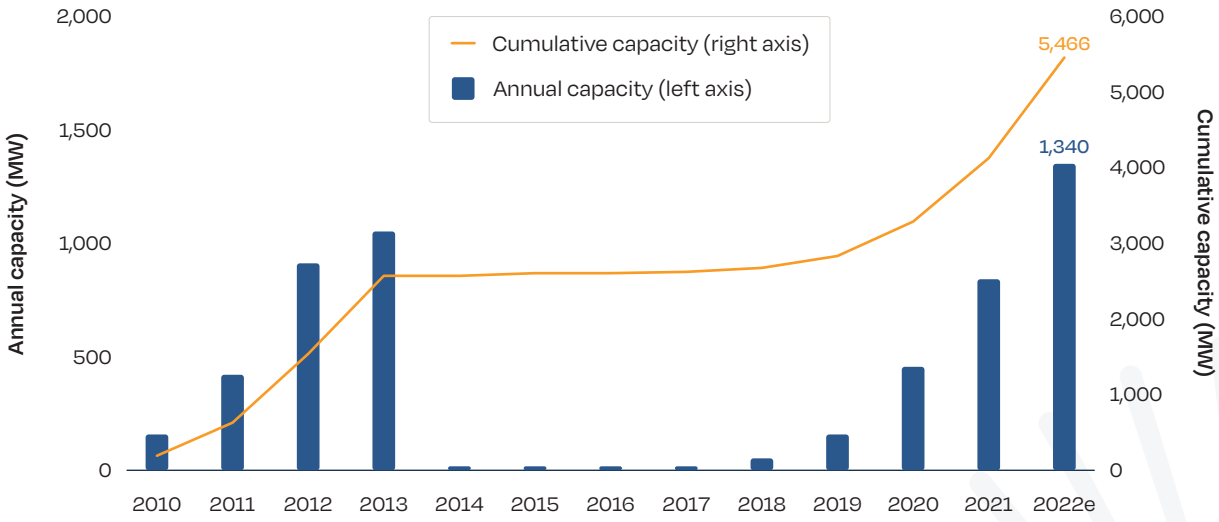
9. Greece

A record year for the Greek Solar PV market

The Greek solar PV market has gained tremendous momentum, which is expected to continue for the next few years. It is expected that 1.34 GW of new PV projects will be connected to the grid by the end of 2022, bringing the cumulative capacity to 5.5 GW. This is the best performance ever for the Greek solar sector.

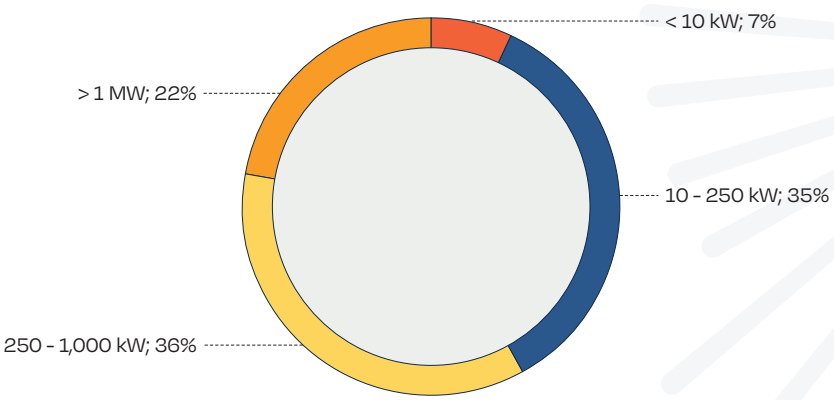
Once again, the market was dominated by medium-size projects between 10 and 1,000 kW. However, the utility-scale and residential self-consumption segments are experiencing noteworthy growth for the first time.

FIGURE GW 9.1 GREECE SOLAR PV MARKET DEVELOPMENT 2010-2022, BY HELAPCO



SOURCE: HELAPCO.

FIGURE GW 9.2 GREECE SOLAR PV MARKET CUMULATIVE CAPACITY SEGMENTATION 2020, BY HELAPCO

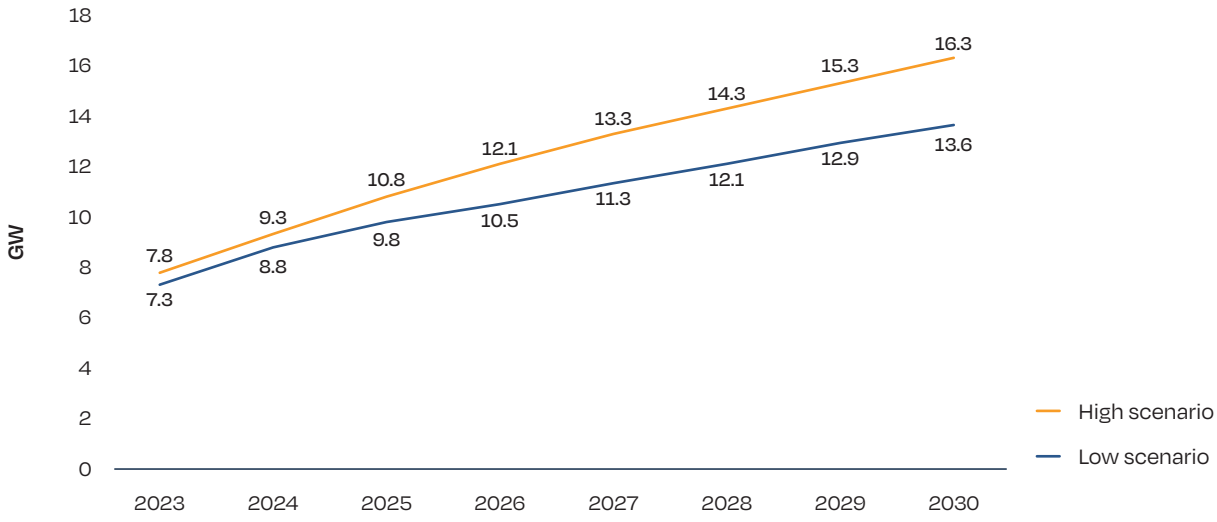


SOURCE: HELAPCO.

The bright weather across the country helped PV to contribute some 14.2% of total Greek electricity production in the first 10 months of 2022, breaking yet another record. This outshined the expected 10% share of solar in meeting gross electricity demand.

Taking into account current trends, Greece is expected to reach its 2030 national solar target of 7.7 GW by the end of 2023. The Greek government is currently revising the National Energy and Climate Plan, and the new targets for PV by 2030 will be much higher. Still, according to HELAPCO, these new, relatively high targets are still below the true potential of the market. Two possible scenarios up until 2030 provided by HELAPCO are depicted in Figure 9.3.

FIGURE GW 9.3 CUMULATIVE GREECE SOLAR PV MARKET SCENARIOS, BY HELAPCO



SOURCE: HELAPCO.

50 MW, Epirus, Greece.

These positive trends are the result of the simplification of authorisation procedures in the summer of 2022, and a very clear message from politicians predicting a bright future for PV. The major bottleneck remains the availability of grid capacity. Most of the medium-voltage grids are now congested, and soon, the same is likely to happen with the high and ultra-high voltage grids. The government presented a priority list for grid connection in August 2022, raising numerous complaints by interested investors. To address these complaints, a roadmap for grid enforcement and development for the coming years was made. However, the appetite of investors transcends this plan.

The real good news come from the self-consumption segment. For the first time annual installations reached the 100 MW milestone, and 2023 is expected to be another record year for self-consumption systems.

Regarding support schemes, some 4.1 GW of RES projects will be auctioned in Greece from 2022 to 2025, with PV expected to get the majority (around 3 GW). Additionally, corporate PPAs are expected to take off soon, and a Green Pool scheme to support PPA deployment has been presented by the Greek Energy Ministry for European Commission approval.

In 2022, the Greek Parliament also passed a thorough regulatory framework for storage. Large scale storage (above 900 MW) will be selected through a bidding process. The allocation of the contracts to selected projects should take place before the end of 2023, and storage facilities should be completed by the end of 2025. A support scheme for self-consumption PV systems coupled with storage in the residential and small commercial sectors will also commence in early 2023.

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

294 MW, Kozani, Greece..

© HelleniQ Energy

10. Sweden

Overview

For the first time ever, the Swedish market will reach the GW scale during 2022. The installations during January - September 2022 were approximately 700 MWAC (840 MW_{DC})[7], and it is expected to reach about 940 MWAC for the entirety of 2022, resulting in installed DC capacity reaching over 1 GW with good margins. That is an 80 % market increase compared to 2021, when 498 MWAC (598 MW_{DC})grid connected capacity was installed. By the end of 2022, the total installed capacity in Sweden is expected to be about 2.5 GW_{AC} (3.0 GW_{DC}).

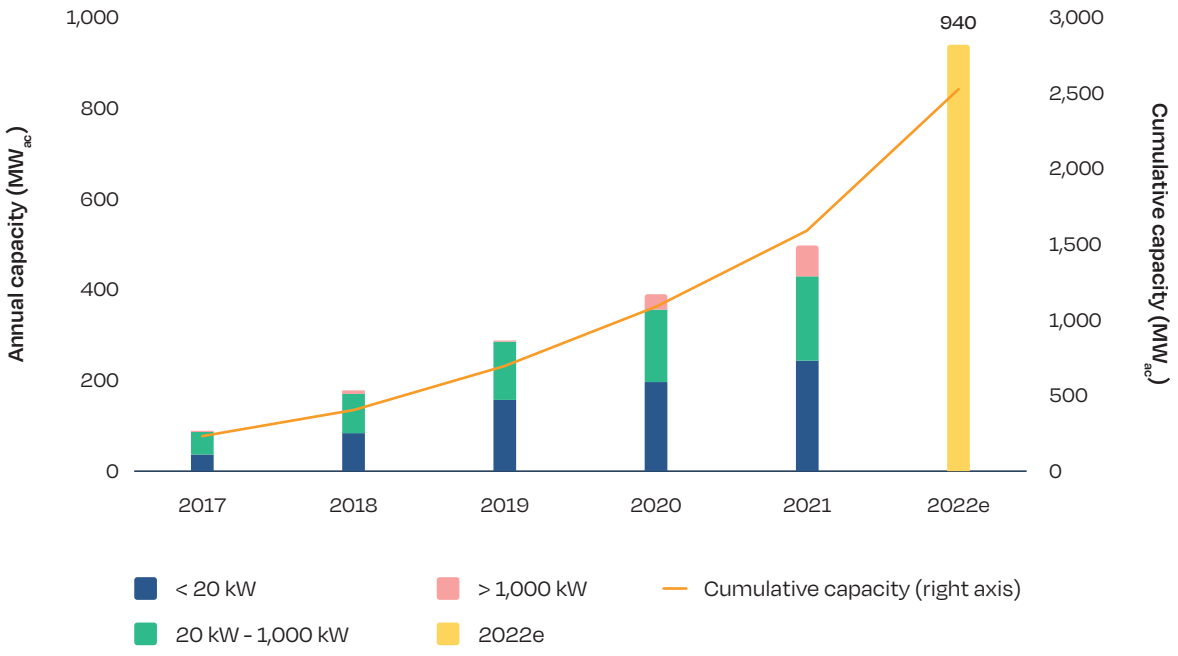
The Swedish market has grown steadily every year, from a very low level in the first half of last decade. It reached over 100 MW_{DC} annually for the first time in 2017, and the total installed capacity at the end of 2021 was about 1.6 GW_{AC} (1.9 GW_{DC}). However, the share of the electricity production from PV in the electricity mix is still very low, at about 1.5%, with expected 2 TWh produced during 2022.

Public target and demand

There is no public target for solar power in Sweden. The level of fossil fuels in the Swedish electrical production is negligible. However, electricity production capacity must be expanded as the industry and transport sector will be electrified in the coming years. There is also a wave of energy-intensive industries being established in the country. The Swedish TSO predict that electricity consumption might be doubled until 2045. At the same time, Sweden exports large amounts of electricity to the Europe, an alternative to fossil fuels.

Swedes are most optimistic about solar power compared to other energy sources. In 2008, the Swedish right-wing government set a target for wind power capacity, which was a key for the strong expansion of the wind industry. We are still waiting for the government to set a target for solar power expansion; it is an integral part of the expansion of electricity production.

FIGURE GW 10 SWEDEN ANNUAL AND CUMULATIVE INSTALLATION CAPACITY 2017-2022, BY SVENSK SOLENERGI



SOURCE: Svensk Solenergi .

7 AC to DC conversion rate in Sweden is assumed to be 1.2 in this article.

Key drivers

The Swedish market reached the GW scale this year because of high electricity prices in Europe. In particular this impacted the South of Sweden. where there are optimal conditions for PV generation. Russia's invasion of Ukraine also drastically increased the demand for batteries and back-up installations. Nearly 20% of the households installing PV in 2022 invested in a battery, compared to about 10 % in 2021 – and this might have even been higher if product shortages did not occur.

The solar market in Sweden is driven by the residential market, which constitutes about 50% of the installed capacity, followed by the C&I segment, with about 35-40%, and the utility-scale market (about 10-15%).

The subsidies for solar energy in Sweden are mainly directed to the residential sector. There is a tax deduction for green technologies for private homeowners. The investment cost for installation and material costs are reduced by 15% for PV installations, and by 50% for energy storage connected to PV and EV chargers. For small prosumers with grid connections of maximum 100 A, there is a tax deduction of 60 öre/kWh (5.5 EUR cents/kWh) for exported electricity, as a light version of net-metering.

From July 1st 2022, a change of the law allows micro producers to generate more electricity than they consume per year without getting charges from the grid company for overproduction. This makes it more profitable for micro producers to install larger PV systems.

Key challenges

The interest to build utility-scale plants in Sweden is very high, as indicated from recent announcements of several large PV projects in the multi-hundred MW scale. Yet, so far, there is no plant larger than 22 MW being built, and there is only a handful of plants larger than 10 MW. One reason for this, is the legal uncertainty. In many counties, the local administrative board (*Länsstyrelsen*) rejected larger installations, and rulings have been appealed. In November 2022 the highest Swedish court concerning land and environment legislation issued its first ruling, which may result in a clearer legal position. It is still uncertain when the first utility plants larger than 20-30 MW can be built. However, Sweden is a country with large land availability and low population density – only Finland has lower population density in the EU. There is also a lot of fertile land available. There are promising opportunities for ground-mount PV in Sweden.

20 MW, Strängnäs, Sweden.

© Jann Lipka

Dependent on future legal interpretations, political initiatives may have to be introduced to facilitate the permitting of utility-scale projects.

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

For the C&I segment, the largest obstacle for expansion is a rule that indirectly limits maximum rooftop systems size to 499 kW. According to this rule, property owners must pay energy taxes on self-consumption for installations over 500 kW. The government has not indicated whether it will review this rule which strongly inhibits the expansion of large rooftop installations.

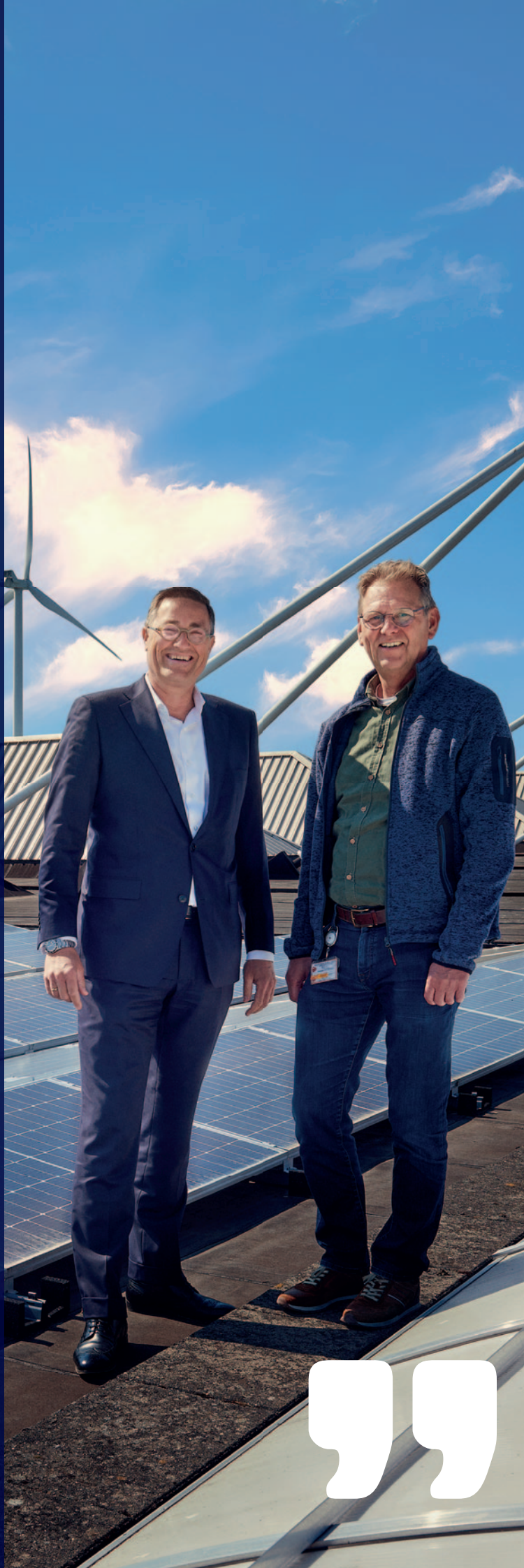
We are also waiting for the government to introduce a proposal to benefit energy communities in Sweden. There is currently no regulatory framework for energy communities and there are no incentives for creation of energy communities.

Prospects

The sustained growth of the Swedish solar market is expected to continue in the coming years. The estimated installation of about 940 MWAC for 2022 (1,128 MW_{DC}) is expected to be followed by another 700 MWAC (840 MW_{DC}) during the first half of 2023. A possible scenario is to reach 30 GW_{AC} in 2030, based on a market growth of 40% a year until 2027. This, however, depends on better possibilities for utility-scale projects.

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

PUT YOUR ENERGY TRANSITION IN SAFE HANDS



101 MILLION SOLAREDGE POWER OPTIMIZERS WORLDWIDE

Businesses and homeowners across Europe are facing a steep rise in energy bills and a deepening energy crisis. This is why so many are transitioning to energy independence with a SolarEdge smart energy ecosystem. SolarEdge solutions are designed with Power Optimizers to get higher yields from every solar panel. And, not unimportantly, they protect your properties with built-in safety features that go beyond today's requirements. Our DC-optimized inverter technology provides the brains behind nearly 3 million solar installations worldwide. With SolarEdge, you're making **THE SAFE CHOICE.**

Learn more

solaredge

SolarPower Europe

SolarPower Europe - Leading the Energy Transition
Rond-point Robert Schuman 3, 1040 Brussels, Belgium
T +32 2 709 55 20 / F +32 2 725 32 50
info@solarpowereurope.org / www.solarpowereurope.org

9 789464 669015

ISBN NUMBER 9789464669015