

European solar under the spotlight

Europe | Not only will solar be the dominant source of new power generation in Europe by 2025, cementing its position as the third largest market for solar globally, but the continent has placed the asset class at the very heart of its COVID-19 recovery strategy. Liam Stoker, Edith Hancock and Jules Scully explore the drivers for solar in Europe, the key markets and the challenges that remain.





Credit: GRIDSERVE

In September 2020, when the International Energy Agency (IEA) said that solar PV would become the eminent source of power generation in Europe within the next five years, truthfully the full, lasting impact of the coronavirus pandemic was not yet known. Subsequent second and third waves of the pandemic have altered the economic landscape beyond recognition.

Still, the IEA's forecast underpinned the astonishing growth trajectory of solar PV in its third-largest market globally. That the agency's forecasts would be further upgraded just six months later, cementing solar's position at the top of the tree, is testament to the industry's resiliency, ambition and plethora of use cases. From utility-scale to prosumer rooftops, solar looks set to spread and play a pivotal role in Europe's economic recovery from COVID-19.

Solar's role in Europe's power sector has, in the wake of the pandemic, taken on a whole new importance. It has now been placed at the centre of the continent's economic recovery from the pandemic and identified as a pivotal industry at the heart of the European Union's industrial strategy.

Deployment of solar PV in Europe continues to rise, increasing 11% from the 16.2GW installed in 2019 to 18.2GW last year, according to trade body SolarPower Europe (SPE), taking cumulative solar generation capacity to 137.2GW. The IEA meanwhile now expects 23.5GW of solar to be deployed in Europe this year, followed by 25.6GW in 2022. But the IEA's forecasts are historically on the low side. The last-published edition of SPE's

45GW

2024 solar deployments
forecasted in SPE's
High scenario

The York Solar Farm, completed by GRIDSERVE in the UK in 2019, was the UK's first commercial deployment of bifacial solar panels with trackers.

EU Market Outlook forecasts for 22.4GW to be installed this year, followed by 27.4GW in 2022 and 30.8GW in 2023. A further 35GW is expected by SPE to be installed in 2024 under its moderate scenario, illustrating the rapid rate of escalation solar deployment is to enjoy.

However that figure jumps significantly to 45GW installed in 2024 within SPE's High scenario, which has underlying assumptions that the industry will be a big beneficiary of Europe's green deal and COVID recovery packages, there remain no import taxes on solar products and, simply put, no other barriers are placed in solar PV's way. A conducive environment is therefore highly integral to solar's continued success

and growth in Europe, but what does that environment look like?

Policy and pricing

Policy has, obviously, played a critical role in helping establish solar as a force to be reckoned with in Europe. The minimum import price protected the continent's domestic manufacturing scene for years, and subsidies made available by national governments helped the technology deploy and compete until it no longer needed the support. Policy has also contributed significantly to the peaks and troughs European solar has experienced from 2011 until today, with some markets in particular still reeling from policy decisions taken almost a decade ago. Now policy is taking on an entirely different role, levelling the playing field and ensuring that field is clear of any obstacles or hurdles, rather than supporting the technology fiscally.

Critical to Europe's future success will be a raft of policies and targets set by the European Commission, such as the 55% greenhouse gas reduction aim the Commission set in December 2020 to be achieved within the forthcoming decade, an upgrade on the previous aim of a 40% cut in emissions. While that target was criticised for not being ambitious enough, it has laid the groundwork for member states to build on. Further measures that make up the Clean Energy Package 2.0, including the Renewable Energy Directive which, amongst other things, intends to simplify permitting for new renewables projects in the bloc, and stricter carbon pricing signals should nudge the market towards a more renewables future. Equally, the EC's Green Hydrogen Strategy, published amidst the COVID-19 fallout last summer, has established the target of building total hydrogen electrolyser capacity of 40GW within Europe by 2030 – that will require up to 120GW of new renewable capacity to power it, with solar expected to play a leading role.

Heymi Bahar, senior analyst for renewables at the IEA, says that while policy has indeed taken solar PV to new heights, the biggest driver in recent years has been an "incredible" amount of corporate power purchase agreement (PPA) activity in selected markets, particularly Spain. "It has changed the trend in Europe from mostly small scale, distributed PV applications to more large-scale installations," Bahar says. Corporate entities in Spain have flocked to sign PPAs with solar projects

blessed with high irradiance able to offer low power prices as a result. While the market slowed somewhat last year, in 2019 Spain deployed around 4.8GW of solar PV, enough to challenge Germany for the crown of Europe's leading solar market that year. Germany looks set to come roaring back courtesy of the lifting of a subsidy cap last year and new, more ambitious targets under the country's EEG law, more on that you can read on page 18.

"Policy is playing an incredible role, because the governments shape these policies based on their ultimate [central European] target," Bahar says, noting the drivers being not just interim targets set for 2030, but the overall net zero ambition which is set for 2050.

Technology driving change

While policy would appear to be doing a lot of the heavy lifting as the key driver for facilitating deployment, the technology is proving itself in different ways. The addition of trackers and bifacial panels is proving successful in more northerly locations than previously thought possible. Frank Niendorf, general manager for Europe at 'Solar Module Super League' member JinkoSolar says that while Europe is perhaps lagging behind other markets in its adoption of bifacial panels to date, bifaciality is widely anticipated to spread into Europe's key markets and be included

within most new project designs. Sufficient solar glass capacity – another of the solar PV sector's material constraints of recent months – could prove a stumbling block, but Niendorf is backing Europe's adoption of bifacial panels to continue at pace. "I have no doubt that the bifacial market share will surpass 50% by 2025, at least for the ground-mount project segment," he says. The same goes for large-format modules that utilise wafers of either 182mm or 210mm sizes. While adoption has perhaps been slower than some may have anticipated, most new project designs are taking these size modules into account.

Europe's turnaround from a market that installed in excess of 20GW of new solar in 2011, before collapsing to around 5GW in each of the years from 2014 to 2016, courtesy of a drastic fall in new installations in markets such as Italy, Germany and France, before rebounding once again to a 20GW+ market is garnering attention. "What we are currently experiencing is a very impressive turnaround of the European market which offers fantastic perspective for the coming years. We are very bullish, very confident about Europe in general," Niendorf says.

Europe's solar potential therefore continues to abound, driven by the collective ambition of the European Union's member states – and other nations on the continent – to decarbonise their economies. But as you will read in the forthcoming pages, European solar is a diverse collective. It is multifaceted, from R&D and manufacturing knowhow to financing and deployment nous that is almost unrivalled. Policy levers differ from nation to nation, and each country has its own drivers, niches and histories which make them tick.

The pages ahead provide a deep dive into the key markets driving European solar forward, right the way through from the perennial leaders such as Germany and Spain, to the emerging markets including Poland that are expected to play pivotal roles out to 2024. We also analyse the growing calls for a domestic manufacturing renaissance in Europe and the role in which COVID recovery stimulus packages can – and some may argue should – play in that, while also tackling the hurdles and challenges that remain.

European solar is once again on the rise, and this is the story behind that resurgence.

SolarPower Europe's six recommendations for member states

Boost utility-scale solar and storage

Allocate funds to finance renewable energy tenders, using recovery funds to accelerate permitting procedures.

Roll out solar rooftop and storage

Design solar mandates for all new and existing buildings with suitable rooftops to feature solar installations.

Promote electrification and invest in smart grids

Prioritise investments into the integration of battery energy storage systems and smart grid projects that unlock flexible and distributed energy resources.

Support the European solar manufacturing sector

Use recovery funds to facilitate the development of new manufacturing projects in Europe to strengthen energy security and independence.

Reconvert former coal and industrial sites with solar

Reconvert former coal and industrial sites into hubs for innovative solar applications such as floating, biodiverse and agricultural solar projects.

Finance training and re-skilling programmes

Support job creation in solar by offering fiscal and administrative incentives for companies growing their workforces and launch large-scale training programmes to upskill employees.

To discover more about Europe's energy storage sector, turn to page 83.

Germany

Germany made swift progress last year in spite of COVID-19 disruption. The country's developers installed 4.8GW of solar PV in 2020, more than any other EU market, with the sector boosted by a tried and tested regulatory scheme as well as attractive feed-in premiums for medium- to large-scale commercial systems, according to SolarPower Europe.

In July, the German Bundestag increased the expansion target for renewable energies in the electricity sector to 65% by 2030 as part of a series of amendments to its Renewable Energy Act (EEG). The country has now targeted adding 98GW of installed solar by 2030, up from the current level of approximately 54GW.

To achieve this, the coalition government agreed to increase the 2022 PV tender volumes from 1.9GW to 6GW.

However, the country's solar industry association BSW dismissed the announcement, calling for the industry to see it as "a mere electoral manoeuvre". Carsten Körnig, BSW's chief executive, tells *PV Tech Power* that Germany will need to quadruple its installed solar capacity to 200GW by 2030 if it is to meet the European Union's new climate goals, which includes raising the continent's emissions reduction target to 55% by the end of the decade. Körnig believes the greatest barrier to hitting that 200GW mark will be addressing tender volumes which he says are limiting the sector. "The greatest challenge will be to raise the tender volumes," he says. "The growth of ground-mounted PV plants

depends largely on the bid volume in the tender scheme, which limits growth possibilities."

Although it did increase its renewables target in the course of a coal phase-out, Körnig says one of the amendments to the EEG disadvantaged those plants that use some of the power they produce. An amendment focusing on EEG surcharge, where a charge is added to a consumer or a corporation's bills in proportion to their power consumption, deemed that local solar operators will need to pay a proportionate surcharge for solar self-consumption of more than 10MWh and for solar system output over 20kWp. The surcharge will then be due for every kWh of solar power consumed after 20 years of operation.

Although companies' interest in solar plants is growing, the amendment of the EEG law, which Körnig criticised as a "sun tax" last October, has since worsened the regulatory framework for plants with high levels of self-consumption. BSW said last year that the current plans could lead to a slowdown

in new installations, as well as many solar systems being prematurely decommissioned.

Nevertheless, there has still been strong growth across the market over the past 12 months. After lawmakers lifted Germany's 52GW subsidy cap for solar installations, the vast majority of new installed capacity came from systems smaller than 750kWp, which would have been "directly impacted" by the threshold. "Without the removal of

the subsidy cap the installation of PV in this market segment would have collapsed," Körnig said. The residential market, he added, has also seen new growth opportu-

"The growth of ground-mounted PV plants [in Germany] depends largely on the bid volume in the tender scheme, which limits growth possibilities."

nities driven by an uptick in electric vehicle (EV) owners who prefer charging their battery with low carbon energy.

On the monetisation side, although Spain and Italy have historically led European power purchase agreements due to their higher irradiation, Luca Pedretti, the co-founder of software company Pexapark, believes Germany could be "the biggest emerging market" in Europe's unsubsidised solar space, due to the volume of potential corporate offtakers based in the country. Local utility EnBW is in the process of constructing Germany's largest unsubsidised solar plant at a capacity of 187MW, and said last year it has multiple options for marketing the electricity. Körnig says the PPA market will grow in the following years, but it will "only cover a small part of the PV installations needed until 2030."

Domestic manufacturing, on the other hand, will be "very important" to deployment over the coming decade, Körnig says. Swiss company Meyer Burger is so far leading the push in Europe to build out domestic production capabilities. It will open facilities in Bitterfeld-Wolfen and Freiberg, Germany, in late May to begin mass production of its heterojunction (HJ) modules, which will be shipped across Europe and to the US. The manufacturer said in January, after it was awarded €22.5 million in regional German government grants to build HJ PV cell factory there, that it wants to scale up its production capacity to 1.4GW by 2023.

For more on Europe's solar manufacturing prospects, turn to page 28.

4.8GW

Solar PV installed in Germany in 2020



Germany's largest solar farm, the 187MW Weesow-Willmersdorf project, began exporting to Germany's grid in November 2020.

Spain



Credit: Solarcentury/Statkraft

A new auction mechanism and efforts to tackle grid permitting issues look set to build momentum in Spain's solar sector, which was last year driven by a booming power purchase agreement (PPA) segment and merchant projects.

Thanks to a commissioning deadline for projects awarded in previous auctions, 2019 saw the country top PV deployment rankings among European markets. This was followed by a 45% reduction last year, when around 2.6GW was installed, the majority of which came from PPA-based systems. As well as being Europe's largest solar PPA market in 2021, the country is now home to the world's biggest corporate PPA deal to date, which saw French oil major Total last year acquire a 3.3GW solar pipeline and become the offtaker for 3GW.

In addition to measures to further support the development of PPAs, Spain's government last year passed legislation that aims to speed up licensing approvals for renewables projects and minimise the reselling of permits following a tsunami of applications in 2019.

According to Pablo Otín, CEO of developer Powertis, the legislative package represents an overhaul in the way Spain

Spain's recent solar development has so far been dominated by sizeable projects in excess of 100MW, such as this 300MW project under development on behalf of Encavis.

will tackle the next wave of renewables: "And it was much needed because it has been a while for the government to put everything in place." Otín says that while complications can arise when dealing with Spanish local authorities, which "don't necessarily understand the good of what solar could be for the community or for the country", Spain's federal government is on the whole "doing a great job".

Part of last year's overhaul saw the country introduce a new renewables auction mechanism that is expected to support at least 10GW of PV capacity by the end of 2025. The first of the new auctions took place earlier this year, with solar securing two-thirds of the allocated 3GW capacity, and winners required to complete their projects by March 2023.

Given that winning solar bids were made by 26 companies, 70% of which are Spanish, and average winning prices were €24.47/MWh (US\$29.38/MWh), results from the first auction have been welcomed by trade association UNEF. "The good results of the renewables auction guarantee its

effectiveness and we hope that they will be maintained over time and that they will be similar to the one recently held, which has been very satisfactory," says José Donoso, director general at UNEF.

The association is calling for future auctions to have 20% of allocated capacity specifically for installations solar smaller than 10MW and is pushing for another to take place for projects with energy storage. According to Donoso, the auctions "are necessary because both PPA and merchant projects are limited when it comes to obtaining financing".

UNEF believes Spain will be able to beat its target of reaching 39.2GW of installed PV by 2030, by which time the country aims to have 74% of electricity generation from renewable sources. The solar industry is also expected to be boosted by government plans to grow its green hydrogen sector and reach 4GW of installed electrolysis capacity by the end of the decade. Spanish utilities such as Iberdrola and Naturgy have made notable green hydrogen announcements in recent months, while Endesa is planning 23 green hydrogen projects in the country that will be powered by 2GW of renewables.

Ana Barillas, head of Iberia at consultancy Aurora Energy Research, says that although Spain's hydrogen market is still in its infancy, the sector "is a real upside" for the development of solar in the country. She adds: "When people think about the risk of deploying solar in the Iberian market, the long-term risk of cannibalisation is an important one. And I think anything that can help support prices in the long term, whether that's electric vehicles, whether that's storage or whether that's green hydrogen, will help the sector invest with a bit more certainty and mitigate some of the long-term risks."

10GW
Solar capacity to be supported by Spain's auction mechanism by the end of 2025



Credit: Powertis

All expectations are that Spain will beat its target of 39.2GW of installed solar by 2030.

The Netherlands

The Dutch Cabinet has targeted a 49% reduction in greenhouse gas emissions compared to 1990 levels by 2030, and in correlation to that the Netherlands Environmental Agency expects renewable electricity to grow to 75% of total consumption by 2030.

But the country has struggled to meet targets in the past. The Netherlands' government was ordered by the supreme court to slash emissions by 25% by the end of 2020 last year, after losing its final appeal in a six-year legal case brought by climate group Urgenda Foundation. It has also struggled to catch up with renewables penetration, generating just 7.4% of its energy from renewable sources at the close of 2018, shy of the 14% it was asked to accomplish by 2020 under European legislation.

Nevertheless, trade body Holland Solar sees solar playing "an enormous role" in the country's climate targets, according to policy officer Nold Jaeger. The organisation predicts that the Netherlands will host 58GW of solar capacity by 2030, and more than 200GW by 2050.

As of 2019, the Netherlands hosted 6,754MW of solar power capacity, according to the country's Central Bureau of Statistics. Today, its capacity sits at slightly over 10GW, according to the trade body, with just under 3GW added last year.

Last year, the government awarded more than €2.1 billion in its subsidy scheme, SDE+, to solar projects total-

ling 3,440MW capacity. The scheme was expanded this year and is now called SDE++, offering a budget of €5 billion to develop renewables projects from next September.

"Depending on how the different policies work out, the coming years will decide what the exact mix between solar and wind energy will be," he says, "but it is very clear that solar will take up a very significant portion of that 75% renewable energy [target] in 2030."

While the COVID-19 pandemic did impact the growth of solar power in the commercial and industrial (C&I) space, Jaeger says that residential installations surged last year as consumers "suddenly spent their holiday savings... on solar panels". Around one million homes had installed solar by the end of last year, helping the Netherlands pass the 10GWp capacity barrier, he says.

The question, Jaeger says, is more now about how solar can be integrated into areas beyond electricity, such as heating, cooling, industry, and mobility to help those carbon-intensive areas go green. "In that sense we foresee a bright future for solar in the Netherlands because of the expected increase in demand for green energy from other sectors."

Clearly, to go from roughly 10GW to 58GW in nine years will require deploy-

€2.1 billion

funding allocated to solar under the Netherlands's SDE+ subsidy scheme in 2019, supporting 3.4GW of solar PV

ment to speed up. The Netherlands faces a handful of challenges to get there, namely the limits of its grid infrastructure. An increasingly large part of the country now qualifies as "filled up", according to Jaeger, making it much harder for solar developers to gain connection. "This doesn't mean that the sector will stop growing," he says, but it does have the effect of requiring those working in the energy sector in the Netherlands to "think more creatively about how to solve these issues on a local level." The trade body has negotiated with local grid operators to allow solar power developers to connect their plants at 70% of their maximum capacity, which means more installations can gain grid access overall.

The challenges the market faces today, Jaeger says, are grid infrastructure limits, ensuring local support for projects and establishing "a business case that needs to rely less and less on subsidies." To win over communities, the Holland Solar has launched a code of conduct for ground mounted solar parks in collaboration with several NGOs.

One of the country's strengths is its suitability for floating solar technology. There have been a few examples of partnerships with sand production lakes, which typically allow developers to install solar on their lakes while they offtake the electricity produced, creating a compelling business case.

With land scarce, rooftops have become a key battleground for Holland Solar, which has been lobbying frequently for the government to invest in strengthening support structures in buildings so they can take the weight of panels. Building regulations in the Netherlands have allowed building developers to build constructions that can bear the weight of a good amount of snow or rain, Jaeger says, "but that simply doesn't allow for the constant weight of a solar system." This is especially true of larger flat-roofed commercial buildings, which can become greater platforms for solar installations. "This does require the government to concretely change its policies so that future buildings are all constructed solar proof and that existing buildings can be renovated in such a way that they are able to carry the weight of large solar installations."



Credit: BayWa r.e.

Floating solar projects, like this one in Sekdoorn developed by BayWa r.e., will be essential to the Netherlands' solar growth.

The emergent markets

POLAND

Driven by successful renewables auctions and a generous net metering scheme for solar projects, Poland has firmly established itself as the market to watch for PV deployment, as the country weans itself off coal generation and aims to derive 23% of its energy from renewable sources by 2030.

Following a 2020 that saw Poland more than double PV deployment year-on-year to 2.2GW, trade association SolarPower Europe labelled the market “Europe’s latest shooting star” and “the biggest surprise on the EU’s solar map”.

The country looks set to smash its target of installing 7.3GW of PV by 2030, and while it was the only EU member state not to commit to carbon neutrality by 2050 when the goal was set in 2019, steps have recently been taken to reduce the share of fossil fuels in power generation.

“I think the Polish government and Polish regulators, they definitely have an appetite for much more solar power,” says Przemek Pieta, CEO of R.Power, a Warsaw-based developer and EPC provider that aims to install approximately 200MW of solar in Poland per year as it picks up additional capacity in the country’s auctions.

An auction that took place in December for projects up to 1MW is expected to result in the deployment of 700MW of solar, with winning projects eligible for a 15-year guaranteed tariff, and another auction is set to go ahead this June that

is projected to award 1GW for small-sized projects and 700MW – 800MW for large-scale plants.

Pieta says “there is a pretty stable outlook”, given that the government has announced more auctions for the next couple of years. He hopes the current size of the auctions will be maintained, not increased, in order to prioritise stability and prevent a boom-and-bust cycle of deployment.

Poland’s solar sector has also been boosted by a favourable self-consumption scheme for prosumers and a growing micro-installation segment of projects smaller than 50kW that consisted of around 350,000 systems at the end of 2020. As strong micro-installation deployment is expected to continue, there have been calls to update the country’s grid to prepare for the increase in the number of prosumers.

Grid issues have also affected utility-scale project developers that are experiencing longer delays securing a connection. Josef Kastner, CEO of European region at ReneSola Power, says the developer has seen grid connection delays reach as much as six months, leading to complications in terms of licencing schedules. “We hope that the utilities grid operator would increase their capability to connect all plants in some kind of reasonable timing,” he says.

But while some European markets’ solar sectors are held back by limited land

availability, this is not an issue for Poland. Kastner makes a comparison between Poland and Germany, which are approximately the same size; while the former has a 2030 PV deployment target of 7.3GW, Germany’s is 98GW. “I guess there will be a lot of places in Poland to install solar, so we are very optimistic that this market keeps growing, and we will grow with the market,” he says.

Alongside deployment from auctions, where ReneSola has been active, securing 38MW of projects last December and dozens of small-scale solar plants in previous years, Kastner says he now expects a lot more solar parks to be backed by power purchase agreements (PPAs) in the country.

German developer BayWa r.e. earlier this year signed what it claimed was Poland’s first solar corporate PPA, with a 64.6MWp solar project set to provide power to a cement manufacturer under a ten-year deal. At the time, BayWa r.e. said the partnership “marks a new era of clean and sustainable corporate energy sourcing” and could serve as a blueprint for more PPAs in the country.

While the nascent PPA segment gains traction, there have been demands for changes in regulations to fully unleash the segment’s potential. Ewa Magiera, CEO of the Polish Photovoltaic Association, says it is necessary to alter Polish law so that electricity can be directly sold by renewables installations to end users. She adds that companies in Poland are looking to buy energy from renewables projects to guarantee a stable supply of electricity and to secure predictable energy costs.

With the PPA market on the rise and PV developers continuing to secure capacity through auctions, the growth of Poland’s solar sector could also serve to increase energy security in the country. According to Pieta of R.Power, as Poland’s service sector has grown in recent decades, changing electricity patterns means there is much more consumption during peak hours and during summer, with more people working in offices and higher demand for air conditioning creating a “huge imbalance” between demand and supply. He adds: “And obviously, solar is cheapest and the easiest way to fix it.”



A solar project from ReneSola in Poland.

DENMARK

A successful move towards solar projects backed by power purchase agreements (PPAs) is significantly boosting the technology's deployment in Denmark, which at the end of 2020 had 1.7GW of installed PV and has the potential to surpass 10GW by the end the decade if obstacles are removed.

This year is expected to see at least one renewables auction take place in the country, however a price cap is likely to put off solar bidders, according to Eric Anderson, CEO of Denmark-based developer European Energy. "I foresee that the interest in this auction will be low, maybe close to zero," he says.

Instead, developers such as European Energy are focusing on subsidy-free projects and are now awaiting the outcome of a government decision on how it intends to fund much-needed grid upgrades, amid concerns that the renewables sector will be burdened with much of the cost. With a decision yet to be made, there has been a recent drop in solar project connections to the grid.

As electricity consumption in the country is expected to double in the next nine years, some solar companies acknowledge that they should take on some of the upgrade costs and are now pushing for clarification from authorities so completed solar projects can secure a connection.

"The main obstacle right now is the electricity grid," says Peter Bjerregaard, director of regulatory affairs at Better Energy, an independent power producer that earlier this year signed a ten-year solar PPA with Centrica Energy Trading. Bjerregaard describes that deal as a "historic moment" for Denmark's PV sector.

GREECE

Grid issues are also plaguing Greece's PV sector, which will be boosted by government plans to shut the country's last coal plant in 2025, but needs to overcome problems surrounding licensing and land availability to fully unleash its potential.

With a successful auction scheme driving deployment, as much as 1GW of new installations are expected to be installed this year. However, with authorities overwhelmed by requests for grid connection terms, large-scale solar projects could be excluded from participating in future tenders due to the bottleneck.

This is compounded by a growing objection to PV by local authorities and communities because of soaring applications for new plants, according to Takis



Credit: Juwi Hellas

Construction underway at the 204MW Kozani park, which will be Greece's largest PV project when complete next year.

Sarris, managing director of juwi Hellas, the Greek subsidiary of German EPC juwi. Local authorities "don't give the permissions that are required" to further develop PV projects, he says.

Sarris adds that these objections are also making it difficult to obtain suitable land at a reasonable price for large-scale projects, with plots for installations in the 20-50MW range "very hard to find".

Juwi Hellas is currently constructing Greece's largest PV project in Western Macedonia, the country's most coal-dependent region. Featuring bifacial modules, the 204MW Kozani plant is due for completion in early 2021 and is backed by a PPA with Hellenic Petroleum Group.

According to Stelios Psomas, a policy advisor at Greek PV association HELAPCO, "it is certain" that the country will reach its 2030 installed PV target of 7.7GW, which is expected to be raised in the coming years as a result of new EU emissions reduction goals.

HUNGARY

Hungary's third renewables auction is set to take place this July, as the country looks to promote PV deployment to reach a target of 90% carbon-free electricity production by the end of the decade.

The tender will have maximum subsidised volume of 300GWh per year and be divided into two baskets for projects in the

300kW-1MW and 1-20MW ranges.

With the country's previous auctions heavily oversubscribed, there were hopes among developers that more capacity would be made available. "What we see here is that this tender regime is not well balanced, the tender volume is very much limited," says Josef Kastner, CEO of European region at ReneSola Power, a developer that entered the Hungarian market three years ago and now sees potential for its solar PPA market.

Additional demands from solar players in the country include an enhancement of cross-border trading and efforts to ease access to the grid, which, according to PV trade association MANAP, is currently "almost impossible". It is hoped the grid access issue will be solved by a new regime on the connection process that expected to be revealed in the coming months.

Photon Energy, a Netherlands-based developer that last year commissioned 23 PV plants in Hungary with a total capacity of 23MWp, is also calling for government support for energy storage systems.

Zoltan Takacs, the company's project development and acquisition manager in Hungary, warns that if rising land prices and the scarcity of grid capacities continue, the country's 2030 goal of reaching 6.5GW of installed solar will be harder to achieve.

Europe's other hot markets



Credit: EDP

PORTUGAL

Although it made headlines for receiving record-low prices in both its solar auctions to date, Portugal's PV sector deployed just 153MW of capacity last year and is now restrained by complex licensing processes and grid connection scarcity.

The country's first solar auction took place in 2019 and resulted in 1,292MW of capacity awarded. This was followed by another last year, which included an energy storage option, allocated 670MW of capacity and saw Spanish renewables company Enerland post the record bid of €11.14/MWh for a 10MW lot, with the low prices reflecting the limited grid access. Winning bidders from both tenders contacted by *PV Tech Power* say they are progressing with project development as planned.

Due to potential land availability issues in the future, Portugal's government is now preparing a third solar auction for "non-conventional surfaces", which will include lots for projects at land beside motorways as well as floating installations on water bodies such as reservoirs.

Alongside the auctions, solar projects can also be submitted via the market,

by agreement with the network operator, ensuring part of the financing for the expansion of the electricity network, according to Pedro Amaral Jorge, CEO of Portuguese renewables association APREN. He says the country's clean energy sector faces "two major problems that must be quickly addressed" if it is to achieve its climate goals: licensing and networks.

With the current licensing process requiring promoters to deal with several

A floating solar pilot project from EDP in Portugal.

A spokesperson from EDP Renewables, which is majority-owned by Portuguese utility EDP, says that despite recent efforts to simplify the process, the company has faced greater difficulty in licensing projects with the introduction of additional intermediate procedures.

EDP Renewables participated in both of Portugal's auctions, securing a contract in 2019 for its 142MW Ribatejo solar project, which is expected to be installed next year. The company will consider its participation in the next one when the rules have been fully defined. The spokesperson says that in order to guarantee the completion of projects, the progress of the development process of plants presented for auction should be more demanding.

With just over 1GW of solar installed as of the end of 2020, the country is already behind its energy and climate plan, which forecasted that 2GW would have been deployed by then. Pedro Amaral Jorge says that while Portugal is among the most promising European markets for solar PV development, extra effort will be required to reach its target of 9GW deployed by 2030.

He says: "This extra effort is partly due to the resolution of problems and barriers."

"The renewable electricity sector today faces two major problems in Portugal that must be quickly addressed to ensure the achievement of climate goals and objectives: licensing and networks."

agencies, APREN is carrying out a project that aims to bring together all the stakeholders that work in renewables licensing to find solutions that can streamline the process.

ers that are currently identified in the sector, both with regard to the complexity and length of the licensing process, the unavailability and inadequacy of the electricity grid, and the inappropriate imposition of fees and disproportionate taxes on producers.”

FRANCE

France's government has called for 44.5GW of solar to be installed in the country by 2028, but figures from trade body Syndicat des énergies renouvelables (SER) published in February last year warned that the country must double its current installed PV capacity by 2023 to meet future targets. More recently, grid operator RTE has said that that a downturn in economic activity related to the COVID-19 pandemic has created a fall in the deployment of solar, meaning that the country's 2023 targets for deployment appeared “out of reach”.

Alexandre Roesch, who became chief executive of SER in 2017, tells *PV Tech Power* that things are starting to move in the right direction. The country said last October it would guarantee tariff support to 341MW of solar projects following the completion of an oversubscribed auction that featured reduced prices compared to previous rounds, and more than 452MWp of solar was awarded at auction this February, with energy prices jumping by 4.7%. Roesch points to France's “clear calendar of tenders” providing opportunities for further deployment, and a move towards a new feed-in-tariff for installations below 500kW capacity to boost the rooftop segment.

However, access to land remains one of a handful of challenges for developers looking to install more solar capacity, with Roesch describing this as a bottleneck for the market to overcome.

One solution currently being considered is combining existing farmland with new solar technology. Solar PV systems could become a “very interesting compliment” to France's agricultural sector as developers seek to add capacity and land is in higher demand, Roesch says. SER published a report in December last year, exploring several examples of ‘agrisolar’ systems. The report takes in case studies from a variety of land uses including greenhouse fruit and vegetable cultivation, vineyards, rooftop installations for farm buildings, fisheries and sheep breeding.

Roesch says that the trade body has

“tried to show some good examples of how we can do so on an agricultural land, and we have been inviting different representatives from the agricultural sector.” The case studies include innovations such as multi-chapel greenhouses fitted with solar panels in a way to ensure there is “sufficient minimum light” for the crops cultivated.

Another case study demonstrates agricultural shutters for vineyards, that include a raised structure that allows machinery to pass under, and with modules that can be moved to shade crops when necessary and, SER claims, could preserve or even “improve agricultural yield compared to a similar plot”. Elsewhere, the trade body is looking into collaborating with army officials to install panels on military land, and is also exploring the growth of the floating solar segment to evade the land issue altogether. “We have French factories, which are very active in this market segment,” Roesch says.

ITALY

Although known for being somewhat fragmented, Italy has become a lucrative hotspot for the solar sector. A report from LevelTen Energy published in January this year found that it was the top European market for power purchase agreements (PPAs), accounting for 31.7% of offers from developers. Meanwhile, Italy's solar capacity is projected to increase briskly. Research by Aurora Energy Research expects new unsubsidised solar PV capacity in the country to grow to 5GW by 2025, 12GW by 2030, 32GW by 2035, and 57GW by 2050.

Paolo Rosco Viscontini, the president of Italia Solare, says that this should be “even higher”, as the country would need to reach 240GWp overall by 2050 to support its net zero emissions target. If authorisation processes for deploying solar on agricultural land can be solved, he says, “this can absolutely be reached”.

At the moment the majority of the country's unsubsidised capacity is based in southern regions as developers have leaned on the region's high irradiation to produce better project economics, and due to the relative ease of sourcing land for utility-scale projects compared to the north. Viscontini says there is something of an untapped potential towards the north, particularly where the unsubsidised market is concerned. The risk in the South, he says, is that prices will be very low, even zero for “many hours per day”.

“Now we see entering into the development market more expert investors that are pushing developers to redirect their strategy considering areas where the main driver is not only the irradiance but the expected energy price,” he says.

Key players in the market right now include global giants like Lightsource BP, which recently brought its Italian development pipeline to 1.2GW with the purchase of a 78MW project from local developer EGI Sicily. French independent power producer (IPP) Qair is also trying to obtain permits for around 500MW of solar projects in south-eastern Sicily, and like BP's renewables arm, hopes to start construction next year.

For now, one of the country's major barriers to deployment is access to land. Industrial lands, Viscontini says, are still favoured, but constrained by a relatively long (12 month) approval process. The situation for agricultural lands, on the other hand, “is very complicated, both in timing – not less than two years – and in final results [answers are quite often negative].” One of the key actions the trade body has taken recently is to lobby the new Draghi government, which came into office in February, to demonstrate how the bureaucratic simplification and clarification of authorisation processes will increase PV installations. Beside this, Viscontini says improvements must be made to the FER1 Decree, which grants incentives to installing renewable energy sources on industrial lands and rooftops.

TURKEY

Turkey's lawmakers have made continuous efforts over the past three years to remove barriers for solar deployment, but simultaneous attempts to regulate the market have caused growth to slow down. Historic figures from the International Renewable Energy Agency (IRENA) show a surge in installed PV capacity in 2016, rising from 249MW the year before to 833MW. Since then, capacity has soared to 3.4GW in 2017, and then 5.06GW a year later. As of 2020, IRENA reports that Turkey's total renewable energy capacity surpasses 49.3GW, around 6.7GW of which is solar PV.

Özge Özeke, secretary general of the Turkish non-profit think tank solar 3GW, says the slowdown in growth in 2020 was more the result of policy than pandemic-induced delays. In 2017, a set of regulations were put into place which made investments for residential solar power plants harder and more costly, such as

an increase in system usage fees, limits to the maximum capacity that can be built according to consumption, strict limits to the maximum power that can be transferred to the grid instantly, and harsh penalties for those who violate that limit. These, he says, have resulted in a gradual decrease in the total annual installed solar power in Turkey since then. While the industry witnessed substantial capacity growth in 2017 and 2018, the rate of additions has slowed down substantially, with just 660MW added last year. Roughly 250MW was added in the first quarter of 2021, Özeke says.

Nonetheless, solar does keep connecting to the grid. Özeke says this is the result of other beneficial policies, such as a regulation change in May 2019 that gave customers the chance to partake in net-metering. This proved popular with the commercial and industrial sector (C&I) in particular. Another regulation that came into effect this year enables "hybrid investments", so that solar can be added to a power producer's main supply provided its production does not exceed the original source. "An 80MWp solar power plant has already been deployed to a 550MW dam", Özeke says, "and many more are on the way to be added to hydro, wind, thermal, and geothermal power plants."

Finally, falling development and power costs are making solar more attractive. In the country's recent YEKA tenders (Renewable Energy Resource Areas), investors proposed an average price of TRY22/kWh (US\$2.67/kWh) of electricity, while in comparison free market electricity producer prices are above TRY30/kWh. "That shows solar has achieved grid-parity in Turkey and even more," Özeke says.

The think tank's mission statement is to get Turkey into a position where 3GW of solar is being deployed each year. Özeke concedes his team are "away from their target" right now. The biggest challenge developers face, he says, is the "reluctance of the government to grant new capacities for solar power". It is announced that each year 1GW of YEKA tenders will be held for solar, but the current tenders have been in place for more than two years. "Therefore, with this speed, it is not very realistic that government can make 1GW of YEKA tenders each year." Solar power-purchase agreements and merchant installations, he says, could bring Turkey back to gigawatt growth. The think tank is working on a report on the subject that the director general hopes may persuade lawmakers.



Credit: NextEnergy Solar Fund

The 50MWp Staughton Solar Farm, owned by NextEnergy Solar Fund, is among the UK's first pure subsidy-free solar assets.

THE UK

Regulators across the world have professed about the need to use subsidies to put emergent technologies on steady glidepaths towards lower costs, avoiding boom and bust cycles which lead to intense periods of activity and deployment followed only by prolonged periods of comparative quiet. While the UK's energy department repeatedly intended to do just that, the way in which the country's Renewables Obligation (RO) scheme, which incentivised the development of utility-scale solar farms in the UK until its closure to new applicants in March 2018, achieved quite the opposite. In its successful years for solar between 2014 and 2017, the RO turned the UK into one of Europe's PV heavyweights, routinely deploying in excess of 2GW each year, and fuelling growth of developers that would become global mainstays, such as Lightsource BP and Solarcentury. But its closure sparked a near complete cessation in build activity and an exodus of market players who left for pastures new.

Now, however, buoyed by grid parity economics, nascent technologies, interest from corporate offtakers and additional revenue streams sparked by co-located energy storage, the UK large-scale solar machine is ready to roar once again.

16.9GW

The UK utility-scale solar pipeline as of April 2021

The most recent update from PV Tech Power publisher Solar Media's in-house market research team indicates that the pipeline of ground-mounted solar sites had reached almost 17GW at the end of April 2021, with around 800 – 900MW of new assets being identified each month as pre-build activity has soared. While the majority of sites – more than 10GW – have been identified as being in the mid-term development stage, indicating they are being slated for buildout from 2023 onwards, around 3.3GW have planning permission. Of that figure, Solar Media Market Research estimates that around 1.8GW is in the mix for buildout this year.

A recent increase in module pricing could prove to be the determining factor for what's built in 2021, however. With little to no government support in terms of subsidy or state-backed power procurement contract – the industry expects little from forthcoming Contracts for Difference rounds, which are expected to be dominated by offshore wind – short-term price fluctuations are significant for fully merchant projects.

However that impact is only expected to be temporary, and Solar Media's head of research Finlay Colville says deployment in 2022 onward could be "potentially explosive", with multi-gigawatt-level project pipelines able to come forward, returning the UK to gigawatt market status.

Manufacturing

Since SolarWorld's collapse in 2018, Europe's solar manufacturing scene has mulled its place in the global value chain. While Europe houses some of the world's leading research institutes, has unquestionably some of the best technology development centres and has a plethora of academic resource at its disposal, it has not been able to compete with the volume and scale of manufacturing on offer in Asia. To date, modules from China account to more than 90% of those sold each year.

But could that be about to change? Efforts to bring about a solar manufacturing renaissance in Europe have gathered pace, spurred on by concerns over supply chain logistics – Frank Niendorf, general manager for Europe at JinkoSolar, notes that the average cost of shipping containers has soared in recent months – the carbon footprint of manufacturing and shipping solar panels halfway across the world and a desire to once again have skin in the game in one of the world's most strategic manufacturing industries.

In Early May, the European Commission published its eagerly anticipated revised industrial strategy, a document updated a year after the onset of the COVID-19 pandemic principally because the crisis had shifted much of the landscape it was originally drawn up on. The strategy concludes that European industry has been “exposed to new vulnerabilities and older dependencies” while also illustrating the “need for more speed in the transition towards a cleaner, more digital, and

more resilient economic and industrial model”. Its solution has been to identify 14 strategic industries and tailor support for them, one of which is domestic renewables manufacturing.

Walburga Hemetsberger, CEO at SolarPower Europe, lauded the inclusion as a “much-awaited signal to reignite solar manufacturing in Europe and enable the EU to take the lead in the next generation of cutting-edge solar technologies.”

Efforts are already afoot, of course. Meyer Burger has recently completed its pivot away from tool and equipment provider to a pure solar cell and is to shortly market a range of heterojunction solar modules in Europe and the US. Its initial volume of 400MW is expected to ramp up to 1.4GW by 2023.

That kind of production volume will not, however, be sufficient to compete with the continent's international counterparts, and is a “drop in the ocean” compared to what's necessary, Meyer Burger CEO Dr Gunter Erfurt says. Speaking at SolarPower Europe's SolarPower Summit in mid-May, those involved in Europe's fledgling manufacturing renaissance noted that it would require up to €7 billion (US\$8.5 billion) of investment to hit the kind of scale to be globally competitive – around 20GW. This takes into consideration requirements across the value chain, right the way from polysilicon production, to ingot/wafering, to cell production and module assembly. While Europe's supply of polysilicon could be catered for domestically from existing facilities

owned by Wacker Chemie, according to the company's vice president of marketing, sales and application engineering Christian Westermeier, the rest of these critical cogs in the system are lacking in Europe.

Political support

Financial clout will therefore be essential to the success of Europe's manufacturing renaissance. Financiers will need to be less risk averse, but the business model could also be handed considerable help through political interventions.

Niendorf says that while the idea of localised supply chains is growing in appeal once again, it remains difficult to see Europe competing with Chinese manufacturers in the immediate future. “Just purely looking at the economic viability of the whole value chain of manufacturing cost... [Chinese manufacturers] have completely different economies of scale, compared to what might be possible in Europe,” he says. “It will be difficult to reach the manufacturing cost, no matter how much automation of the production process along the value chain you have, it will still be difficult to keep up with the costs that have been achieved in China.”

What Europe will continue to lack, Niendorf says, is the “whole industry cluster” that surrounds solar module manufacturing. “It's not just wafers, cells and modules, there are so many more components,” he says, stressing the importance of other materials such as glass in the process. “We would need that in Europe as well to make it competitive, because if you have to fly in either solar glass or certain components from other regions in the world, automatically, that drives up the cost.”

One potential lever to incentivise the support of a domestic solar manufacturing industry in Europe is the much-mooted addition of carbon footprint requirements on modules. Policy details are being drawn up and are expected to be outlined this summer by the European Commission, but it could prove to be a useful lever in making domestically-manufactured solar products more competitive on price. In a sector as price sensitive as power generation, Europe's solar sector will need all the policy help it can get to compete with China's considerable clout.

Meyer Burger has transformed itself from an equipment supplier to a provider of heterojunction cells and modules, with an initial volume of 400MW



Credit: Meyer Burger

The challenges that remain

While the preceding pages have outlined the sheer scale of the opportunity within Europe's solar PV sector across the value chain, a number of common hurdles have emerged and for solar to truly fulfil that potential, the solar and wider energy economies must overcome these.

Grids have, predictably, been identified as a near universal source of ire for the utility-scale solar industry and the one that poses the biggest threat to the technology's dominance of power markets going forward. Decades-old infrastructure is struggling to keep up with an avalanche of modern, sophisticated power generators that disrupt the status quo and, as a result, new grid connections have ground to a slow, if not a complete halt.

Heymi Bahar, senior analyst for renewable energy markets at the International Energy Agency, says that the biggest issue remains that a large amount of renewable energy deployment activity, but grid deployment activity fails to match it. This, Bahar says, has been a "big challenge for Europe". Expanding grids, both at the distribution and transmission level, is considerably costly, and those costs are often borne by grid operators but passed onto consumers via levies on utility bills, additions which are politically contentious.

Furthermore, gaining permits for what can essentially boil down to huge quantities of tall pylons and thick cables can not only be difficult, but can also elicit uproar from local residents. The 'not in my back yard' types – or NIMBYs as they've come to be christened – are not only contesting planning applications for solar sites, but the infrastructure necessary to accommodate them too.

Bahar adds that difficulties in obtaining grid connection agreements has been a prevalent issue for wind and solar assets in northern Germany for some time, while speaking at PV Tech Power publisher Solar Media's Large Scale Solar Europe conference in April 2021, Berto Martins director for electricity markets at utility EDP Portugal, spoke of constraints throughout the Iberian peninsula – a hotbed for solar deployment activity moving forward.

The crux of the matter is that solar, and indeed other renewables, are just moving too fast for the grid to keep up. "The pace of building wind or solar plants is much, much faster than building the grid," Bahar says, a problem that is worse in emerging economies where some project developers have built renewables projects but not been able to connect them. Frank Niendorf, general manager for Europe at JinkoSolar, says that grid infrastructure project lead times are often in the five to

10-year range, creating significant bottlenecks for solar project development.

Furthermore, the problem is not confined to or felt more acutely in either the transmission or distribution grid, but felt equally across the two, with Bahar adding that growth in distributed solar

"The growth of storage solutions... will help lead to, let's say, a more decentralised electricity generation system, and consequently, take some pressure off the shoulders of the grid."

exacerbating the issue even further.

Martins is of the opinion that the first step will be to determine whose job grid expansion is anyway.

Moving beyond 'T' versus 'D'

"The topic here should be how to establish the adequate level of responsibility. Until now, we have – in my opinion – faced arguments over who will be responsible for which grid," Martins said during the LSS Europe event. His view was echoed by Randolph Brazier, director of innovation and electricity systems at the Energy Networks Association, a UK-based trade body representing network operators. "We need to get out of this competition mode of 'T' versus 'D', and networks arguing each other. If we want to meet our net zero targets, we don't have time to waste. We need much deeper collaboration between transmission and distribution, and we very much need to take a whole systems approach. That needs to be driven not just from the networks themselves, but also by the policy and regulation they work under," Brazier said.

The UK's network operators are all run as monopolies and licensed by government-appointed industry regulator Ofgem. Their expenditure is carefully controlled and vetted, with additional license conditions dictating that any action or intervention considered must also be measured against potential consequences further down the network, ensuring a whole systems



Credit: NGET

The UK's National Grid Electricity Transmission is to pilot new power flow technology to unlock grid capacity.

approach is front and centre. Martins added this was being particularly felt in Iberia, where grid connection requests have soared to unmanageable levels. As a result, authorities in Spain and Portugal in particular are understood to be experiencing difficulties assessing the impact on local grids of multiple connection requests. Martins said that while in the past the transmission and distribution grids – both of which can accommodate renewable power connections – have needed to be viewed separately, technology advancements and more modern approaches have enabled them to be viewed together, potentially finding areas of the grid where more renewables could be accommodated.

There have also been recent moves to identify and create additional grid capacity for renewables throughout some of Europe's key markets. In the UK, transmission system operator National Grid Electricity Transmission (NGET) recently revealed a trial it was undertaking of power flow control technology at three substations with the aim of unlocking 1.5GW of grid capacity. Meanwhile, Portuguese grid operator Redes Energéticas Nacionais committed in May 2021 to invest some €900 million (US\$1.1 billion) in various grid reinforcements to accommodate new renewables projects. JinkoSolar's Niendorf says the growth of energy storage will also be a gamechanger, driven by cost reductions in the technology that will help the asset class become an alternative to the grid. "The growth of storage solutions... will help lead to, let's say, a more decentralised electricity generation system, and consequently, take some pressure off the shoulders of the grid," he says.

These improvements are, however, perhaps too isolated to truly ease concerns over the grid. Numerous sources spoken to for this piece highlighted the key role legislation passed by the European Commission can and should play in stimulating grid investments. There are also issues to contend with further up the value chain, ones which are having a very tangible impact on deployment today.

A material world

The solar manufacturing industry has been in recent months by soaring polysilicon prices, continuing a trend first felt towards the end of last year after incidents at a number of facilities in China disrupted global supply. While these incidents have



Credit: EDP Renewables

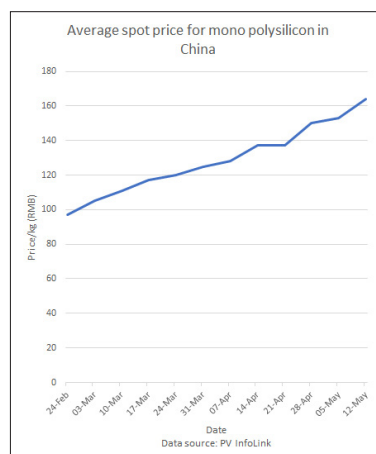
Solar project development in Europe remains subject to component costs, which are rising.

largely been overcome, demand for the material continues to far outstrip, and prices have gone through the roof. As the cost of manufacturing solar modules has increased, purchase prices have had to rise in tandem, threatening project economics across the continent. Project developers spoken to by PV Tech Power remain split, but the general consensus is that some in the sector will be unable to develop at the module price, and projects previously slated for connection in 2021 will be pushed into 2022 when prices are expected to stabilise.

The IEA's Bahar sees this as a threat particularly pertinent for those participating in Europe's band of renewables auctions. "Those that are deep into the auctions, betting on lower PV prices... if they had tight margins, then they are in a challenging situation to wait or not to

US\$25.4

The spot price for mono-grade polysilicon in China in the week commencing 10 May 2021



wait," he says. Portugal's record-breaking auctions of 2020, which saw prices plummet to low of just €11.14/MWh (US\$13.12) spring to mind in particular.

It's not just modules, either. Steel costs have also soared – tracker manufacturer Array Technologies lamented a doubling in steel costs felt between April 2020 and April 2021, and a further 10% hike felt early in this financial year – while semiconductor shortages are leaving inverter suppliers hamstrung.

But, as Bahar says, given the cost trajectory of solar over the last decade, the industry owes far less to component costs than it used to. "Let's remember that of the overall system costs modules are just a portion... there are a lot of other things involved. So the impact [of price increases] to a total PV system is not that big," he adds. Polysilicon prices are also widely expected to peak in July or August this year before normalising into Q2 2022, with huge additions set to come onstream at the start of next year. Any price impact will be in the short- or medium-term, however the prospects for sub-US\$0.20c/W modules may perhaps have been revised as a result of the last six months.

Pricing and grid availability may therefore pose threats to solar deployment in the short- or medium-term, but long-term prospects for the technology are significant. The IEA expects north of 20GW of solar to be installed in Europe in each of the forthcoming five years, forecasts matched, if not exceeded, by all other analysts. The future is bright for solar in Europe.