Global Market Outlook

For Solar Power / **2017 - 2021**

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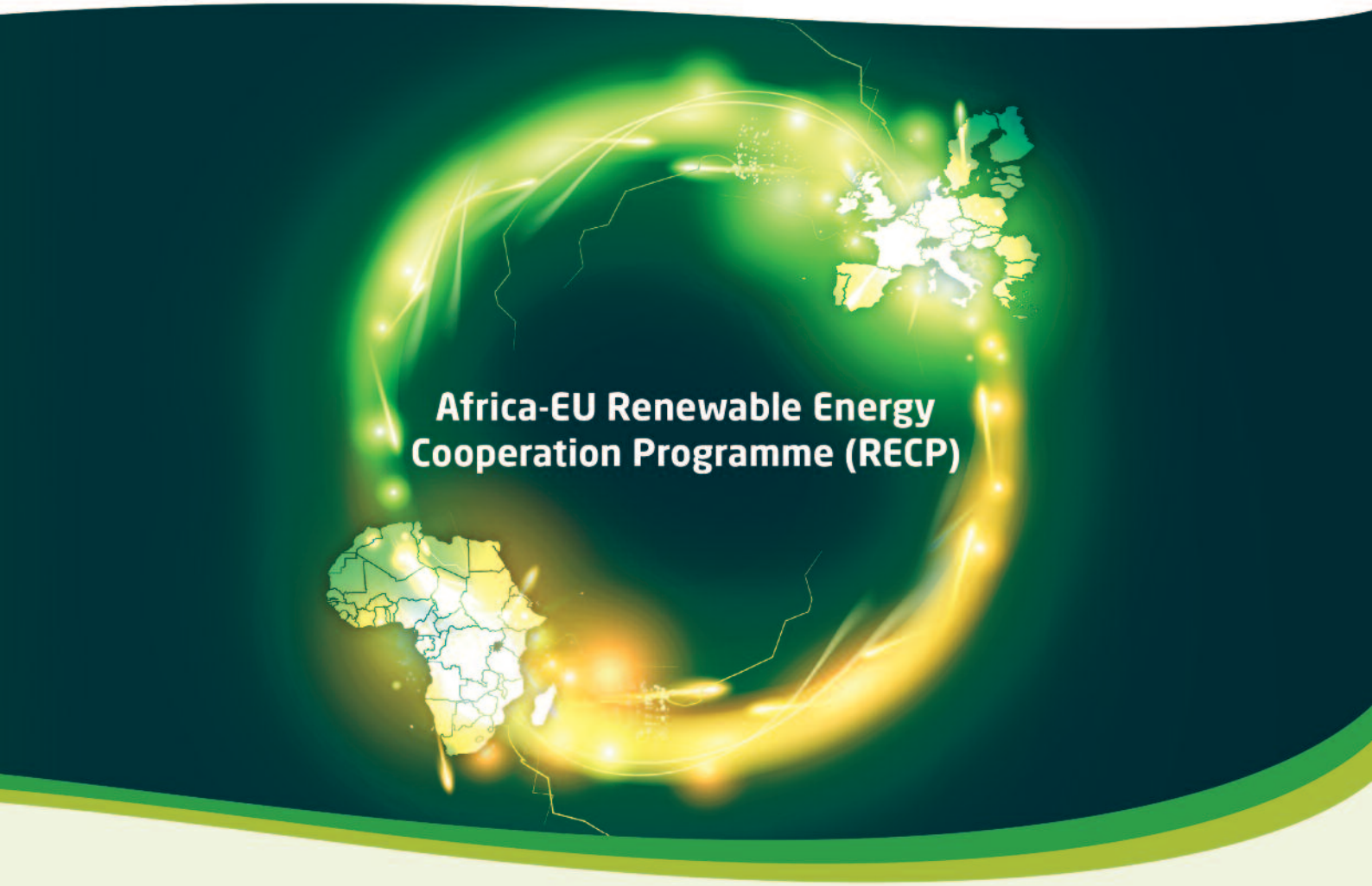

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FOREWORD

Welcome to SolarPower Europe's Global Market Outlook 2017 - 2021. This Global Market Outlook is special for various reasons: in response to the rapid developments in the solar sector it contains much more information than last year's edition. It was also fully produced in-house by our newly established market intelligence team, who will develop more reports going forward. This year we begin a cooperation with the Global Solar Council for this report, and our sister organisation, the China Photovoltaic Industry Association, has contributed a chapter of the world's largest solar market - China.

Never before have we seen more solar power being installed in a single year than in 2016. The global solar PV market grew much more than expected – by 50% to 76.6 GW year-on-year. For the first time, solar left behind its renewable energy peer, wind, in terms of annual installations. Together with wind, solar contributed over three quarters of power capacity installations in the European Union last year. All renewables added more than half of new global power generation capacities for the second year in a row.

When looking at cost, solar continues to expands its leadership role. In 2016, another world-record low solar power supply contract was awarded in the United Arab Emirates for 24.2 USD/MW (or 2.4 US cents/kWh). Today, utility-scale solar is generally already cheaper than new combined cycle gas turbines, coal and nuclear power plants, while rooftop solar is usually cheaper than grid-power as long as this is not subsidised.

Solar power has also become a job machine in countries that have embraced the technology. In the US, which doubled annual PV installations last year, one in 50 new jobs in 2016 was created in the solar sector.

While all these solar growth numbers sound very impressive, the fact is that solar still has a long way to go to fully tap its potential. The 306.5 GW of grid-connected PV capacity installed end of 2016 generated around 2% of the world's electricity demand. From today's perspective, we expect total global installed PV capacity to exceed 400 GW in 2018, 500 GW in 2019, 600 GW in 2020 and 700 GW in 2021. If policy makers get things right by addressing the needs for a smooth energy transition, such as through establishing the right governance, market design and renewable energy frameworks, solar demand could increase much faster, and touch nearly 1 TW of total generation capacity in 2021.

The energy transition towards renewables doesn't have to be costly today. While about 8% renewables generation capacity was added last year (which is obviously too low), investment dropped by 23%, according to the recent United Nations Environment Programme (UNEP) "More Bang for the Buck" report. That means, solar and renewables are doing the right thing – companies are quickly reducing cost for their products. A "de-investment" in renewables is, however, the wrong message to potential investors. With the 1.5°C Paris goal requiring gigantic efforts, it needs much more money to be directed into renewables. China is clearly showing the way - by more than doubling its solar capacity additions in 2016, reaching an annual global market share of over 45%.

Indeed, there are several obstacles that need to be overcome for solar to be able to move into the fast lane. That's why SolarPower Europe has looked at challenges and solutions for 10 Topics & Trends that will be key for a rapid expansion of solar in the coming years. A large part of this chapter's content has come from our Task Forces, where we work with our members on business models and policy recommendations in the fields of Trade, Storage, Digitalisation, Tenders, O&M, and Corporate Sourcing.

Enjoy reading our Global Market Outlook 2017 - 2021.

Sincerely,

JAMES WATSON
CEO

MICHAEL SCHMELA
EXECUTIVE ADVISOR

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Supported by: Intersolar Europe, Global Solar Council (GSC).

SolarPower Europe's methodology includes only grid-connected systems.

EXECUTIVE SUMMARY

2016 was a record year for solar. A total of 76.6 GW was installed and connected to the grid in 2016. That's a 50% year-on-year growth over the 51.2 GW installed in 2015 and the third highest rate recorded since 2010, though at much higher absolute levels. The 76.6 GW exactly coincides with the upper end of the high scenario forecasted in the previous Global Market Outlook, due to a number of markets exceeding expectations.

In 2016, global solar power capacity exceeded 300 GW, after it took the 200 GW mark the year before, and the 100 GW level in 2012. The total installed solar PV power capacity increased 33% to 306.5 GW by the end of 2016, up from 229.9 GW in 2015.

The global solar market in 2016 was even more dominated by one country than it was the year before – China, which connected 34.5 GW to the grid, a 128% increase over the 15.1 GW it added the year before. The 2016 PV installations were equal to a global market share of 45%. At the end of 2016, China had a total of 77.9 GW installed PV, owning one quarter of all global solar power generation capacity.

2016 was a disappointing year for solar in Europe. With only 6.7 GW of newly installed PV capacity, the European solar power market shrank by 22% year-on-year.

In 2016, Asia-Pacific has become the largest solar-powered region in the world – with 147.2 GW of total installed capacity, equal to a 48% global market share. The European solar pioneers, which still owned the major global portion in 2015, are now ranked second – with a cumulative PV capacity of 104.3 GW and a 34% share.

Despite the gigantic 50% leap that resulted in topping the 70 GW level of total global installed PV in 2016 from the 50 GW range in 2015, there is a good chance that the market will further grow in 2017, even passing the 80 GW mark. Our Medium Scenario estimates about 80.5 GW newly installed PV in 2017, which would mean a 5% growth over the 76.6 GW installed in 2016.

All scenarios in this Global Market Outlook 2017 are more positive than in the previous edition. Last year, we anticipated a total installed capacity of 358 GW for the Medium Scenario in 2017, this year the estimate is roughly 8% higher - 387 GW. We expect the total global installed PV capacity to exceed 400 GW in 2018, 500 GW in 2019, 600 GW in 2020 and 700 GW in 2021.

The quickly decreasing solar power costs continue to improve solar's competitiveness. Basically, all solar tenders awarded since 2016 are lower than the price guarantee the UK government signed for the Hinkley Point C nuclear power plant last year. A new world-record low 25-year solar power supply contract was awarded in Abu Dhabi in 2016 for 24.2 USD/MWh. The latest Levelized Cost of Electricity (LCOE) calculations of US investment bank Lazard Capital clearly demonstrate that utility-scale solar is today already cheaper than new combined cycle gas turbines (CCGT), coal and nuclear power plants.

Despite the positive cost and growth developments, there are still many obstacles that need to be overcome for solar to fully tap the manifold new business opportunities that are now opening up. SolarPower Europe has looked at 10 Topics & Trends that support the dissemination of solar power and outlines both the challenges and solutions.

The report and all figures can be downloaded at
www.solarpowereurope.org

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GLOBAL SOLAR MARKET

UPDATE 2000 - 2016

52.5 MW, Jordan. © First Solar

2016 will be remembered as the year solar became cheaper than wind. That's how the first chapter of last year's Global Market Outlook started. At that point in time it was not foreseeable that 2016 would also be remembered as a record solar growth year, resulting in 50% more installed capacity than the year before.

The fast growing competitiveness of solar power is one of the main factors for its unmatched success story in the energy sector over recent years. With tenders having established themselves as planning tools for developing solar power plants that governments are increasingly using to control growth and cost of solar, the related PPA prices have been rapidly falling over the last few years. The 800 MW Sheikh Maktoum Solar Park Phase 3 in the United Arab Emirates tender of the Dubai Electricity and Water Authority (DEWA), which was awarded in mid-2016, resulted in a winning bid of around 2.95 US cents per kWh. There were many experts discussing the sustainability of such a low price, even though the plant is scheduled to be operational only in 2020.

The price spiral quickly continued its way downwards. In August 2016, a power supply contract over 280 GWh per year was awarded for 29.1 USD/MWh in Chile, which is scheduled to be generated from a new 120 MW PV plant as of 2019. The latest record holder is again the UAE, where the Abu Dhabi Water and Electricity Authority (ADEWA) tendered the Sweihan project. Originally planned to have 350 MW, the awarded capacity that is scheduled to be online in 2019 is 1.18 GW – with a new world-record low 25-year power supply contract for 24.2 USD/MWh. As these record solar projects were awarded under nearly "ideal" circumstances (stable political framework, very high irradiation, very good financing environment), most tenders in the near future in other regions will result in somewhat higher prices. But, their "lighthouse" effect has been raising expectations from policymakers and putting price pressure on many other tenders around the world.

2.4
US cents / kWh

was the world's lowest solar supply contract signed in 2016

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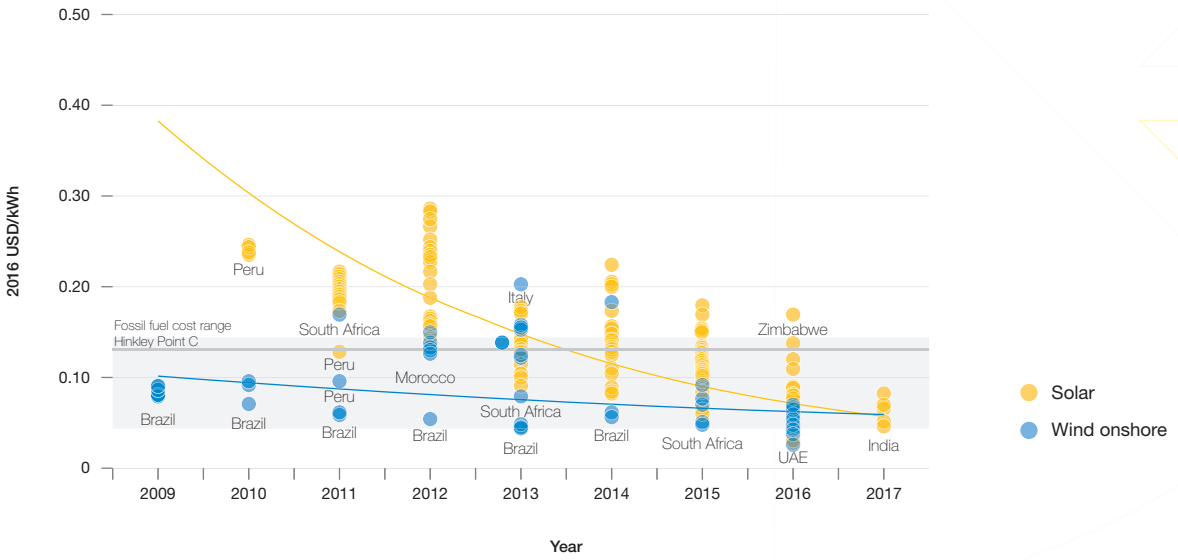
FIGURE 1 PPA PRICES FOR SOLAR PV AND WIND ONSHORE POWER PLANTS IN DIFFERENT COUNTRIES

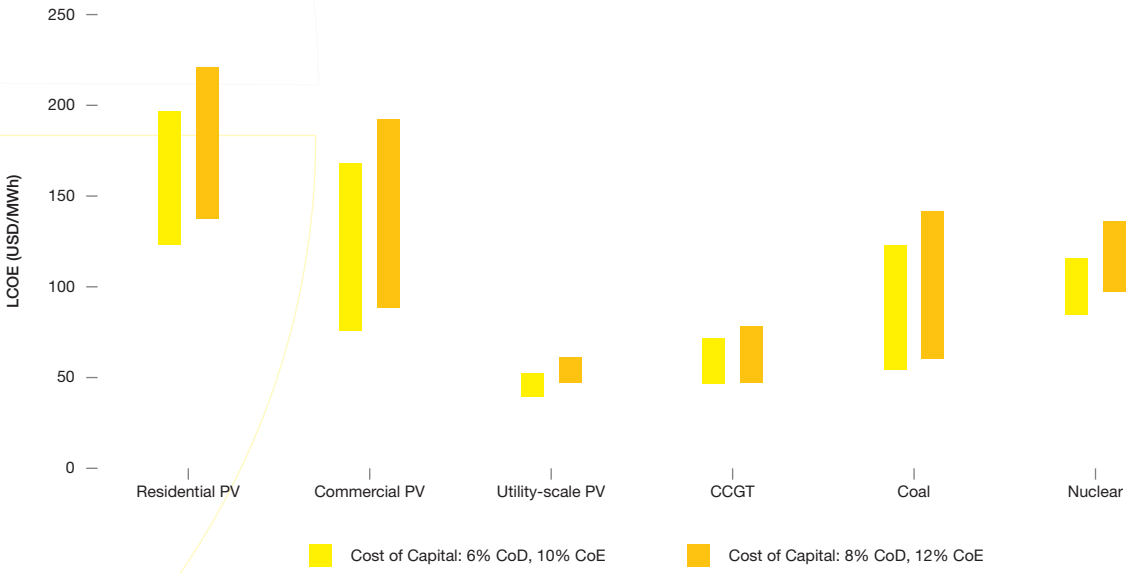


Source: International Renewable Energy Agency (IRENA)

The fast decreasing solar power costs continue to improve solar's competitiveness. Basically all solar tenders awarded since 2016 are lower than the price guarantee the UK government signed for the Hinkley Point C nuclear power plant last year (see Fig. 1).

Utility-scale solar is today already cheaper than new CCGT, coal and nuclear power plants.

FIGURE 2 SOLAR ELECTRICITY GENERATION COST IN COMPARISON WITH OTHER POWER SOURCES



Source: Lazard

The latest Levelized Cost of Electricity (LCOE) calculations of US investment bank Lazard Capital clearly demonstrate that utility-scale solar is today already cheaper than new combined cycle gas turbines (CCGT), coal and nuclear power plants (see Fig. 2). Solar's advantage considerably improves with lower cost of capital needs, which explains why solar PPAs in India or African countries with higher financing cost cannot reach solar LCOE levels like in Dubai or Abu Dhabi.

A total of 76.6 GW of solar was installed and connected to the grid in 2016 (see Fig. 3). That's the largest amount of solar power that was installed in a year so far and a 50% year-on-year growth over the 51.2 GW added in 2015. This is the third highest rate recorded since the start of this decade, only exceeded in 2010, when grid-connections grew by 115% to 17.4 GW, and in 2011, when the market increased by almost 80% - though at much lower absolute levels. The 76.6 GW exactly coincides with the upper end of the high scenario forecasted in the previous Global Market Outlook, due to a number of markets exceeding expectations.

The global solar market in 2016 was even more dominated by one country than it was the year before – China.

China connected 34.5 GW to the grid, a 128% increase over the 15.1 GW it added the year before. This strong growth rate came as a surprise and was triggered by a feed-in tariff cut in the middle of the year that led Chinese developers to install over 20 GW alone in the first six months of 2016. After demand almost paused in Q3, strongly falling module prices enabled a year-end run that led to an annual installation volume in China representing nearly half of the entire world's new solar capacity in 2016.

The **United States** was the world's second largest solar power market in 2016. The country's annual installed capacity was up 97% year-on-year, resulting in 14.8 GW, compared to 7.5 GW in 2015. In the US, solar power was the number one source of new electric generation capacity that was added in 2016 with a share of 39%. While the 2016 solar growth was carried on many shoulders – with 22 states each adding more than 100 MW, California remained the largest market with over 5 GW, much ahead of Utah with 1.2 GW. Most of the US solar growth come from utility scale solar, which was even bigger than the years before – reaching around 10 GW or over two thirds of newly added capacity. This was due to an expected expiration of the 30% solar investment tax credit at the end of 2016, which finally did not take place, but resulted in a huge pipeline that was contracted to be online by the end of that year.

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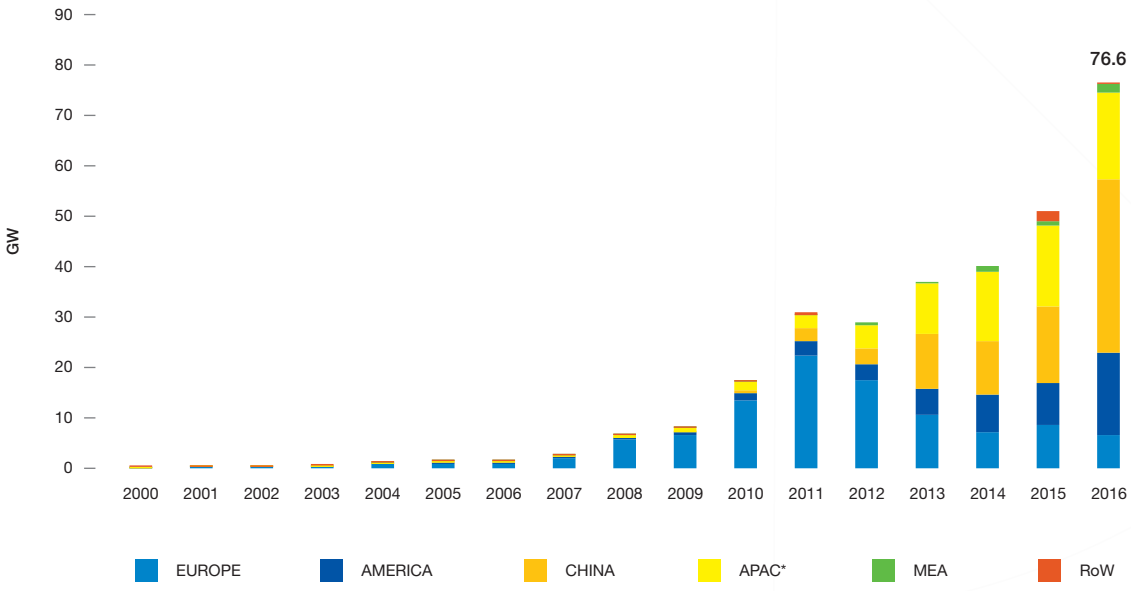
UPDATE 2000 - 2016 / CONTINUED

FIGURE 3 EVOLUTION OF GLOBAL ANNUAL SOLAR PV INSTALLED CAPACITY 2000-2016



*APAC excl. China

Following its demand climax in 2015, the solar market in **Japan** decreased as anticipated in 2016, despite its nearly 50 GW large pipeline of approved but not yet built utility-scale solar plants. At 8.6 GW newly added capacity, Japan was still the world's third largest solar market in 2016. But in the coming years, new PV capacity additions are expected to shrink further. The reasons for Japan's solar market consolidation are manifold – from declining government support for solar, which prefers the comeback of nuclear and heavily invests in coal, to PV development and grid connection difficulties and an energy market reform that is unbundling the oligopoly of Japanese power generation companies. As Japan will move from a feed-in tariff to a tender scheme for large-scale solar this year, the PV rooftop segment will soon play an increasing role in the country's solar market.

After a slight market uptick in 2015, solar in **Europe** continued its several-year long downward trend in 2016, adding 6.7 GW, a 21% decrease compared to the 8.6 GW installed in 2015. The European market decline in 2016 is primarily a result of the UK terminating its attractive solar incentive program. Two European countries belonged to the top 10 global solar markets in 2016 – the UK ranked 4th and Germany ranked 5th.

While the UK shrank more than half to 1.97 GW in 2016, from 4.1 GW in 2015, in the same period of time, **India** grew by 125% to 4.5 GW from 2 GW. This means, that in 2016, India took over the 4th rank from Europe's largest solar market. Despite its rapid growth, India was not able to meet its ambitious solar targets (in Fiscal Year 2016-17, ending in March 2017, it was planning to install 12 GW PV, but reached only 5.5 GW). India's government is systematically addressing the teething problems of the country's solar sector as it quickly advances towards its National Solar Mission's (NSM) goal of 100 GW total installed solar capacity by 2022. As in all emerging solar markets, utility scale solar is dominating in India, with a share of almost 90%, although rooftop systems, which are targeted to contribute 40 GW to the NSM goal, have started to pick up as primarily state-owned companies have been attaching solar to their facilities.

Next to the big **Asian PV markets** China, Japan and India, there are many other fast growing solar markets in the region, but they are all in the infant stage. In 2016, South Korea was the only other country exceeding the gigawatt-level for newly added PV system capacities.

Australian solar power capacity additions decreased by nearly 20% to 750 MW in 2016 as the country is shifting from a traditional residential feed-in tariff driven PV market towards self-consumption, increasingly with battery storage. With solar LCOE's now being increasingly competitive, also commercial and ground-mounted systems have started to see growing interest in the last few months. In September 2016, the Australian Renewable Energy Agency (ARENA) awarded funding to 12 PV power plants with a combined capacity of 482 MW to stimulate the utility-scale solar segment.

Beyond the US, there is also increasing solar activity in almost all of the countries on the **American Continent**, with Chile making the largest noise by awarding a record low 29.1 USD/ MWh PPA in 2016 and continuing to keep the lead role, adding 821 MW in that year. Although at 300 MW newly installed PV it is still a rather small PV market in 2016, while Mexico has created its first large solar footprint, when it awarded over 1 GW of solar power capacity at an average PPA price of $40.50/MWh in a single tender.

The large-scale power plants that were recently awarded at record low solar price bids in the **Middle East** will only be built in the next few years in the United Arab Emirates. In 2016, the countries of the region were all rather small solar markets, with Jordan adding the largest capacity (291 MW).

While **Africa's** off-grid market is experiencing a strong boom, with many companies having successfully started to offer pay-as-you-go products that allow customers to buy solar electricity using the mobile phone infrastructure, the continent's on-grid solar markets have mostly disappointed in 2016. South Africa added 509 MW but could have been bigger if its national utility Eskom had not rejected the signing of PPA contracts for a large number of awarded solar projects. In North Africa, Egypt installed only 10 MW, after the government disrupted the process of its 2014 announced FIT program that was planned to lead to 2.3 GW of solar capacity by 2017. And in Kenya, none of the over 2 GW of solar plants awarded via feed-in tariff have been given the green light. On the positive side, there were several first small on-grid solar power plants built in several African countries, including Senegal, Ghana, and Uganda. Moreover, the World Bank Group has established its Scaling Solar Program in Africa, with Zambia awarding the first 100 MW out of 600 MW in 2016 and further projects under development in Senegal, Ethiopia and Madagascar.

In summary, the low cost of solar has sparked huge interest for this clean and flexible technology in many countries around the world.2016 was dominated by China and a few other solar markets that were driven by 'traditional' subsidy schemes.

In 2016, global solar power capacity exceeded 300 GW, after it took the 200 GW mark the year before, and the 100 GW level in 2012.

The total installed solar PV power capacity increased 33% to 306.5 GW by the end of 2016, up from 229.9 GW in 2015 (see Fig. 4). In just a decade the world's cumulative solar capacity increased by over 4,500% - from merely 6.6 GW in 2006. From the start of the millennium, when the story of on-grid solar power kicked off with the launch of Germany's feed-in tariff program, total solar power has grown by an impressive factor of nearly 245 times.

50% solar global market growth to 76.6 GW in 2016

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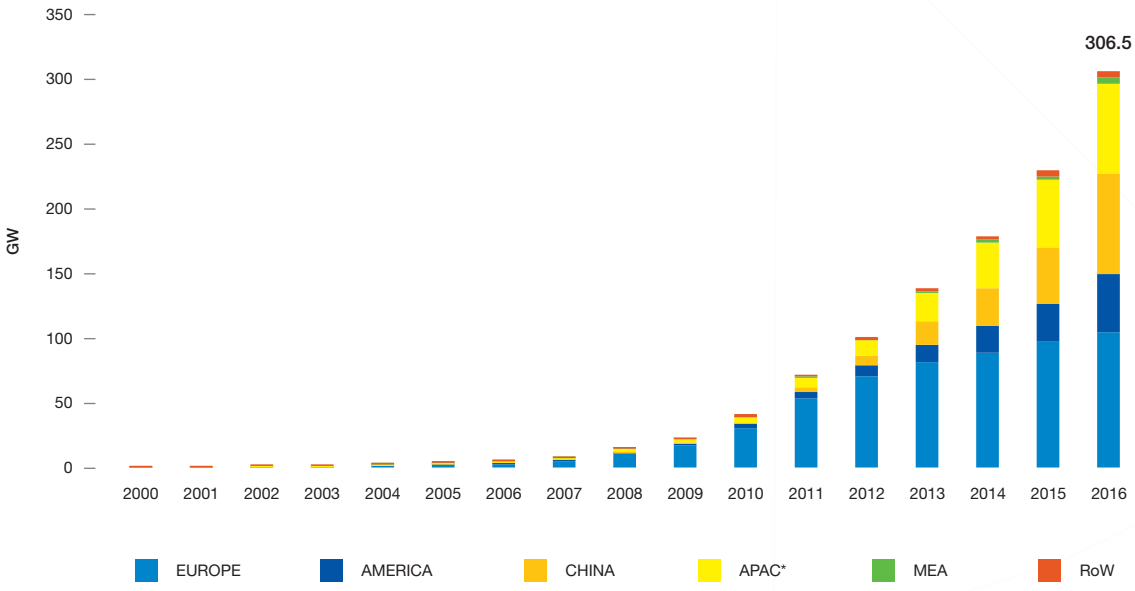
FIGURE 4 EVOLUTION OF GLOBAL TOTAL SOLAR PV INSTALLED CAPACITY 2000-2016



*APAC excl. China

In 2016, Asia-Pacific has become the largest solar-powered region in the world – with 147.2 GW of total installed capacity, equal to a 48% global market share (see Fig. 5). The European solar pioneers, which still owned the major global portion in 2015, are now ranked second – with a cumulative PV capacity of 104 GW and a 34% share. America (including North, Central and South America) remains third at 45.9 GW and a 15% stake. The Middle East and Africa lost market share – the total solar capacity of 4.7 GW results in a world market share of 1.5%.

After China took over the No. 1 global solar market position with the largest cumulative PV capacity in 2015, it strongly expanded its leadership in the following year: The addition of 34.5 GW in 2016, led to a total of 77.9 GW grid connected solar, with China owning one quarter of all global solar power generation capacity, up from 18.9% the year before (see Fig. 6). In 2016, both Japan and the United States overtook long-time solar market leader Germany. Japan, now ranked second, had an installed capacity of 42.9 GW and a 14% world market share in 2016; the US reached 42.4 GW, equal to 13.8%. Germany's fourth rank, based on 41.1 GW and 13.4% share, means that no European country is among the top 3 global solar markets anymore.

Two further countries had solar capacities exceeding 10 GW at the end of 2016 – Italy at 18.9 GW and the UK at 11.5 GW. While India reached the 9.5 GW mark at the end of 2016, it has surpassed the 10 GW level in the first quarter of 2017. No other country is expected to reach a 10 GW cumulative solar power level this year; when looking at the total solar capacities of the closest candidates at the end of 2016, the gaps are too big for France (7.1 GW), Australia (5.8 GW) and Spain (5.5 GW).

FIGURE 5 EVOLUTION OF GLOBAL REGIONS' TOTAL SOLAR PV INSTALLED CAPACITY SHARES

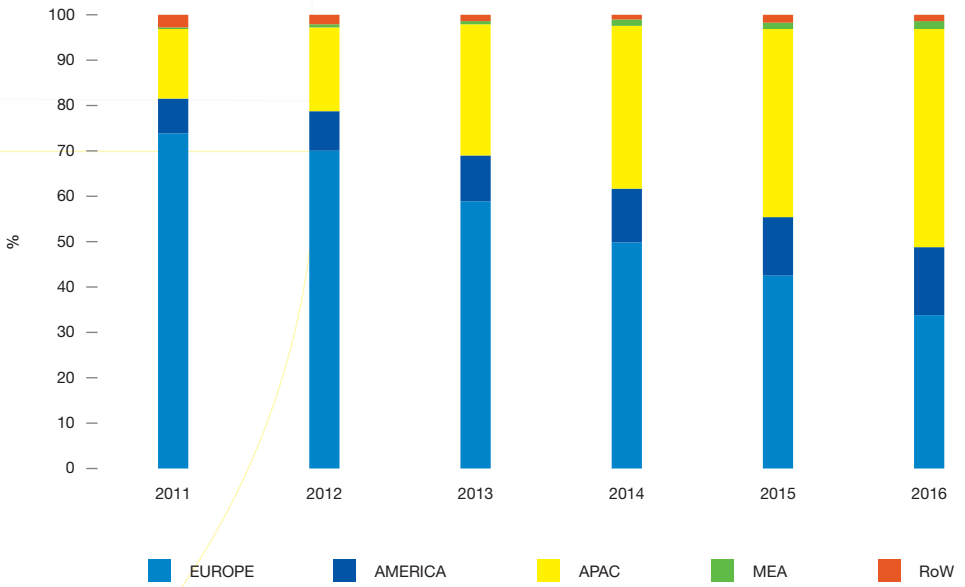
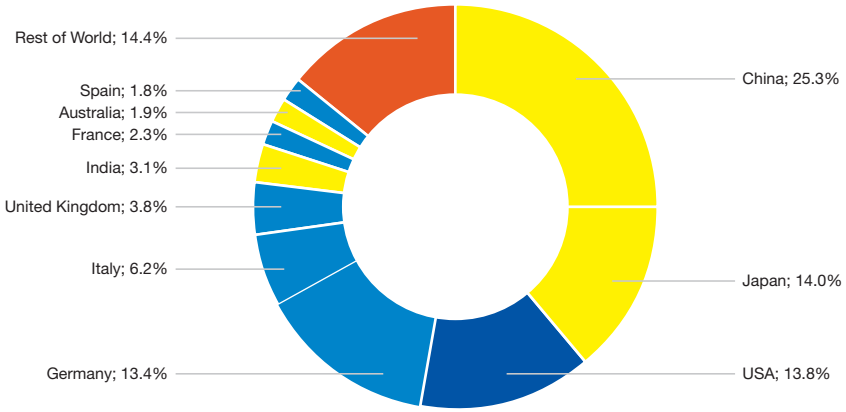


FIGURE 6 GLOBAL TOP 10 SOLAR PV MARKETS TOTAL INSTALLED SHARES BY END OF 2016



1 GLOBAL SOLAR MARKET

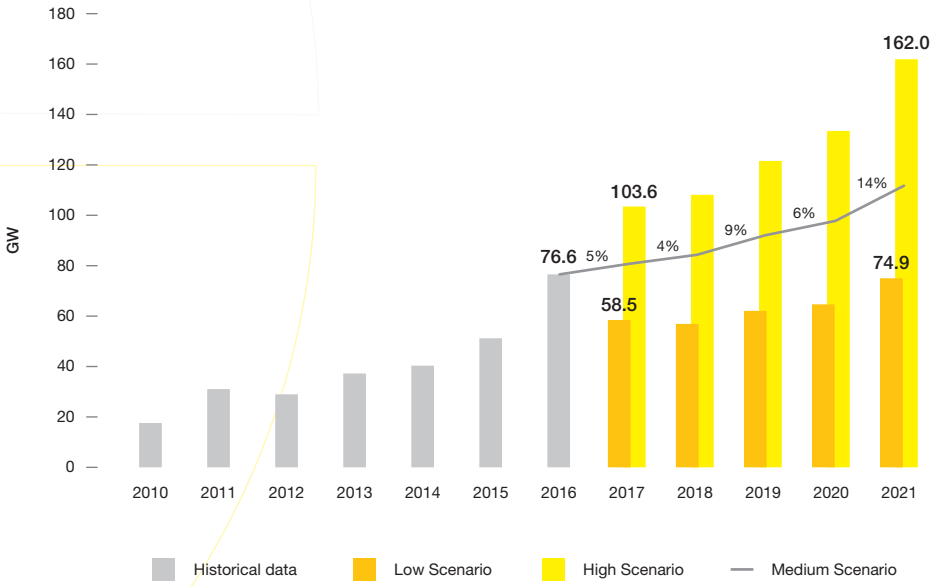
PROSPECTS 2017 - 2021

Despite the gigantic 50% leap in grid connected solar that resulted in topping the 70 GW level in 2016 from the 50 GW range in 2015, there is a good chance that the market will further grow in 2017, even passing the 80 GW mark.

Our Medium Scenario estimates about 80.5 GW newly installed PV in 2017, which would mean a 5% growth over the 76.6 GW installed in 2016. The Low Scenario, which assumes that governments in key markets withdraw support for solar, would result in a demand meltdown to 58.5 GW in 2017. This is very unlikely to happen in view of the installations and plans announced by major solar actors in the first quarter. The High Scenario seems very ambitious at first sight, but considering that the leading markets are still based on uncapped support mechanisms (China and Japan: FITs, US: tax credits) there is big upside potential. Nobody had originally forecasted a 50% year-on-year growth for 2016 in its business-as-usual scenario – and it was only captured at the upper end of our High Scenario.

In **2017** again, global growth will mostly depend on Chinese activities. Most experts anticipate a slow-down over last year's gigantic 34.5 GW demand – and the China Photovoltaic Industry Association (CPIA) is very cautious with their forecast, providing an extremely wide range of 20 to 30 GW for this year (see Chapter 2, p. 39). But China indeed commissioned 7.2 GW in Q1/2017, which is even 0.1 GW higher than what was installed in the first quarter of the 2016 record year. This is even more remarkable, when taking into account that the closure deadline for one of the Chinese PV incentive schemes, the so-called Top Runner Program, has been pushed back to September to avoid a similar steep demand cliff experienced last year after June. This year only the feed-in tariff is scheduled for its annual reduction in June. With further support mechanisms available, such as the poverty alleviation program, and the Chinese companies' usual 'Angst' of a demand slump in the second half of 2017, there is quite some upside potential in the world's largest market this year beyond the 29 GW anticipated in our Medium Scenario.

FIGURE 7 WORLD ANNUAL SOLAR PV MARKET SCENARIOS 2017 - 2021



Other wildcards are the US, Japan and India. The US started rather slow this year – and is expected in our Medium Scenario to add 12 GW, which would be a 19% decline over the 2015 additions. But the fear of negative implications from any rulings of the Climate Change-sceptic Trump Administration, such as higher trade barriers or changes to the very lucrative solar investment tax credit, might push developers to accelerate their projects. Depending if, when and to what extent such effects would be implemented it could also adversely affect the US market – uncertainty is never good to attract investors.

The further solar development in Japan is also difficult to predict. Starting with the new fiscal year, in April 2017, Japan has revised its FIT program, decreasing the tariff by 3 JPY - to 24 JPY/kWh for systems of 10 kW and larger, and to 31-33 JPY for systems smaller 10 kW. New projects above 2 MW will now be tendered. The big question regarding the development of the PV market in the next few years is: how much capacity of the gigantic pipeline of approved non-commissioned PV systems in the FIT program - around 50 GW by November 2016 - can be realized? In our Medium Scenario, we anticipate the Japanese market to shrink further to a volume of 7.5 GW in 2017.

India's National Solar Mission targets 15 GW of new capacity in the fiscal year 2017-18 (ending in March 2018). Although installation activities in the Indian market have been very high since the beginning of the year and the constantly improved policy framework facilitates faster development, our Medium Scenario assumes 9.9 GW of new capacity additions. This would be more than double the 4.5 GW installed in 2016 and takes into account the fact that India missed its FY 2016-17 target by 46%.

In **2018**, it is assumed that China will better control solar power growth, even if the uncapped FIT provides space to manoeuvre and makes forecasts difficult. We expect the Chinese demand will contract by around 7 GW year-on-year to 22 GW in our Medium Scenario. Nevertheless, we expect the global market to improve slightly by 5% to 84.1 GW in 2018. Quickly growing project pipelines in emerging markets will be supported by further decreasing solar prices, which will compensate for any demand decrease in established solar markets.

The years **2019 and 2020** will be characterized by further, though somewhat slower annual growth: 9% in 2018 and 6% the following year, with a number of emerging markets beginning to digest the first wave of large solar additions. The focus will be on establishing new electricity market designs, integration of storage technologies, improving distribution and transmission lines.

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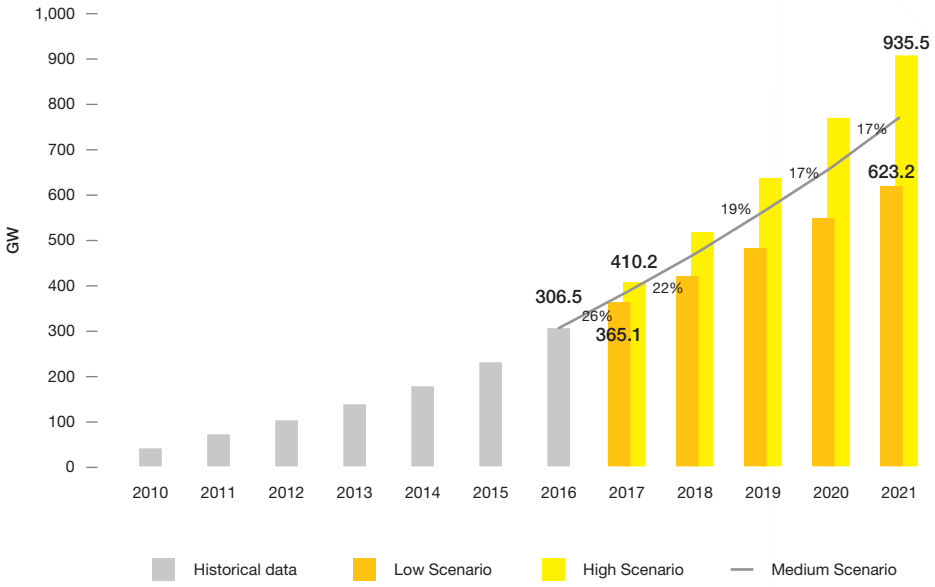
PROSPECTS 2017 - 2021 / CONTINUED

FIGURE 8 WORLD TOTAL SOLAR PV MARKET SCENARIOS 2017 - 2021



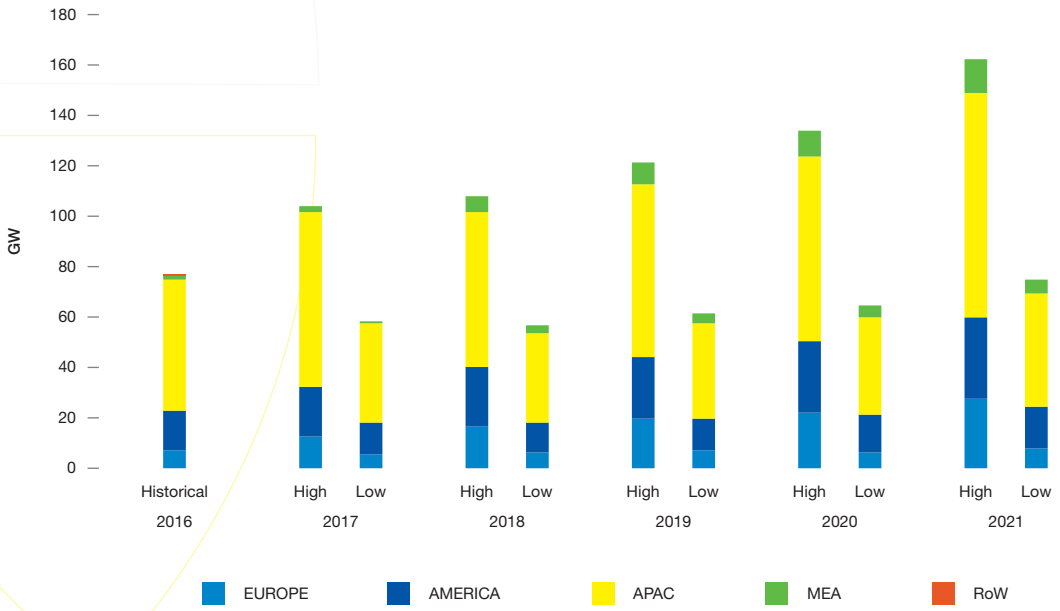
As most policy leaders will have accepted the unique value of solar as the cheapest power generation technology, and the way it can play in concert with wind and storage to provide secure energy supply, **2021** will mark the point of another two-digit growth phase. Our Medium Scenario assumes global demand to increase 14% to 111 GW of solar in 2021.

All scenarios in this Global Market Outlook 2017 are more positive than in the previous edition. Last year, we anticipated a total installed capacity of 358 GW for the Medium Scenario in 2017, this year the estimate is roughly 8% higher - 387 GW. When looking at the final year of the 5-year forecast in the GMO 2016, we assumed a range between 490 and 716 GW with the most likely Medium Scenario resulting in 613 GW of cumulative operating solar power in 2020; this GMO anticipates between 548 and 733 GW, with 661 GW forecasted for the most likely scenario in 2020 – that's roughly 8% higher. By 2021, the world's solar generation plants could have a capacity of up to 935 GW, though 772 is considered more likely.

After the 300 MW milestone was reached in 2016, we expect the total global installed PV capacity to exceed 400 GW in 2018, 500 GW in 2019, 600 GW in 2020 and 700 GW in 2021.

Despite solar power costs continuing to go down rapidly and today already outcompeting centralized, inflexible new power generation plants, sustainable growth can only take place with a stable policy environment. The lower prices don't help if a government puts obstacles in the way of solar, as is the case in sunny Spain where the market has been negligible for several years, or if it disadvantages solar by subsidizing centralized power generation, such as new nuclear in the UK. With the top 3 solar countries responsible for over 75% of global demand in 2016, it needs only one major market making the wrong policy decisions to disrupt the entire solar sector. Taking such risk into account, our Low Scenario assumes a development that results in annual global market of only 65 GW in 2020.

FIGURE 9 EVOLUTION OF GLOBAL ANNUAL SOLAR PV MARKET SHARES FOR HIGH AND LOW SCENARIOS UNTIL 2021



%	2016	2017	2017	2018	2018	2019	2019	2020	2020	2021	2021
	Historical	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
Europe	8.8	11.9	9.9	15.3	11.5	16.4	10.9	16.8	10.0	16.9	10.8
America	21.3	18.8	20.4	21.5	20.5	20.2	21.4	21.1	22.6	20.0	21.4
APAC	67.6	67.1	67.5	57.1	62.1	55.9	60.6	54.4	59.8	55.1	59.9
MEA	2.2	2.2	2.1	6.0	5.9	7.5	7.1	7.7	7.6	8.1	7.8
RoW	0.1	0	0	0	0	0	0	0	0	0	0

It is certain that Asia will continue to dominate the solar sector in the near future, whether the growth follows the Low Scenario or the High Scenario. In comparison to our previous GMO, we anticipate even higher shares for each of the five years of the report. For 2017, the Asia-Pacific share is expected to absorb at least two thirds of total installations and remain in the upper to mid-50% range until 2021.

Nearly

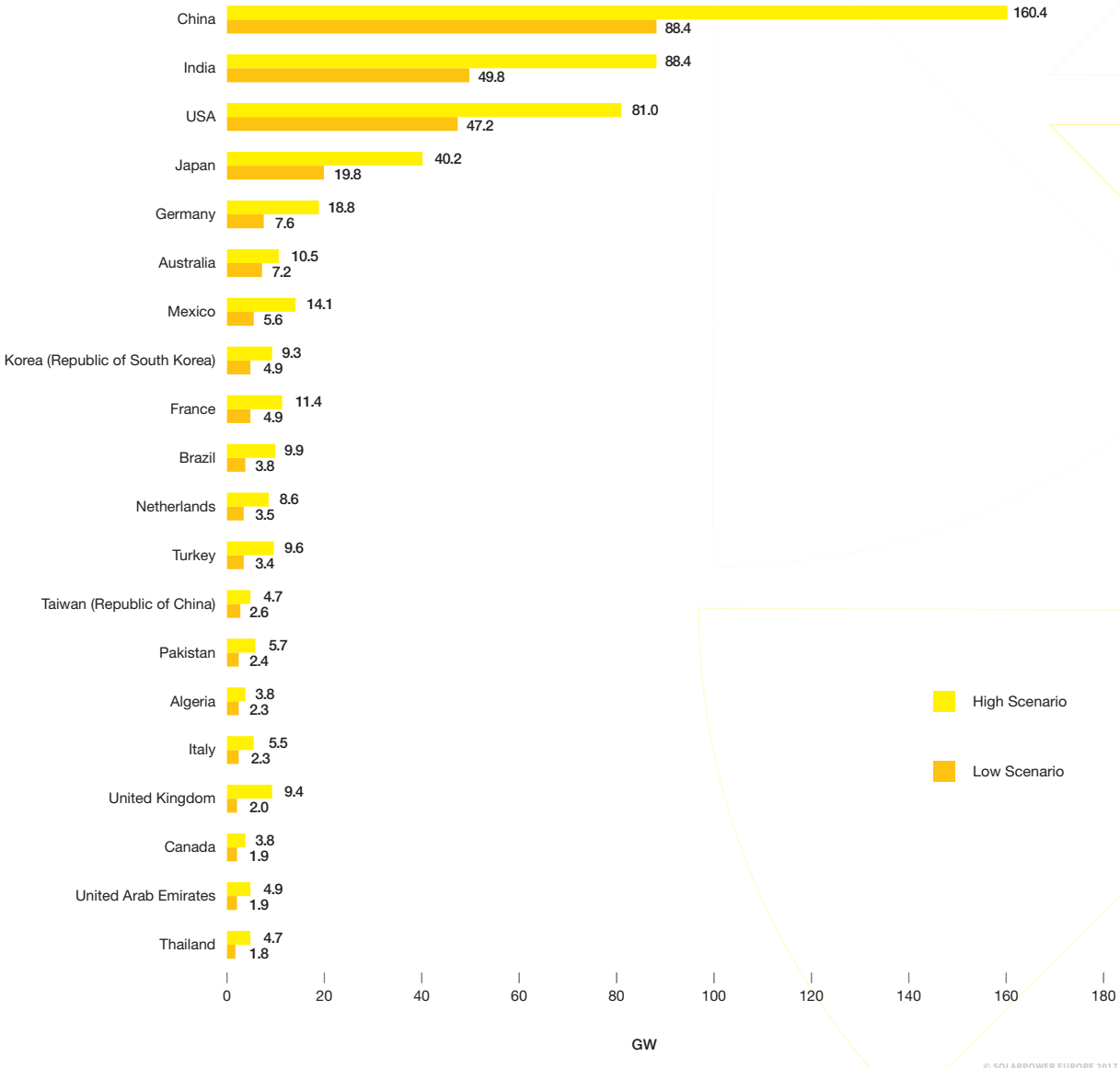
1 TW

total installed solar power possible by 2021

1 GLOBAL SOLAR MARKET

PROSPECTS 2017 - 2021 / CONTINUED

FIGURE 10 TOP 20 MARKETS' SOLAR PV ADDITIONS FOR HIGH AND LOW SCENARIOS 2017 - 2021



Over the next 5 years, only a few countries will continue to absorb the bulk of the solar power system capacity, even if the number of notable solar markets goes up. Among the Top 20 prospect markets, only one country, China, is supposed to add more than 100 GW until 2021 and just two other markets could install over 60 GW – the United States and India. As in last year's GMO, just 4 countries – China, India, the USA and Japan – are expected to install over 20 GW over the next 5 years.

However, our assumptions for the minimum installation volumes of these Top 4 countries together between 2017 and 2021 are now over 43 GW higher, 205 GW.

At the same time, an increasing number of emerging markets around the world will quickly embrace solar power. If the High Scenario comes true, eight of the Top 20 prospects would install over 10 GW each and in any case, each of the leading 20 solar markets will install at least 1.8 GW.

The 'weather' forecast for most of the leading non-European global solar markets remains sunny for the next 5 years. All Top 20 markets will see average annual growth rates of two-digits for the Medium Scenario until 2021, of which 3 countries - Saudi Arabia, Egypt, and Brazil - are supposed to grow beyond 100%.

As in the previous GMO, Japan is the only non-European leading solar nation with a 'rainy' 5-year forecast. The country is expected to add 29.6 GW, according to our Medium Scenario by the end of 2021, which would be only topped by three other countries (China: 120 GW, the USA: 69.9 GW, and India: 66.4 GW) and is 3 times as much as Mexico, the next largest solar market, is supposed to add. However, its newly installed annual capacity is projected to shrink each year until 2021. As full details about Japan's new tender process are not yet known and it is still unclear how much of the approved multi-gigawatt FIT project pipeline will be cancelled by the Japanese government, it is possible that the island nation's solar demand turns out to be even less.

FIGURE 11 TOP GLOBAL SOLAR PV MARKETS' PROSPECTS*

	2016 **Total Capacity** (MW)	2021 **Total Capacity Medium Scenario by 2021** (MW)	2017 - 2021 **New Capacity** (MW)	2017 - 2021 **Compound Annual Growth Rate** (%)	**Political support prospects**
China	77,921	197,921	120,000	20%	
United States	42,362	112,262	69,900	22%	
India	9,548	75,898	66,350	51%	
Japan	42,947	72,547	29,600	11%	
Mexico	505	10,505	10,000	84%	
Australia	5,843	13,623	7,780	18%	
Korea, Republic of (South Korea)	4,921	12,121	7,250	20%	
Brazil	112	6,492	6,380	125%	
Pakistan	910	5,310	4,400	42%	
Taiwan (Republic of China)	320	4,020	3,700	66%	
United Arab Emirates	219	3,769	3,550	77%	
Chile	1,675	4,925	3,250	24%	
Thailand	2,167	5,267	3,100	19%	
Algeria	85	3,085	3,000	105%	
Philippines	892	3,632	2,740	32%	
Canada	2,671	5,357	2,686	15%	
South Africa	1,470	4,125	2,655	23%	
Saudi Arabia	4	2,309	2,305	257%	
Egypt	26	2,076	2,050	140%	
Jordan	367	2,097	1,730	42%	

Top global markets does not include European countries. For top European markets, see Fig. 19.

1 GLOBAL SOLAR MARKET

PROSPECTS 2017 - 2021 / SEGMENTS

The global solar market remains driven by utility scale solar power systems – more than ever before. This trend will continue for the next five years even if leading solar countries are striving to quickly develop their rooftop segments.

While distributed solar systems were the preferred solution in the pioneering times of on-grid solar in Japan, Germany and the US in the 1990s and early 2000, uncapped incentive schemes drew investors' appetite towards large scale solar installations. Deploying gigawatts of utility-scale solar is much easier to establish than a distributed PV rooftop market, which requires a substantial period of time and a lot of effort to educate consumers, while setting up an effective platform with the right financing mechanisms and technical standards.

That's why emerging markets usually start their solar story with utility-scale PV and often struggle to set up the distributed rooftop segment, even if politicians generally prefer PV on roofs which they consider the natural place for the technology. It is not as low-cost as large ground-mounted solar plants, but opting for rooftop PV avoids any potential conflicts on land use.

In Europe, the established solar markets are now using tenders to control deployment of ground-mounted PV. Japan will start to replace its uncapped solar feed-in tariff through a tender scheme for systems larger than 2 MW in 2017. The intention of India to use tenders for solar from the start of its National Solar Mission was primarily not about controlling growth (in fact the government would like to see solar demand increase faster), but to keep cost as low as possible.

However, most of the utility scale PV projects in 2016 were built using uncapped subsidy schemes in the three world's largest markets – feed-in tariffs in China and Japan, and investment tax credits in the US.

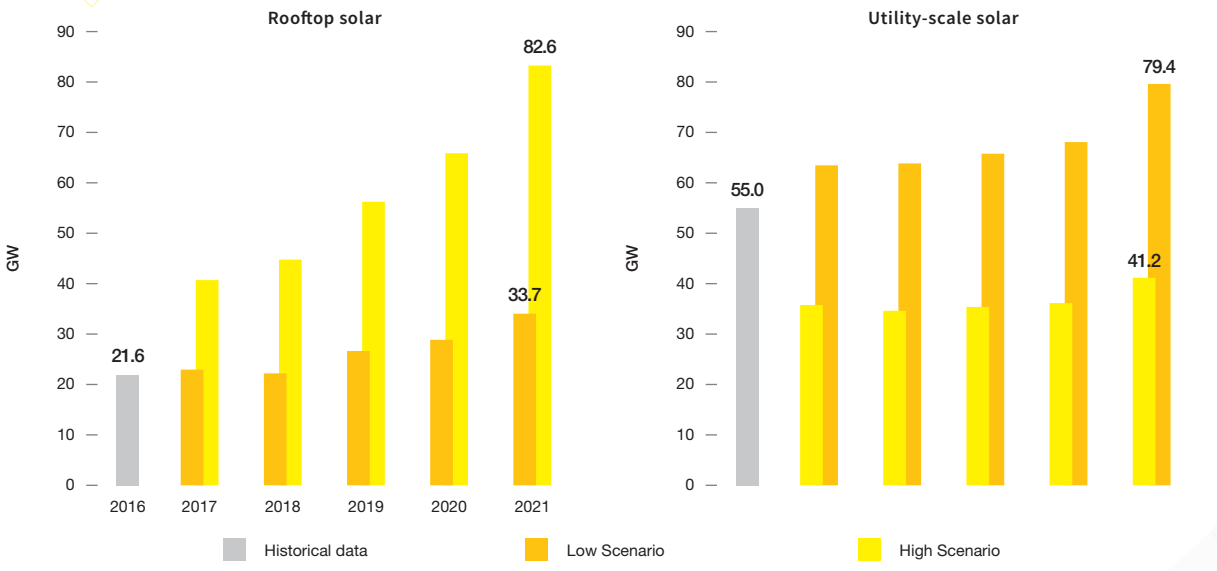
The unexpected Chinese growth triggered by the feed-in tariff decrease, coupled with the fear of the ITC termination which induced a US demand push and the growth of many emerging markets, in particular India, has led to a strong uptick of the global utility-scale solar share in 2016. After adding 55 GW of utility-scale solar globally in 2016, equal to 72% of all installations, this portion grew by 7% compared to 32.6 GW and nearly two thirds of newly installed capacities in 2015.

This higher than usual solar utility-scale activity will continue this year – with strong demand in China and many emerging markets around the world installing notable amounts that are mostly ground-mount.

Even Australia, the only fully developed solar market that is almost completely dominated by residential rooftop systems, with over 1.6 million homes, has recently begun to expand into the large-scale utility segment.

In the long run, distributed solar will gain market share. Even India targets a 40% solar rooftop share for its 100 GW program by 2022, although it is questionable as to whether this will be achieved. The transformation from feed-in tariff or net-metering markets to self-consumption schemes is slowly progressing in established solar markets. Once policy makers have fully acknowledged the true value of distributed solar and battery storage, and have also implemented appropriate electricity market designs and removed regulatory barriers for self-consumption, consumers will go 'solar and storage' to reduce and control their electricity bills.

FIGURE 12 SCENARIOS FOR GLOBAL SOLAR PV ROOFTOP AND UTILITY SCALE SEGMENTS DEVELOPMENT 2016 - 2021



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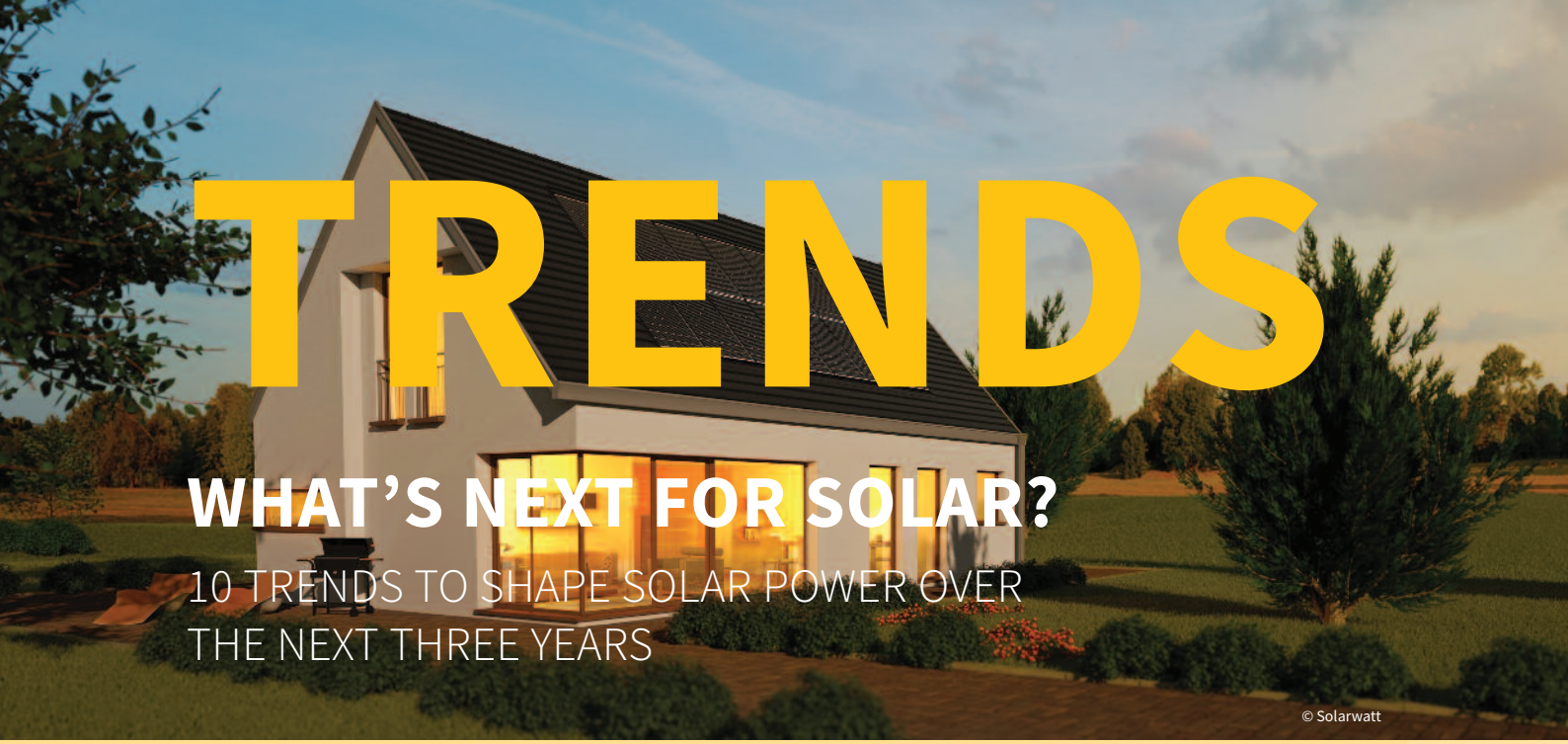


TRENDS

WHAT'S NEXT FOR SOLAR?

10 TRENDS TO SHAPE SOLAR POWER OVER THE NEXT THREE YEARS

© Solarwatt

As solar is becoming the lowest-cost power source for many applications and in many regions, it is obvious that its growth potential is quickly increasing. There are, however, many obstacles that need to be overcome for solar to fully tap the manifold new business opportunities that are now opening up.

SolarPower Europe has looked at 10 Topics & Trends that support the dissemination of solar power and outlines both the challenges and solutions.

A large extent of the content from this chapter is the result of the work of SolarPower Europe's Task Forces, where we work with our members on business models and policy recommendations in the fields of Trade, Storage, Digitalisation, Tenders, O&M and Corporate Sourcing, among others.

1 **Trade**
2 **Market Design**
3 **Active Consumers**
4 **Storage**
5 **Digitalisation**
6 **Tenders**
7 **O&M**
8 **New Industry Leaders**
9 **Technology Development**
10 **Corporate Sourcing**

1. SOLAR TRADE ANTIDUMPING MEASURES – WILL THEY STAY OR WILL THEY GO?

Alongside the dramatic growth of solar power in the past years we have seen the emergence of a new era of trade disputes. Several countries around the globe have opted to use trade antidumping and countervailing duties to protect domestic solar manufacturing from injury. This is true for the EU, US, India, China and others. In Europe, for example, anti-dumping and countervailing duties have been in place on imported solar panels and cells from China since 2012. While the EU and China arrived at an agreement to introduce a "Minimum Import Price" (MIP), a set price and an annual quota on Chinese solar products, the dispute is now past its fourth year and is the largest trade case the EU is currently prosecuting against China.

There is a vast and growing opposition to these measures, which add cost to solar installations, from the large majority of upstream and downstream companies.

In Europe, for example, in January 2017, 18 European Union Members States voted to reject the Commission's proposal to extend the trade measures for 2 years on anti-dumping measures. This was the first time in EU trade history that a trade case went to the Appeal Committee. In March 2017, the European Commission announced they would reduce the application time of the measures from the original 24 months to 18 months and open an interim review into the MIP mechanism. The EC is now looking to replace the MIP and is expected to bring out the new mechanism in September 2017. Even though the Commissioner has pledged to "gradually phase out the measures" there are no guarantees that this will transpire in September 2018. Much will depend on the work of the services of DG Trade in the interim period.

Looking Ahead

Solar is currently booming across the world. As several new markets are emerging, more trade related solar disputes will evolve as governments try to protect local production jobs from unfair trade practices. Turkey, for instance, recently announced a list of China-based solar PV manufacturers that will be subject to anti-dumping

© Lightsource

Free trade, more jobs: Solar trade barriers artificially inflate the price of low-cost solar power, which negatively effects demand and solar jobs.

duties. In the US, a bankrupt local cell and module manufacturer filed a complaint that, if successful, would lead to even higher trade barriers for foreign solar products to enter the US.

New political positions have been expressed in the US leaning towards a more protectionist stance, that are warier of open international trade. These developments may harm the global solar industry, an industry now worth around 114 billion USD and employing 2.8 million people.

The Environmental Goods Agreement (EGA), which aims to remove barriers to trade in environmental or "green" goods that are crucial for environmental protection and climate change mitigation have the potential to be the first-ever worldwide agreement to facilitate trade in the solar sector. Yet, the EGA negotiations recently stalled, which means that the future of global solar trade remains uncertain.

2. BRAVE NEW ENERGY WORLD – WHAT MARKET DESIGNS ARE NEEDED FOR SOLAR TO GROW QUICKLY

Traditionally, the energy system used to be centralised and powered by conventional dispatchable sources of energy. A durable development of solar requires a transition towards a more decentralised energy system able to integrate major shares of variable sources of electricity, including at distributed level. In a liberalised energy system, such a transition involves major changes in the way rules are set for providing access to markets for all types of actors, enabling a flexible energy system able to cope with high shares of variable renewable energy sources.

The European Union is a good example for a decentralized power market that is characterized by generation overcapacities with increasingly lower wholesale prices through the constantly growing share of renewables. Currently, the EU is in the process of changing the energy market rules to make the system more liquid and granular, as well as more short-term based and interconnected. If applied, these changes would offer solar better access to the different power market sections - including energy-only, balancing and, potentially, local flexibility markets. The market design part of the European Commission's Clean Energy legislative package proposal also aims at tapping the flexibility potential of new actors, such as aggregators, storage and demand response, looking to provide solutions to the specific features of a more decentralized clean energy system.

In the United States, creating more flexibility in the electricity system is a major focus, especially in states like California, which experience important changes in both supply (from renewables) and demand. Some market operators have allowed demand response to successfully participate in energy markets as well as markets for ancillary services or capacity markets. In Korea, for example, demand response has been recently developed as a way to avoid a repeat of rolling outages.

The experiences of these 'pioneers' will be very important as other countries are increasingly moving towards liberalizing their energy markets as they face major challenges and investment needs in the energy transition process.

The right market design is the key towards an electricity system based on renewables – and the longer it takes to renew today's framework to be more suitable for flexible generation sources, the longer the energy transition will take. **There are three key challenges that need to be mastered:**

- **The danger of capacity mechanisms:** Phasing-out the support through capacity remuneration mechanisms to inflexible sources of energy that can be responsible for overcapacity, inefficient price formation, and solar curtailment risks. **The addition of carbon criteria in any capacity remuneration mechanisms to avoid public money going to the most polluting power plants.**
- **Incentivizing the emergence of new actors and their access to markets:** All potential sources of flexibility should be maximized, focusing on long-term benefits, rather than short-term costs.
- **Integrating externalities in the price of electricity:** Renewables are not only cheaper than new inflexible power plants, they can even compete with existing fossil fuel-powered plants in an energy system where electricity prices integrate all the related costs. The development of a functioning Emissions Certificate Trading System or a simple phase-out schedule for coal (like UK) and nuclear (like Germany), while subsidies for such technologies are stopped (unlike in the EU), could represent solutions for level-playing field between all sources of energy.

In the end one thing is clear: **The creation and implementation of a market design for a renewables-based energy market will depend only on strong political leadership.**

3. ACTIVE CONSUMERS – POWER TO THE PEOPLE

In an increasing number of countries, the cost-competitiveness of solar and the reduction of support levels is triggering new business models. Besides the revenues generated by the electricity injected into the grid, people also want to reduce their bills via optimised levels of self-consumption. This represents a new revenue stream for both households and businesses.

In fact, net-metering programmes have been in place in the USA and Europe for quite some time. Recently, more elaborated business models are appearing which enlarge the concept of self-generation and consumption to wider groups of consumers. One model allows groups of consumers located in areas using the same grid-connection point to jointly engage in solar (such as the "Mieterstrom" or "Tenant Power" model in Germany, collective self-consumption model in France or in Austria the community power schemes). Other models also enable consumers to "go solar" even if they do not share the same distribution grid (virtual net-metering, power sharing and solar flat rates).

But these new solar business models are more complex to regulate and therefore more volatile for those using them, as a substantial share of the revenue depends on the retail tax and grid tariff arrangements and, more generally, on the regulatory treatment of prosumers.

Achieving legal clarity is thus crucial. In the EU, the European Commission, made a step in the right direction by presenting in November 2016 a proposal for a new European legal framework for active consumers and self-generators, acting alone or in groups.

GLOBAL DEVELOPMENTS SUPPORTING THE UPTAKE OF ACTIVE CONSUMERS	BARRIERS IDENTIFIED	SOLUTIONS
• Price decrease of solar demand response and storage devices. • Need for increased flexibility at local level for grid operation. • Increasing competition on the close-to-the consumer services.	• Volatility of the business model: self-consumed electricity can be exposed to taxes and grid fees. • No market for local flexibility. • Low and slow development of aggregation services for the residential segment. • Lack of combined offers (self-generation, demand response, outsourcing of balancing responsibilities.	• Do not expose self-consumed electricity to specific taxes. • Ensure a staggered approach in the evolution of distribution grid tariff structures. • Ensure that excess electricity receives at least the market price. • Make the development of standardised local flexibility products mandatory by a given date; oblige DSOs to procure flexibility from distributed assets. • Ensure that the deployment of storage is market-based. • Provide an enabling framework for aggregation services. • Develop new types of contracts which provide "do-it-for-you" services to the prosumer.

What's Next?

The potential of active consumers is very large. In Europe, it has been estimated that one out of two people - or 264 million people - could be producing their own electricity by 2050.[1]

But how do we unlock that potential? **SolarPower Europe sees four trends which may develop over the next 5 years:**

- **Self-consumption will become "smarter":** This means that prosumers will not only have to consider the local optimisation of their generation and consumption, but will also increasingly support grid operation, and hence become a new source of local flexibility. This will depend on the existence of local flexibility markets and the emergence of standardised local products that distribution system operators will be able to buy.
- **A "Smart interfacing" industry will grow:** There is already a convergence between the inverter, storage and home automation industries. SolarPower Europe expects this to continue, which will lead to a more diversified solar PV value chain.
- **Utilities and new entrants will increasingly compete to offer new, combined services to prosumers:** Such offers will range from solutions to help finance the acquisition of equipment for self-generation and consumption, to competitive offers for the outsourcing of balancing responsibilities.
- **Regulation of distribution grid tariffs will evolve:** The consumer-led energy transition may be hampered or delayed by an unbalanced shift to capacity-based distribution grid tariffs. Grid tariffs will be a real game changer.

1 CE Delft - "The potential of energy citizens in the EU" (2016).

4. BATTERY STORAGE – CHARGING SOLAR UP TO THE NEXT LEVEL

Solar and Storage is the perfect fit to enable solar power to reach the next growth level in developed solar markets, and to help accelerate the dissemination of distributed solar in emerging markets – both on- and off-grid.

Today's world leading on-grid solar and storage markets are countries with high penetration rates of residential solar installations. In Europe, Germany is the number one spot for solar and storage, with a market share of around 80%, while the remaining 20% are shared among the UK, Italy, Austria and France. At the end of 2015, Germany had around 35,000 battery storage systems installed (> 200 MWh), which increased by around 25,000 or more than 70% over the course of 2016.

In several regions of Australia, distributed solar and storage is cheaper than buying retail electricity from the grid today. The country, which has solar on around 1.6 million homes, added around 7000 battery systems in 2016. With large scale solar and storage already being competitive with gas-fired CCGTs, developer Lyon Group announced in March 2017 it would build the largest solar and storage plant in the world – a 330 MW PV system linked to a 100 MW / 400 MWh battery storage in South Australia.

Another global leader in battery storage is California, the largest US PV market. The state regulator, California Public Utilities Commission (CPUC), has set targets for investor-owned utilities to procure 1.3 GW of storage by 2020.

Despite the positive signals for solar and storage around the globe, energy market designs most commonly fail to recognize the full value that the combination of the two technologies bring to the energy system and thereby slow down the energy transition (see table).

GLOBAL DEVELOPMENTS SUPPORTING SOLAR AND STORAGE	BARRIERS FOR DEPLOYMENT	SOLUTIONS
• Declining costs of solar and battery storage technology. • Consumer interest to be part of the energy transition and to control their energy bills. • Need for higher flexibility, faster and more accurate response to system needs. • Incentive programs (e.g. in Germany and Sweden). • Electrification of society (e.g. heating and cooling, transport, industry sectors). • Competitiveness of a local/regional battery industry (value-chain). • High-tech jobs (R&D, production and downstream) and economic growth. • Solar and Storage provides clean and cheap electricity 24/7, which addresses the challenges of a flexible renewable energy market, (e.g. solar eclipse).	• Current electricity market rules are framed without storage in mind. (New rules are needed for a new "species" in the energy system that can absorb and release energy when required). • Double taxation. • Ownership models. • Grid costs – "how to set up grid charges, so that the correct price signals are sent to grid users and grid owners?". • Right balance of long and short-term contracts for provision of ancillary services. • Lack of standards and safety (e.g. who, where and what type of technology can be installed in the residential segment?).	• Creation of local flexibility markets. • Opening of markets (new products for different timeframes and a level playing field for all technologies). • Transparency and updated design of balancing markets (contracts, remuneration, procurement timeframes, technical requirements). • Quantification of the real impact of prosumers on the energy system and design of distribution tariffs. • Ability to stack benefits. • Capabilities of "smart" meters. • Data access and management. • Responsibilities and cooperation between TSOs and DSOs. • Volatility of prices and spreads during peak and off-peak hours.

Outlook

The cost for battery technology is quickly falling – according to BNEF it will fall to $120 per kWh by 2030 compared with over $300 now and $1,000 in 2010. This - combined with further cost declines for solar - will drive the combination of both technologies, with research firm IHS Markit expecting an average global annual storage growth rate of more than 60% over the next 4 years, to reach around 16 GW deployed by 2020. In Europe, the market for home storage is expected to grow from around 32,000 newly installed systems in 2016 to nearly 60,000 systems in 2020.

While there are many business models for solar and storage, the growth level will finally not only depend on cost, but on the way energy regulatory frameworks will be changed to enable stationary storage to bring its advantages to the energy system.

5. DIGITALISATION – SOLAR POWER'S FUTURE STARTS NOW

Digitalisation is the major theme for the power sector. It is an umbrella term for the application of big data analytics, the internet of things, smart monitoring, wireless mobile technology and much more – and it will dramatically change the energy industry over the next few years.

When looking at digital grids, this will allow more PV to be integrated and potentially reduce installation and operating costs. Digital grids will also support the maximisation of PV's flexible nature and strongly support business models for demand response, storage and smart energy management.

Globally, Singapore and Australia are flag bearers in the field of digitalisation of the electricity sector. In Europe, Nordic countries are the most advanced, while the developing countries have the opportunity to leap-frog the old centralised grid and move straight to smart microgrid solutions.

What's Next?

Over the next five years, new innovative business models will emerge with digitalization enabling "smarter" solar. Chief among these is likely to be new peer-to-peer models for prosumers to sell excess solar electricity directly to other consumers. This will be either using online platforms provided by a utility, or by using entirely new technology such as blockchain distributed ledger systems to cut out the 'middle man' altogether.

Solar is likely to be more and more sold as part of a smart building "package" of technologies, many of which increase self-consumption rates. Foremost among these are smart building energy management systems – separate from or integrated into inverters – which use deep machine learning to manage on-site consumption. Other examples include storage systems, combined heat and power units, smart household appliances and smart thermostats. Building regulations must encourage such innovation with 'smartness indicators', as proposed for the EU.

The implementation of smart grids is likely to also be an opportunity for the solar PV sector as this opens up new markets and sources of revenue for solar power in terms of frequency response, voltage control and reactive power services. The potential extra revenue streams for renewables from a move to smart grids are estimated at up to USD 800 billion worldwide.[2]

Finally, digitalisation could have a transformative effect in parts of the developing world that do not yet have access to electricity. New solar-centric microgrids could be run on smart (blockchain-based) platforms with fully flexible demand from the start.

There is a whole swathe of applications of digital technology to solar PV – and this is without doubt a key enabler of further deployment. It is key that the industry engages with this digital transformation to make the most of the opportunities on offer.

2 http://smarter2030.gesi.org/downloads/Full_report2.pdf.

6. TENDERS – LOVE ME SOLAR TENDER?

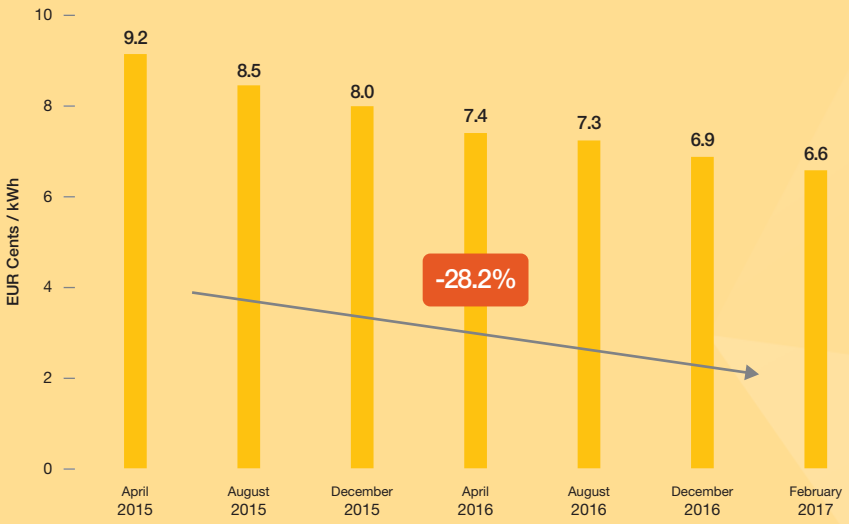
In mid-2016, 67 countries across the globe were using tenders to develop renewable energy capacities . The solar sector is no exception. Many of the main solar markets in the world have already reverted to auctions to build new projects, others are planning this move.

Solar auctions made it to the headlines of the press over the last two years because of the steady and constant price decline observed round after round: $55/MWh in Argentina, $32.8/MWh in Mexico, $29.1 /MWh in Chile, $26.7/MWh in the USA and $24.2/MWh in the Abu Dhabi auction, which is currently the lowest price observed.

In Europe, the requirement stemming from the so-called European Commission "State Aid Guidelines" to use tenders as of the 1 January 2017 for plants above 1 MW triggered several changes in national support schemes. Germany, France and the Netherlands have implemented solar tenders, while such mechanisms are expected to be used in other markets like Spain or Poland.

But while experience on solar tenders is growing internationally, data on realisation rates are more limited. Although tenders have resulted in low prices – in Germany, the awarded bids deceased by over 28% in less than 2 years (see Fig. 1) -, comparability between countries and selection rounds remains difficult and design parameters play a key role.

TRENDS FIGURE 1 AVERAGE WINNING BID SOLAR POWER PRICES IN GERMAN TENDERS



Source: German Federal Network Agency

Solar quickly getting cheaper: In less than 2 years, the average winning bids in German solar tenders decreased by over 28% to 6.6 euro cents per kWh. The lowest awarded bid in February 2017 was even at 6 euro cents per kWh.

What's Next?

Tenders are expected to play a major role in the development of large-scale solar:

- Tenders will be used in an increasing number of markets across the globe: Countries going for solar for the first time will leapfrog to tenders for large-scale solar without going through feed-in-tariffs schemes.
- A stronger framework for ensuring project delivery: Greater attention will be given to implementation rates to ensure the effectiveness of tenders. Design parameters will focus more on ensuring timely implementation of projects. Secondary markets may develop.
- Quality assurance mechanisms will gain traction: In a context of increasing pressure on prices, expectations on performance over time and lifetime will increase.
- Tenders will be increasingly open to cross-border bidders: There was already a first experience of a cross-border solar tender between Denmark and Germany. This will happen more often over the next 5 years, especially in Europe.

GLOBAL DEVELOPMENTS SUPPORTING USE OF TENDERS	BARRIERS IDENTIFIED	SOLUTIONS DEVELOPED BY SOLARPOWER EUROPE'S TASK FORCE ON TENDERS
• Need for the policy-makers to control the volumes of solar capacities deployed in each country. • Need to provide the solar sector with visibility. • Demonstrated ability of tenders to decrease the price per MWh. • Market-based mechanism reducing the need for financial public support.	• Technology-neutral tenders provide no visibility to the solar sector. • Projects smaller than 1 MW provide unnecessary overhead cost for bidders. • Strategic bidding by unserious players may lead to projects not been realised.	• Implement technology-specific tenders, with clarity on the volumes to be auctioned and the frequency of the rounds via transparent, multi-year roadmaps to allow for a proper portfolio planning. • Projects smaller than 1 MW shall be permanently excluded from tenders and should continue to be eligible to other forms of support mechanisms. • Pre-qualification criteria impeding speculative bidders are key for a reliable tendering framework. Overly restrictive criteria hamper competitiveness. An advanced project shall be rewarded by lower bid bonds. • Penalties for delayed projects shall be introduced and consider the origin of the delay. The number of unrealised projects shall be reduced by a staggered liability approach. • Awarded bids should be transferable, to allow a secondary market for awarded projects and thus increase the flexibility for project developers. • Relevant auction figures should be made public. Re-submitting of refused bids shall be made possible at very low cost.

7. OPERATIONS & MAINTENANCE – TAKE GOOD CARE OF YOUR SOLAR BABY

As the solar sector matures, Operations and Maintenance (O&M) services are being recognised for their crucial role in ensuring long-term revenues. This is increasingly the case in Europe, the continent with the oldest fleet of solar PV systems: Once an add-on to EPC contracts, O&M has charted its own course to become a standalone business segment and a critical component of the solar energy value chain. In rapidly growing emerging markets, where most of the installations are large-scale solar plants, O&M is also increasingly playing an important role.

Quickly decreasing PPA prices for solar PV plants around the globe, as well as strong competition in mature O&M markets, such as Europe, is resulting in challenges that are often related to quality issues. According to a survey conducted by SolarPower Europe, two out of three solar professionals active in this segment in Europe think there are 'very large' or 'significant' discrepancies between the quality of services provided by different O&M contractors (see Fig. 2).

GLOBAL DEVELOPMENTS SUPPORTING O&M	CHALLENGES	SOLUTIONS
• Aging of solar PV installations. • Increasing number of solar PV installations with expiring performance guarantee from the EPC Contractor. • Maturing of regulatory environments: moving away from high and favourable feed-in tariffs towards market-based mechanisms requiring longer-term optimum output. • Accumulating O&M experience and consolidating the O&M services market in Europe, the market with the largest and oldest fleet of solar PV. • The largest and fastest growing markets rely mostly on large utility-scale solar plants, which need O&M contracts.	• Fragmented markets: Significant differences between the quality and scope of O&M services offered by different O&M service providers. • Some discrepancies between expectations of Owners/Lenders and actual services provided. • Absence of commonly accepted and known industry standards and minimum requirements. • In developed markets: Increasing price pressure, that may interfere with service quality. • In emerging markets: Ambitious national solar programmes with few experienced O&M service providers.	• Dissemination of industry best practices such as in the SolarPower Europe O&M Best Practices Guidelines. • Publication and dissemination of a globally and freely available, bankable O&M contract template.

What's Next?

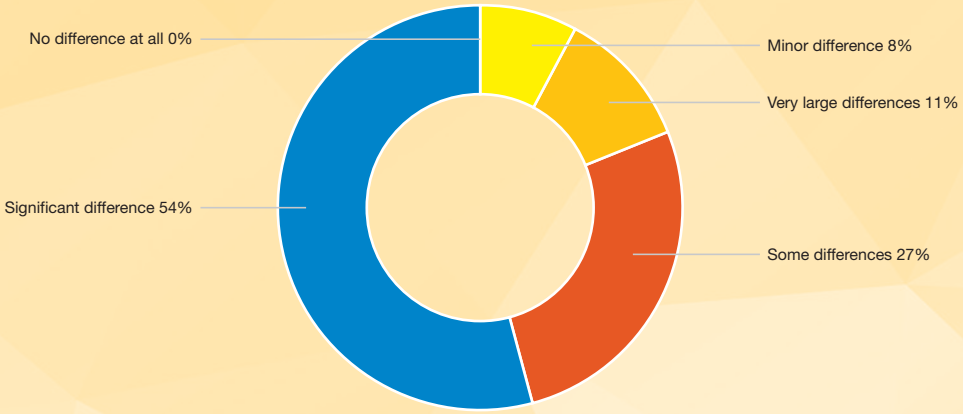
The global market for megawatt-scale solar O&M and asset management exceeded over 180 GW at the end of 2016 and is expected to surpass 500 GW in the next 5 years, driven primarily by the large utility-scale solar markets in China, the US, India and Japan. In Europe, O&M markets will continue their consolidation, resulting in further quality discrepancies and market fragmentation. Ambitious national solar programmes and solar tenders for solar power plants will boost demand for O&M services. But with growing competition and pressure on O&M prices as solar PPA prices continue to go down, there is danger of pushing down quality levels.

Digitalisation will have a significant impact on asset management and O&M. Real time data, mobile and wireless technology, robotics and drones can help to increase yield and reduce cost. Predictive maintenance is already used to reduce downtime for PV plants, and 'digital twin' engineering could use the cloud to simulate components and systems and increase performance.

A joint effort is needed to tackle the challenges facing the O&M sector. The adoption of industry-led minimum requirements and the dissemination of best practices will be the guiding theme of the upcoming years. SolarPower Europe will support this effort with a version 2.0 of its O&M Best Practices Guidelines in late 2017. SolarPower Europe's O&M Task Force is leading the O&M work-stream of the Solar Energy Standardisation Initiative aimed at developing a freely available, bankable template O&M contract to be published in late 2017. The Solar Energy Standardisation Initiative is a joint activity of the International Renewable Energy Agency (IRENA) and the Terawatt Initiative (TWI).

TRENDS FIGURE 2 CONSISTENCY OF O&M SERVICE QUALITY

"HOW WOULD YOU EVALUATE THE DIFFERENCE OF QUALITY OF SERVICES BETWEEN DIFFERENT O&M SERVICE PROVIDERS?"



8. NEW INDUSTRY LEADERS - NOT ONLY THE BRIGHT YOUNG THINGS

With solar growing much faster than any other renewable technology in 2016, it is obvious that this sector is increasingly attracting large corporations. Most major companies are involved in one of the many business fields solar offers. While there are also many start-ups and medium size enterprises involved in all levels of the solar sector – and some of them have successfully transformed into global champions, today large corporations are increasingly engaged in the solar sector. With production rapidly commoditizing, margins in the production sector getting thinner and services and business models becoming very sophisticated, almost everything is about big balance sheets.

Here are today's hottest sectors and some candidates that might play leading roles in solar:

Utilities going solar

The most successful global solar developer/EPC is a European utility – Enel from Italy. Its EGP division installed 763 MW PV in 2016, catapulting its total PV capacity to 1.1 GW. And just in March 2017, it announced to build a 754 MW PV park in Mexico, which will be America's largest system when complete in 2018. Many other utilities are following Enel's path – some with the help of acquisitions to speed up solar growth. Good examples of this are Innogy (the divested renewables arm from German utility RWE) and Engie. While Innogy announced in 2016 it would take over the solar and storage businesses of Belectric, one of Germany's leading solar EPCs, Engie acquired French developer Solairedirecte and has rapidly become a leading player in the solar power space.

At the same time, utilities are increasingly addressing their residential electricity customers with business solutions. For example, mid-size German utility MVV has teamed up with leading PV wholesale company BayWa re to set up a start-up company that offers clients an electricity flat rate. The offer includes a solar/storage system and energy services.

The return of big energy companies

While nearly all of the big western energy companies have been involved in solar in the past, many had left the space several years ago. Only Total has been very actively involved in solar in the last few years. But that's changing again – though the focus is now on PV power plants. Eni from Italy announced in 2016 to build a first PV plant in Algeria, and Shell (aside from its indirect investment in Japanese PV company Solar Frontier) has established a new solar unit that has begun to develop solar systems as well. This trend will continue.

Who will own the digital cake?

While big energy technology companies, like ABB, GE and Schneider Electric have been in solar for many years through their inverter businesses, their main focus is the smart energy network as well as 'intelligent appliances' for the residential, commercial and utility space. This is also the target business of IT giants, like Huawei, which through their solar inverter business has moved into operation & maintenance of solar power plants. One of the inverter leaders, SMA, is also focusing on the digital field with their high-tech products. The digital solar home could be also served from internet giants, like Google. The company is developing solar power plants as it is committed to source 100% of its energy needs with green power, and it offers a solar system simulation software that is now available US-wide and owns a digital power meter company.

Car makers selling solar

The Tesla take-over of leading US solar installation company SolarCity in 2016 placed two companies back in the same hands, while luxury car maker Daimler started selling stationary batteries last year. Chinese company BYD, one of the world's leading battery companies, which is also a leader in electric busses, has been producing solar modules for many years and just opened a 200 MW solar panel assembly facility in Brazil in April 2017.

Solar Supermarkets

We are not yet there – you cannot buy a solar system in any supermarket. But the most innovative companies have started to check out if this works. IKEAs foray into solar is very interesting – after entering solar by putting panels on their shop roofs around the world, the Swedish company started a pilot programme to sell solar systems in their UK, Dutch and Swiss shops and decided in 2016 to roll out their solar business in other countries including Poland.

9. TECHNOLOGY DEVELOPMENT - HIGHER TECH FOR LOWER COST

In 2016, the first solar PPAs were signed under 3 cents per kilowatt-hour, which puts an immense cost pressure on everyone producing components for solar systems. The solar module was still the biggest cost contributor with nearly 50% of the total system capital cost in 2016. With module prices quickly falling, companies are racing to cut on cost as well. The same is true for inverters and mounting solutions. Here are the latest trends SolarPower Europe has seen to reduce solar system cost.

WAFERS

Mono for higher efficiencies: In the last decade multicrystalline silicon wafers have been clearly dominating the solar market, but monocrystalline technology is becoming strong after most manufacturers have switched towards lower-processing cost diamond-wafer technology and processing equipment for low-cost high-efficiency cell designs is available.

CELLS

Everyone wants PERC: Not long ago, only cell technologists knew what a PERC cell is, in 2016 almost every cell producer has jumped on that train – upgrading its old mono cell lines or choosing Passivated Emitter Rear Contact cells for its expansion plans. The technology brings 0.5-1 percentage points efficiency improvements with little more cost for additional production equipment. There are several other promising silicon cell technologies, but according to German research institute ISFH, the efficiency potential is around 24% - and the first cell manufacturers are already working on the second generation of PERC cells, using selective emitters.

MODULES

Cutting cells in two: In order to reduce interconnection losses module manufacturers increasingly use so-called 'half cells', in which a fully processed solar cell is cut into two parts. Why? Because a full cell cut in half means that the series resistance losses, which are a square of the current, decrease to a quarter. REC Solar from Norway said in 2016, it would change all production at its Singapore factory to half-cut PERC cells. Many other manufacturers are increasingly using half cells as well.

Bifacial: A solar cell has two sides, so it makes sense to use both for generating power. That's why module manufacturers have started to use bifacial module technology, using special cell designs and transparent backsheets or a glass for the back cover as well. If installed on sand or white roofs, a system using bifacial modules can easily generate over 20% more output.

INVERTERS

String goes utility scale: There was a time when ground-mounted PV plants were using only centralised inverters. That's definitely over. Today even multi-MW power plants are using small string inverters, which are more maintenance friendly and save on system design cost.

RACKING

The tracker is back. While the use of trackers had almost vanished after the Spanish solar boom nearly a decade ago (at that time two-axis tracking), cost and reliability have improved dramatically so that single-axis tracking systems are increasingly used in utility-scale PV plants again.

SOLAR SYSTEMS

Higher Voltage: An increasing number of suppliers are starting to offer modules and other components for solar system DC voltages of up to 1,500 Volts. This is a solution for large rooftop and utility-scale installations as it allows to decrease the number or combiner boxes, simplifies installation – and has a significant cost reduction potential for solar systems.

BIPV: There is a lot of cost reduction potential through the integration of solar modules into the building skin, as solar replaces the currently used material. It slightly increases capital expenditure for a solar system, as building-integrated modules are simply more expensive than traditional, add-on standard panels, that are manufactured in the millions per year. Still, the presentation of Tesla's Solar Roof, which was introduced to the public in Autumn 2016, caused a gigantic response in the media around the world. There is apparently need for highly-aesthetic solar roof products, which – if branded and marketed well – could address a new group of customers that solar has not yet really reached: housing developers and architects.

10. CORPORATE SOURCING OF SOLAR – SHAVING THE POWER BILL BY GOING GREEN

An increasing number of corporates around the world have started sourcing the power needed for their operations from plants which use renewable sources. These companies do so either because they have to comply with certain legal obligations or because the purchase of electricity from renewable sources is beneficial to them. Such benefits are three-fold:

1. Economic: The purchase of green electricity allows companies to fix, control and even lower their energy costs, thus decreasing their business risk and enhancing their competitiveness.

2. Environmental: By sourcing green electricity, companies reduce their carbon footprint, which contributes to a more sustainable economic growth model.

3. Business-related: Using green power improves the brand image and recognition. Ultimately, it can create new business opportunities for companies.

Companies opting for electricity supply from renewable sources can choose from various options. They can simply subscribe to a green tariff backed by guarantees of origin or they can directly purchase guarantees of origin. But more interestingly, they can invest in renewable energy plants or sign power purchase agreements for renewable energy assets owned by third parties. Thanks to its scalability, PV is a perfect solution for companies that want to engage in near-by or on-site projects. The table below summarises the key drivers for solar PV corporate sourcing.

	DRIVERS FOR DEPLOYMENT OF CORPORATE SOURCING
POWER PRICES	• High and volatile wholesale market prices. • High and increasing retail market prices - No exemption from payment of certain components of electricity tariff for large consumers.
CORPORATES' ENVIRONMENTAL OBLIGATIONS OR INCENTIVES	• Renewable portfolio standards for large consumers. • CO_2 emissions pricing for large consumers. • Investment tax credits.
PV SUPPORT MEASURES	• Incentive schemes providing uncertain revenues and high market risks – e.g. green certificates. • Subsidy schemes providing certain but low revenues to PV – e.g. low FiTs or FiPs. • End of subsidy scheme period approaching (plants becoming 15-20-year old looking for new revenue streams). • No government organised auctions for PV or oversubscribed auctions (non-awarded projects looking for alternative revenue streams). • Guarantees of origin issued also to subsidised plants. • Favourable self-consumption framework.
OTHER DRIVERS	• Easy and cheap grid transport arrangements for off-site PPAs. • Developed non-regulated market. • Established project finance market. • Corporates' commitments to decrease their environmental footprint.

Where are the markets?

So far, the US has been the leading market for solar corporate sourcing. If investment tax credits are maintained as planned, their combination with solar's growing competitiveness, the availability of cheap finance and the sustainability commitment of several US-based corporations will lead to the growth in solar corporate sourcing in the US in the next few years.

Volatile wholesale market prices, unsubsidised retail tariffs for large consumers and the abundance of solar radiation may provide room for the corporate buying of PV in Central and Southern America, as well as in India.

As for Europe, the uptake of this new PV business model depends on governments' ability to clarify and simplify the conditions under which corporate PPAs and self-consumption are possible, and to provide guidance on subsidy compatibility with corporate PPAs. The access to bundled renewable energy and renewable energy certificates seems to be a key precondition for businesses' decision to procure RES due to certain reporting requirements. Hence, the future EU-wide rules on the issuance of guarantees of origin for subsidised renewable energy which are currently being revised are set to have an impact on the size of the future EU PV corporate procurement market.

Finally, the increasing use of tenders to grant public support to a limited number of medium and large scale projects or the simple unavailability of government PPAs for utility scale installations can be a driver for the growth of solar corporate sourcing in Europe: indeed, tenders may create a pipeline of 'second-hand', unsuccessful, yet bankable, projects seeking alternative financing; at the same time, the growing competitiveness of utility scale solar may prove attractive to corporates looking for ways to control their energy costs.

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THE CHINESE SOLAR MARKET

2017 UPDATE & FORECAST

700 MW, Ningxia, China

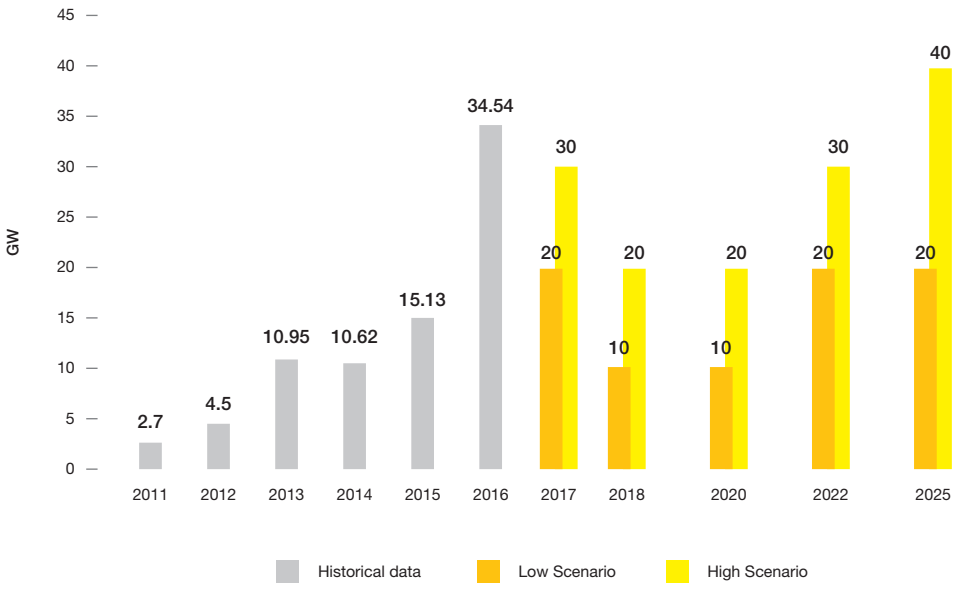
This chapter on PV in China was provided by the China Photovoltaic Industry Association, like SolarPower Europe a founding member of the Global Solar Council (GSC), which, as of this year, is an official partner in the publication of the Global Market Outlook.

1. Overview of Solar PV in China

2016 was a record year for the global solar industry, especially for China. According to the statistics from the Chinese National Energy Administration (NEA), new capacity additions of 34.54 GW in 2016 lead to over 77 GW of cumulative installed PV capacity on the Mainland. That's just the beginning.

The 'Photovoltaic Industry Roadmap' (PVIR) that was published in early 2017 by the China Photovoltaic Industry Association states that the Chinese PV will add between 20 and 30 GW in 2017. In May 2017, the NEA released figures which showed that about 7.2 GW of PV was installed in the first quarter of 2017.

FIGURE 13 CPIA SOLAR MARKET SCENARIOS FOR CHINA



SOURCE: PHOTOVOLTAIC INDUSTRY ROADMAP, CPIA, 2017

Based on the PVIR, the Chinese market is supposed to shrink between 2018 and 2020 to a level of 20 to 30 GW due to FIT cuts, but resume at an even higher installation rate in the first part of the following decade. In the longer term, demand is very likely to spike to 40 GW+ per year as of 2025.

2. Chinese solar/RE targets

Despite the inevitable FIT cuts, China is more determined in developing clean energy than ever. The latest 13th 5-year plan might have brought confusion to the solar community abroad when the Chinese government's 2020 PV target was translated into "110 GW only." Given current market development expectations, the 110 GW target is likely to be reached by Q1/2018. But when carefully reading the original plan with some understanding of Chinese culture, one will understand the idea that the 110 GW is actually the minimum achievable target in the new 5-year plan.

In April 2017, the central department of the Chinese National Development and Reform Commission (NDRC) adjusted the target for the share of non-fossil fuels in primary energy consumption by 2030 upwards, encouraging an increase in the share to 50%, from the previous 20% goal. Considering energy demand in China in 2030, the market potential for photovoltaics remains enormous.

3. Drivers for solar growth in China

- FIT. As in the "traditional" solar markets, such as Germany or Spain, the growth of PV in China has been triggered by a feed-in-tariff. The FIT program provided the strongest support when the price of solar was still significantly higher than other energy resources – but is still the main incentive for solar power, though now at much lower levels which are adapted annually.
- Top Runner Program. The so-called "top runner program" was developed by the Ministry of Industry and Information Technology (MIIT), the National Energy Administration, and the Certification and Accreditation Administration in 2015. The idea is to guide project developers to adopt the latest technology, increase system efficiency and reduce LCOE. Results have been encouraging: by the end of 2016, the average cell efficiency of mono Si produced in Mainland China increased to 20.5%, the LCOE in sun-rich areas was below 0.65 CNY/kWh, and the record auction price reached was as low as 0.45 CNY/kWh (due in 2017).
- Poverty Alleviation. Photovoltaics is widely known as the ideal source of electricity for rural electrification. When poverty alleviation was presented as the top priority to the current government leadership, photovoltaics became an important tool by combining access to electricity and income. In 2017, the segment for poverty alleviation is set to be 5.5 GW.
- "PV+". The fact that PV can harvest solar energy directly without needs for a strong grid infrastructure or specific locations with access to water has offered the technology opportunities to be used for various applications. In China, "PV + agriculture" is becoming a trending tag. Crops, flowers and herbs that prefer shady ambience are now being planted underneath solar power plants to use precious farming land as efficiently as possible.

4. Utility-scale vs. distributed solar development

In the first phase of the PV market development in China, investors were concentrating on the northwest region where solar irradiation is the highest and sandy land was available. However, due to the mismatch of supply and demand of electricity, large scale utility plants located in remote areas were often economically not sustainable.

In Dec. 2016, China reduced the FIT for utility scale plants by 19%, 15%, 13% respectively to 0.65/0.75/0.85 CNY per kWh from 0.80/0.88/0.98 CNY per kWh (with different tariffs paid in 3 different regions - from sun-rich to sun-poor and geographically from northwest to the east coast). At the same time, the FIT for distributed solar has remained the same. Such adjustments are intended to shift the market segmentation towards distributed generation, which is expected to grow strongly to about 5 GW in 2017.

5. Challenges

There's no such thing as a perfect market for everyone. The challenges lying ahead of the Chinese PV players are late FIT payments, curtailment, missing transmission, and others. The Chinese government is working on addressing all these issues, but as the domestic market is very large, things take time.

In early 2017, a Green Power Certificate system was brought online, in order to promote direct transactions between PV electricity producers and customers. The proportion of utility-scale projects auctioned is being increased to save funding. Various Ultra-High Voltage transmission lines are under construction, that are expected to limit the curtailment and make full use of the power from the solar plants.

10 MW, Catania, Sicily.

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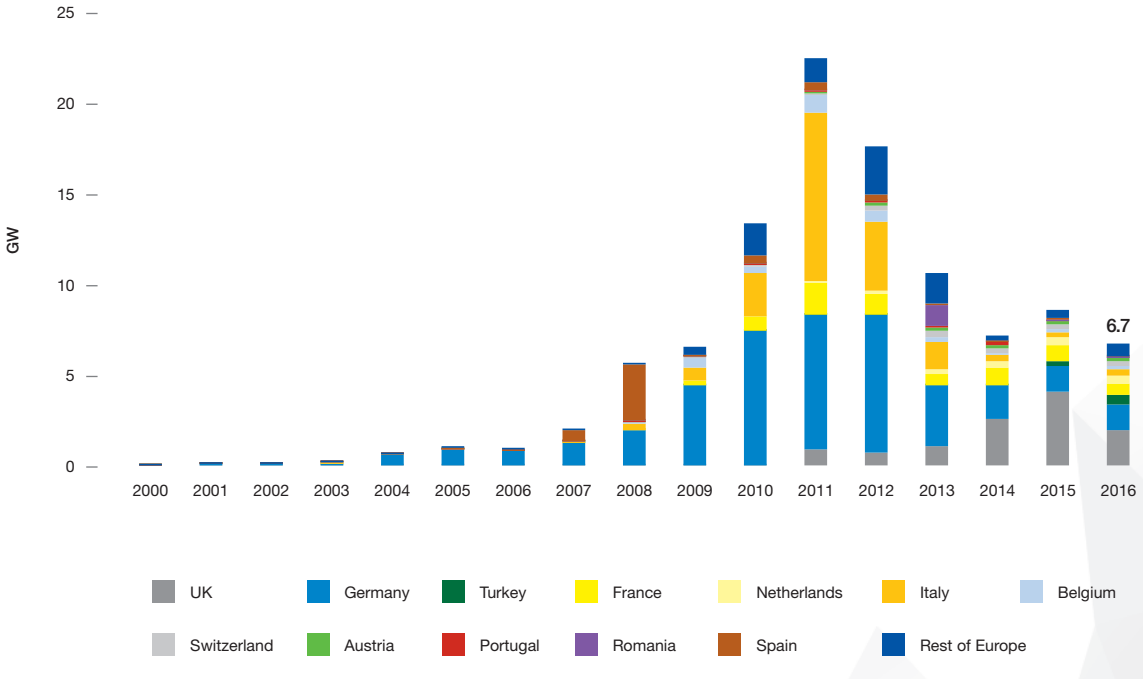
3 THE EUROPEAN SOLAR MARKET

2000 - 2016 UPDATE

2016 was a disappointing year for solar in Europe. With only 6.7 GW of newly installed PV capacity, the European solar power market shrank by 22% year-on-year. This drop comes after a small uptick in 2015 that followed a several years of market contraction which started in 2012, when European solar pioneering countries began to slash their lucrative feed-in tariff incentive programs.

While SolarPower Europe had correctly forecasted a market decline for 2016 in our most probable Medium Scenario in last year's GMO, the slide of the European solar market is a bit steeper than the 7.3 GW we expected. The actual 6.7 GW installation volume dropped by 1.9 GW from 8.6 GW in 2015 and is basically level with the annual PV capacity that was added 7 years earlier - in 2009, Europe installed 6.6 GW on its way up to its 22.5 GW climax in 2011.

FIGURE 14 EUROPEAN SOLAR PV ANNUAL GRID CONNECTIONS 2000 - 2016 FOR SELECTED COUNTRIES



3 THE EUROPEAN SOLAR MARKET

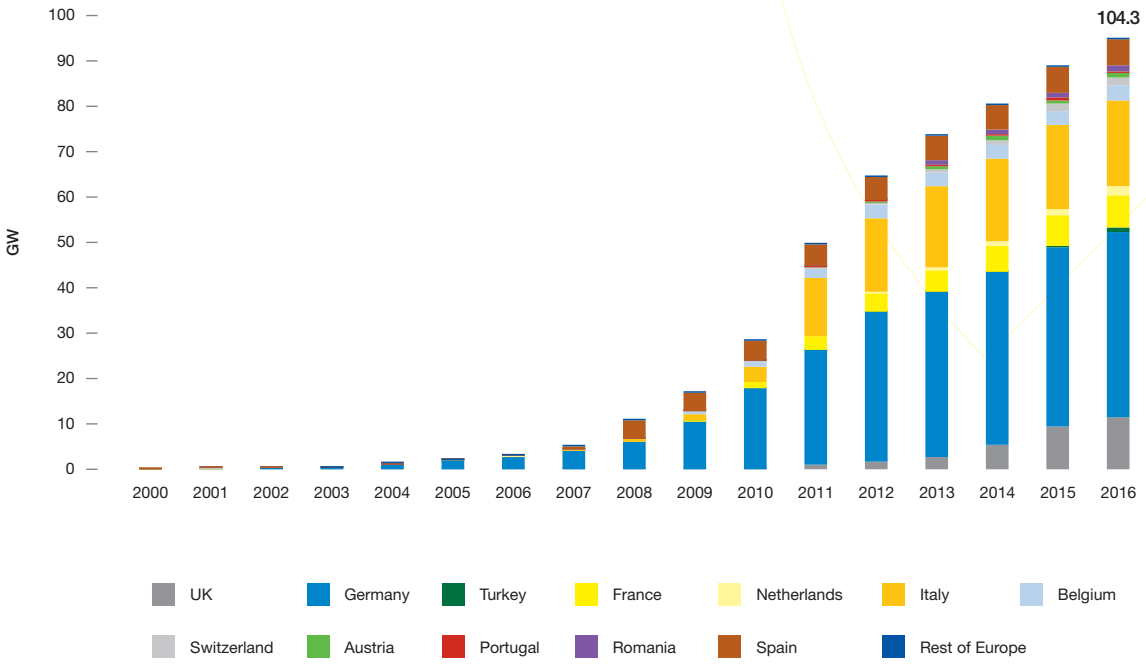
2000 - 2016 UPDATE / CONTINUED

The European leading solar market remained the same in 2016 – the United Kingdom achieved that title for the third year in a row. However, with only 1.97 GW grid connected, newly installed capacity decreased by 52% from the 4.1 GW the country added the year before. The UK government abandoning solar support is the main reason for Europe's strong demand drop in 2016. There was only one short spike in the UK in 2016 when 1.2 GW was grid-connected by March in response to the Renewable Obligation Certificate Scheme's termination for larger solar systems at the end of the first quarter; for the rest of the year, monthly PV additions remained mostly below 50 MW. A cut of the country's other solar support mechanism, a feed-in tariff for small installations, was already announced a few days after the Climate Summit in Paris in December 2015. The UK's Solar Trade Association published a study in June 2016 that one out of three solar jobs was lost within the past year. An impact assessment study by the country's Department of Energy and Climate Change found that the incentive cuts could wipe out up to 18,700 of the UK solar industry's 32,000 jobs.

The second European market was once again, Germany, adding almost exactly the same capacity as the year before – 1.42 GW in 2016, compared to 1.45 GW in 2015. For most of 2016, it seemed as if Germany would barely manage to reach the 1 GW mark, but a year-end rally, triggered by the termination of the FIT for ground-mounted systems up to 10 MW, resulted in over 400 MW of installations in December 2016. Still, in both years - 2016 and 2015, Germany clearly missed the governments solar installation target range of 2.4 to 2.5 GW. Except for the UK and Germany no other European market crossed, or came close to, the 1 GW mark.

Turkey, the new number three on the European solar map was able to increase PV installations by nearly 200% to 571 MW, from 191 MW in 2015, finally starting to deliver what investors had been hoping for years. It is noteworthy that this growth rate took place despite the massive political turmoil, but the solar return promise is high and local financing increasingly available. Turkey had already passed its feed-in tariff law in 2010, but the 13.3 US cents/kWh level was too low at the time. The first 600 MW tender round for 'licenced' solar projects

FIGURE 15 EUROPEAN TOTAL SOLAR PV GRID-CONNECTED CAPACITY 2000 - 2016



between 1 and 50 MW in 2013 was around 15 times oversubscribed, but it took until 2016, before the first two systems awarded in 2014 were actually built. High license fees are the main obstacle for these systems. Most of the PV installations in Turkey belong to the 'unlicensed' systems category up to 1 MW, though it is possible to bundle these projects – the largest PV park in Turkey today, the Kayseri OSB power plant, started with 6 MW in 2014 and has been expanded to 51 MW in April 2017. By the end of September 2016, the Turkish authorities had received 7 GW of applications of unlicensed projects and approved a total of 4.1 GW.

The solar additions for France were the most surprising disappointment in 2016. The country added only 559 MW, down 38% from 895 MW the year before. This strong drop should be an exception. The market will pick up in 2017 as last June the government announced a detailed agenda to augment total installed solar capacity to around 20 GW by 2023 through regular tenders for BIPV, rooftop PV and ground-mounted solar power plants. At the end of 2016, the cumulative PV capacity in France was 7.1 GW. Moreover, in early 2017, the French parliament passed a law that will facilitate investment in self-consumption systems which had been hindered by levies and complicated regulatory frameworks. The first set of solar tenders have already been issued and awarded.

Next to Turkey there were other positive solar developments ins Europe, though only the Netherlands installed a similar volume (500 MW) that was driven mostly by its net-metering scheme, with ground-mounted solar starting to play a big role through its SDE+ program. In 2016, the Netherlands saw its first PV system above 10 MW being built – a 31 MW installation in the northern part of the country, while developments started for a 103 MW system. While PV additions in Italy increased by 23% in 2016, the absolute amount in the once world leading solar market stayed rather low (369 MW). A good sign is Belgium's new PV capacity (170 MW), which means a 70% growth year-on-year, that is based to a large extent on residential and commercial systems.

Strong growth signals were seen primarily in Eastern Europe. Poland doubled its new PV capacities in 2016, adding around 100 MW. The non-EU countries Ukraine, Russia and Belarus went from almost no new solar in 2015 to between 50 and 80 MW each in 2016.

Europe's achievement of reaching the historical 100 GW record of cumulative installed solar before any other region in spring 2016 was impressive but only very short lived. Asia-Pacific ended the year with a total PV capacity of 147.2 GW, with China installing about one third of Europe's cumulative solar capacity in a single year.

The bulk of Europe's total solar capacity is still carried by 2 countries – Germany (39.4%) and Italy (18.2%). Some distance behind trails the UK, where a short 3-year solar boom has resulted in an 11.1% share by the end of 2016. France remains fourth (6.8%). Spain keeps its fifth spot (5.3%) although it added less than 600 MW in the last 5 years. **The solar picture of Europe for 2016 hasn't changed: The European solar power sector continues its transition phase.**

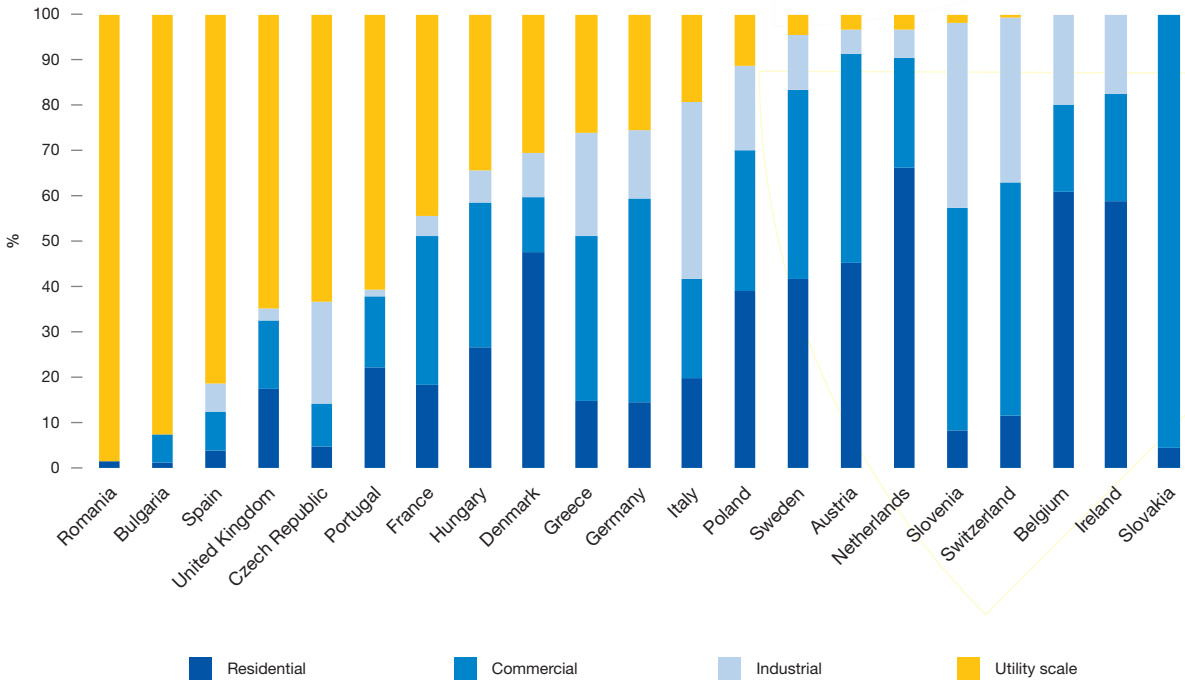
3 THE EUROPEAN SOLAR MARKET

2000 - 2016 UPDATE / SEGMENTATION

The image of the solar segmentation in European solar market remains scattered. However, normally emerging markets start their solar engagement with utility-scale solar plants, which are rather easy to build – and without the need for setting up a sophisticated sales and installers network and educating customers. This has been true for several European markets as well. The rule of thumb is still valid that the less active a once prospering solar market is in Europe, the larger is the share of total installed ground-mounted solar plants. After its short feed-in tariff-driven solar boom periods based on utility-scale plants, Romania, Bulgaria or Spain have never managed to build up notable markets for rooftop installations. Also, the latest European solar highflyer, the UK, grew primarily on subsidies for utility-scale systems, before the program was terminated. The newest emerging solar markets on the Continent – the Ukraine, Russia and Belarus - completely focus on utility-scale installations, and so does Turkey. Even the Netherlands, traditionally a fully-fledged rooftop market, has started to take advantage of low-cost ground-mounted systems, while Europe's largest solar market Germany tenders 600 MW ground-mounted systems between 750 kW and 10 MW per year.

More than two thirds of solar systems in Europe found their place on the roofs of buildings – residential, commercial and industrial in 2016. This dominance is expected to continue.

FIGURE 16 EUROPEAN SOLAR PV TOTAL CAPACITY UNTIL 2016 FOR SELECTED COUNTRIES



3 THE EUROPEAN SOLAR MARKET
PROSPECTS 2017 - 2021

In 2016, the several year-long European market slump should have come to an end. As of 2017, it is very likely that a new growth cycle will start for solar power in Europe.

Despite a further decline of solar demand in the UK by more than half in 2017, the European PV market is forecasted to grow to 8.8 GW. Unlike for the UK, we anticipate that other European countries will experience solar growth in 2017, which will continue in the coming years. Our Medium Scenario expects a strong 31% growth jump in 2017 that will somewhat flatten over the coming years, with annual installations to increase up to 15.7 GW in 2021 (see Fig. 17).

There are several reasons for the next solar growth phase in Europe:

- **Economic benefits of self-consumption:** Solar is already much cheaper than retail electricity in most European markets today and will continue to decrease in cost, which will be a key driver for people to invest in on-site power generation. At the same time, a stage has been reached in the early European PV markets that consumers are increasingly starting to understand that solar often makes economic sense even without high feed-in tariff incentive programmes. The quickly falling cost of battery energy storage combined with the benefits of digital and smart energy products supports the sales case for solar, as most consumers prefer to reach a higher 'energy autonomy' status and fully control their energy bill.
- **Tenders:** Tenders or auction tools have fully disclosed the low cost of solar power and have been embraced by several European countries, substituting traditional uncapped feed-in tariff schemes. France has recently announced and already started a massive solar tender program for the next few years; Turkey has just awarded a 1 GW tender; Spain has announced a renewables tender for this year (although not particularly suited for solar); and in Germany the 2015 started tender pilot was turned into a regular program and expanded in size, with many of the recent winners likely installing their systems very soon to take advantage of new record low module prices expected for H2/2017.
- **EU 2020 targets:** A number of EU governments that still have some way to go to meet their individual RES targets are or will be strengthening their support for solar as they have realized that the technology is a very popular and low-cost means to increase the renewables share.
- **Low cost triggering demand in new and dormant markets:** The low cost of solar is attracting European countries to embrace solar power that haven't been very active in that field, like Belarus and Russia. In other European markets, where the solar development stopped with the termination of early subsidy programs, direct bilateral PPAs will compete with wholesale power markets. Finally, cheap solar is now increasingly able to outcompete other renewables in technology open support programs, like in the Netherlands, where in April 2017 solar accounted for 2.65 GW, or nearly 70% of the pre-assigned capacity of the first round of the SDE+ Program for large scale renewable energy projects.
- **Regulation:** The European Commission, as well as national governments, has begun addressing the needs of a flexible renewable energy system, working on a new electricity market design and implementing new tools and regulations to overcome barriers that have inhibited solar's growth possibilities in recent years, such as missing rules for self-consumption in France or lacking guidelines for solar power sharing and tenant power in Germany.

The spread between our High and Low Scenarios is very large for the coming five years – and over time increasingly widening. The way solar will grow in Europe will fully depend on policy makers in Brussels and the European countries.

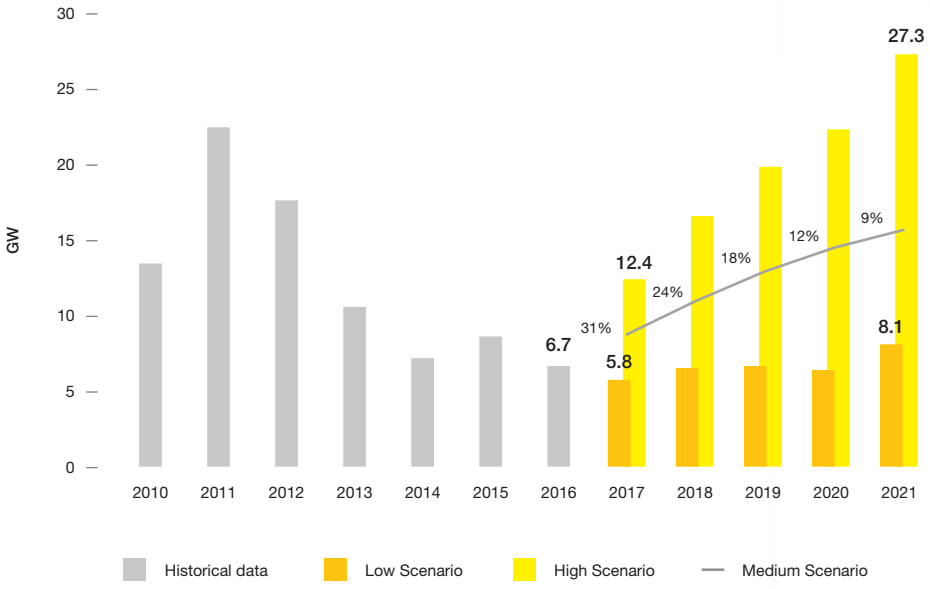
If Europe fully embraces the enticing business case of low-cost solar, in 2020 the market could be nearly as big as in the record year of 2012, reaching 22.4 GW. This High Scenario would require elimination of any trade barriers, like in Turkey or the EU and any taxes on self-consumption. If the EC's Clean Energy For All Europeans Proposal is quickly passed with slight improvements including a higher renewable energy target for 2030, as called for by SolarPower Europe (see Chapter 4, p. 51), and adapted accordingly by the EU member states, these measures could even propel the European market to an annual level of over 27 GW in 2021.

Conversely if the bulk of European governments completely disregard solar's potential and the benefits for their citizens, even the Low Scenario could become reality, resulting in annual additions of only 8.1 GW in 2021.

3 THE EUROPEAN SOLAR MARKET

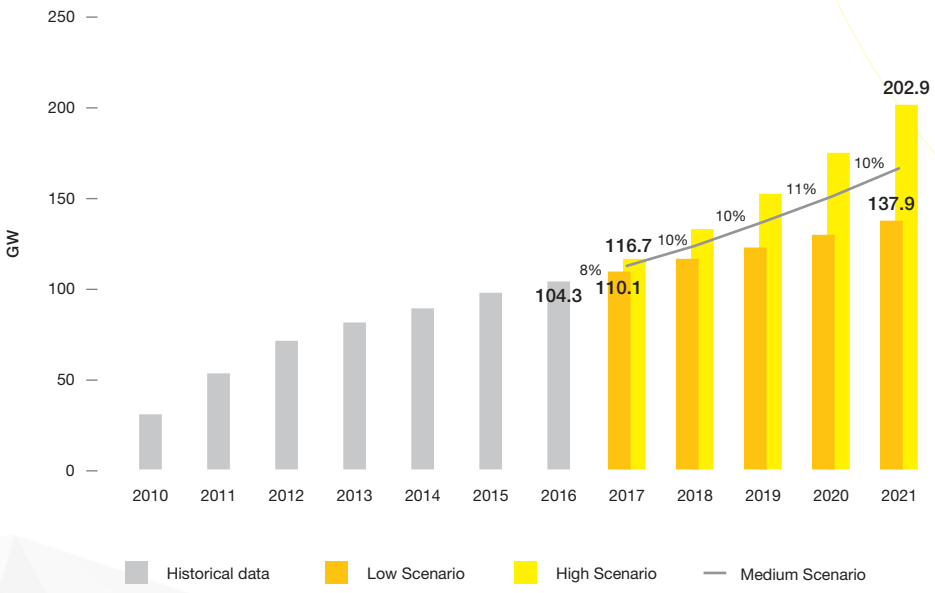
PROSPECTS 2017 – 2021 / CONTINUED

FIGURE 17 EUROPEAN ANNUAL SOLAR PV MARKET SCENARIOS 2017 - 2021



If the High Scenario comes to fruition, Europe's cumulative PV capacity could nearly double to 202.9 GW by the end of 2021 from the 104.3 GW installed by 2016. The Medium Scenario forecasts 167.2 GW. In case the Low Scenario plays out, Europe's solar power capacity would only grow by 33.6 GW to 137.9 GW – that's even less than the capacity added by China in 2016 (34.5 GW).

FIGURE 18 EUROPEAN TOTAL SOLAR PV MARKET SCENARIOS 2017 - 2021



In Europe, the political support prospects for solar are not as bright as elsewhere for the coming years. The solar 'weather forecast' for European countries between 2017 and 2020 is still mostly cloudy but shows increasingly sunny areas and just one rainy spot. The UK is the only European country expected to add less new solar power year on year until 2019.

As in the previous GMO, we expect the same top 3 markets to contribute the largest shares of new solar capacity until 2021 – Germany, France and Turkey. While we have become more bullish on Germany and France, the expectations for Turkey are somewhat less optimistic.

In Germany, an updated renewables law (EEG 2017) went into effect, which sets a stable regulatory framework and should provide the basis for a new growth phase, in particular, because utilities are increasingly engaging in EPC and operations of solar power technology.

France has published new solar targets with a concrete tendering schedule and passed a law to overcome regulatory obstacles for small solar installations. Although the solar sector in Turkey seems to have mastered the limitations of the political turmoil so far, which has made it more difficult to access financing, its recent protectionist turn could make solar more expensive and negatively impact growth prospects in the country. Still, the Turkish solar business case is better than in the European Union – the country's population and its need for power is quickly growing, there is plenty of space, excellent irradiation and no power plant overcapacities.

The Medium Scenario now anticipates the 15 largest European markets to install each a minimum of 1 GW until 2021 (up from at least 500 MW in GMO 2016), with Germany as the largest one adding 12.5 GW (up from 8.7 GW) and France over 8 GW (up from 6.3 GW). A new European market in the top 15 list is Russia, expected to add around 1.5 GW until 2021, while Ireland, though only installing 17 MW in 2016, is now assumed to add 3.2 GW (up from 0.5 GW). In total, we anticipate Europe to add 62.9 GW (up from 52 GW) from 2017 to 2021, based on our most probable Medium Scenario.

3 THE EUROPEAN SOLAR MARKET

PROSPECTS 2017 – 2021 / CONTINUED

FIGURE 19 TOP EUROPEAN SOLAR PV MARKETS' PROSPECTS

	2016 **Total Capacity** (MW)	2021 **Total Capacity Medium Scenario by 2021** (MW)	2017 - 2021 **New Capacity** (MW)	2017 - 2021 **Compound Annual Growth Rate** (%)	**Political support prospects**
Germany	41,111	53,611	12,500	5%	
France	7,134	15,229	8,095	16%	
Turkey	820	7,380	6,560	55%	
Netherlands	1,911	7,691	5,980	32%	
United Kingdom	11,547	15,822	4,275	7%	
Italy	18,983	22,525	3,542	3%	
Ireland	17	3,233	3,216	187%	
Austria	1,077	3,377	2,300	26%	
Poland	182	2,262	2,080	66%	
Switzerland	1,681	3,367	1,686	15%	
Russia	94	1,559	1,465	75%	
Spain	5,491	6,771	1,280	4%	
Belgium	3,423	4,503	1,080	6%	
Greece	2,611	3,650	1,039	7%	
Sweden	182	1,217	1,035	46%	
Rest of Europe	8,060	14,289	6,228	12%	

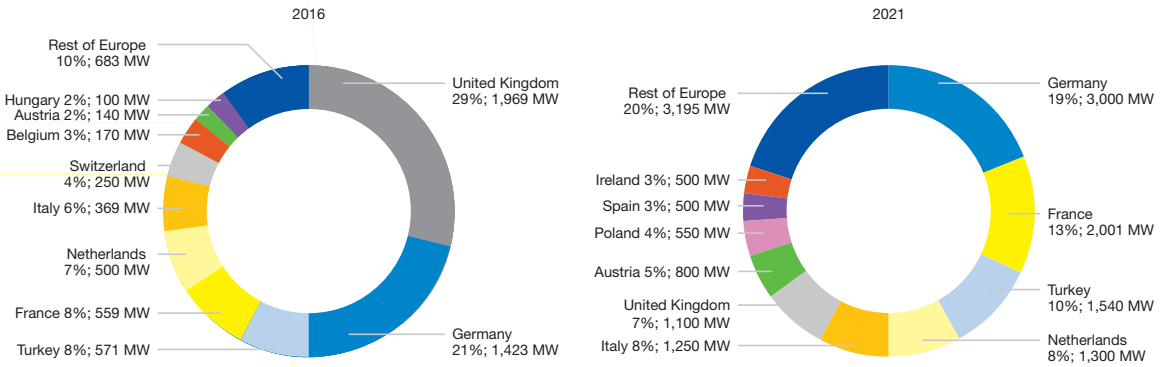
In 2021, Germany is expected to be Europe's largest solar market, according to the Medium Scenario, followed by France, Turkey, the Netherlands, and Italy.

The UK, which led the European solar sector from 2014 to 2016, is not expected to be among the top 5 European markets in 2021 (see Fig. 20).

Germany, France, Turkey

- the top 3 solar markets in Europe until 2021

FIGURE 20 CAPACITY ADDITIONS AND SHARES OF TOP 10 EUROPEAN SOLAR PV MARKETS IN 2016 AND 2021



15 kW, Lithuania.

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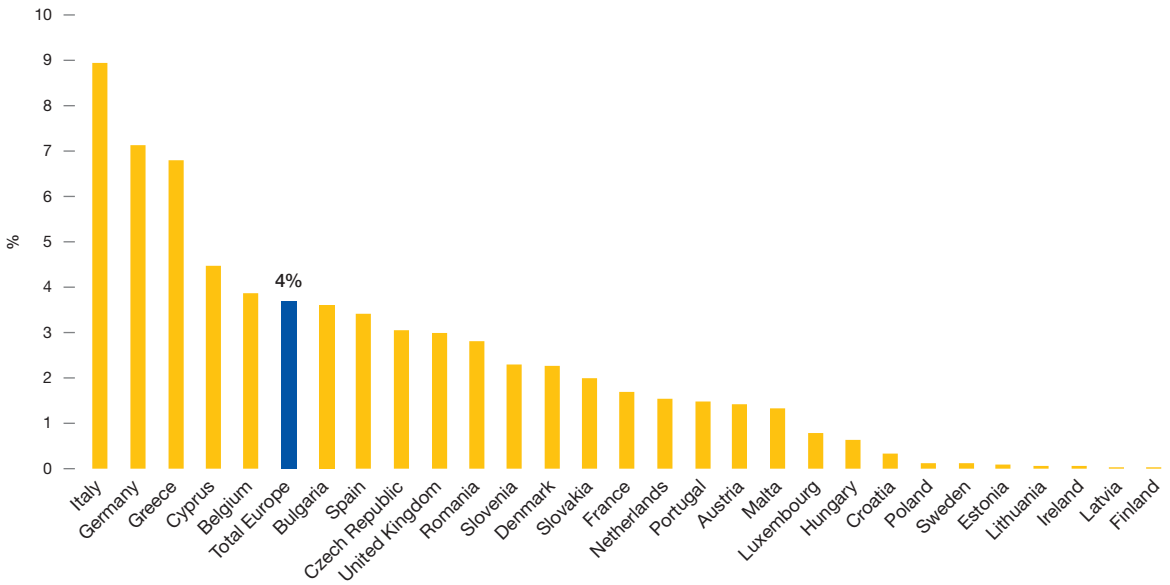
4

SOLAR IN THE EUROPEAN ELECTRICITY SYSTEM

CLEAN ENERGY FOR ALL EUROPEANS

In 2016, solar produced enough electricity to cover nearly 4% of the EU-28 electricity demand. This corresponds to the annual power consumption of the Netherlands alone or the demand for Ireland, Bulgaria and Portugal combined. An increasing share of this electricity is produced locally by citizens and businesses, increasingly using solar and storage. At the end of 2015, Germany had around 35,000 battery storage systems installed (> 200 MWh) in combination with residential solar systems; in 2016, around 25,000 systems were added, equal to 70% annual market growth.

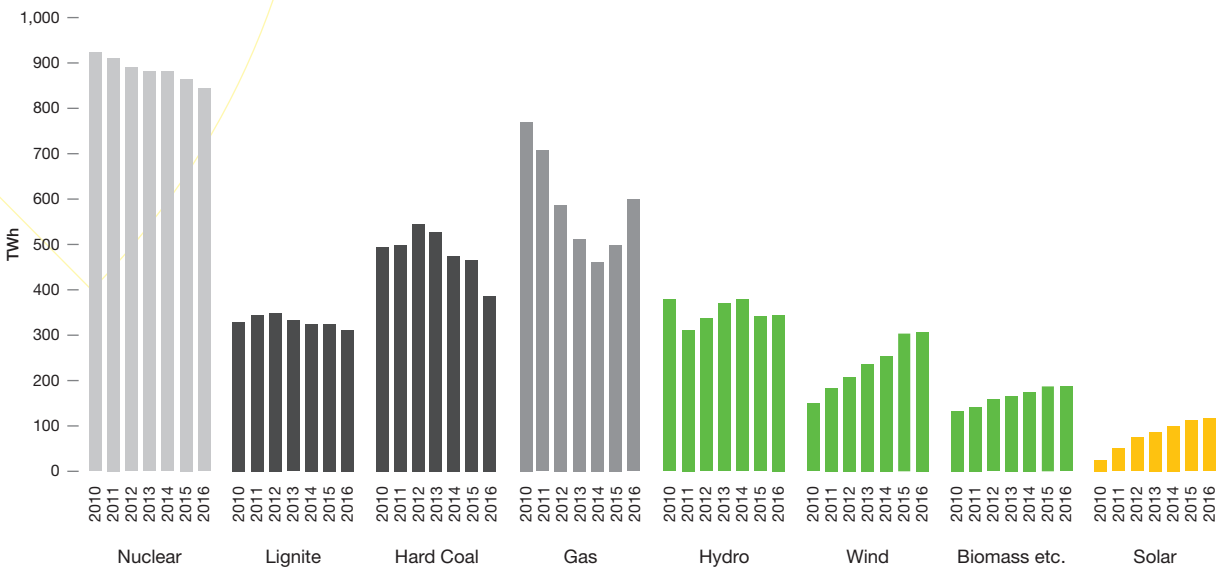
FIGURE 21 SHARE OF ELECTRICITY DEMAND COVERED BY SOLAR IN EU-28 IN 2016



Inflexible energy generation needs to be strongly reduced between now and 2030

Looking ahead, it is expected that the share of renewable electricity in the European Union's power mix will grow from 28.3% at the end of 2015[1] to at least 46% by 2030.[2] The contribution of low-cost solar will depend on the future policy frameworks in the different EU member states. In any case, an energy market with a large share of renewables calls for a much a more flexible energy system – both on the demand and on the supply side. While the power output of wind, and to a lesser extent solar, has constantly increased since 2010, it has not been mirrored by a corresponding reduction of inflexible generation in the European power mix. Hard coal and lignite still represented 22% of the total power generation in 2016, while nuclear produced 26% of the electricity in the same year (see Fig. 22).

FIGURE 22 DEVELOPMENT OF EU-28 POWER OUTPUT BY DIFFERENT TECNOLOGIES FROM 2010 TO 2016



Source: Agora Energiewende and Sandbag (2017)

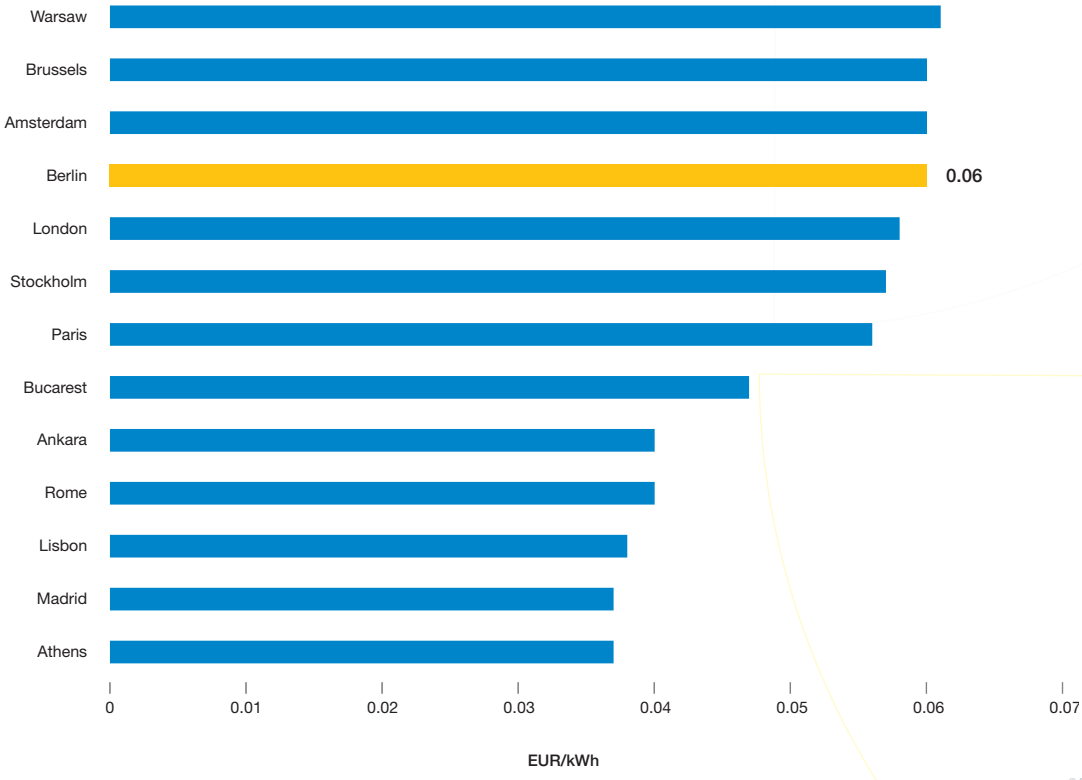
1 Renewable Energy Progress Report, European Commission, 2017.

2 Impact Assessment accompanying the draft revised Renewable Energy Directive. This would correspond to a renewable energy share in the final gross energy consumption of at least 27% in 2030.

Accelerate the energy transition via reliable and ambitious long-term signals

As the European solar market passed the symbolic mark of 100 GW of installed capacity in 2016, solar has become one of the lowest cost power generation technologies in Europe. In the German solar tender in February 2017, the lowest awarded bid was 6 euro cents/kWh. Assuming the same system prices and financing conditions but much better irradiation in southern countries, solar could generate power between 3 and 4 euro cents/kWh today in Europe (see Fig. 23).

FIGURE 23 THEORETICAL LCOE IN DIFFERENT EUROPEN COUNTRIES BASED ON GERMAN Q1/2017 TENDER RESULTS (EUR/kWh)

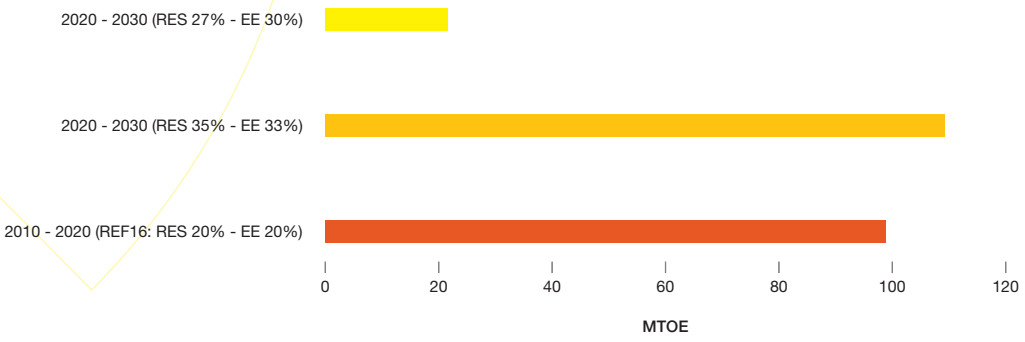


3-4
EUR cents / kWh
is the theoretical cost for solar power in Southern Europe today

If Europe would build on its solar experience and utilize low cost solar, we estimate that the solar capacity in Europe could easily be expanded to 375 GW by 2030 and cover up to 15% of Europe's power needs. Assuming our Medium Scenario takes place until 2021, it would require annual additions of 23 GW in each of the following years until 2030 to meet the 375 GW number. To provide the necessary signals to the investment and financing community long-term targets are needed.

The 27% RES target by 2030 as suggested by the European Commission falls short of ambition as it would translate into a fivefold market contraction for renewables between 2020 and 2030, as compared to the volumes expected to be deployed in the previous decade 2010-2020 (see Fig. 24).

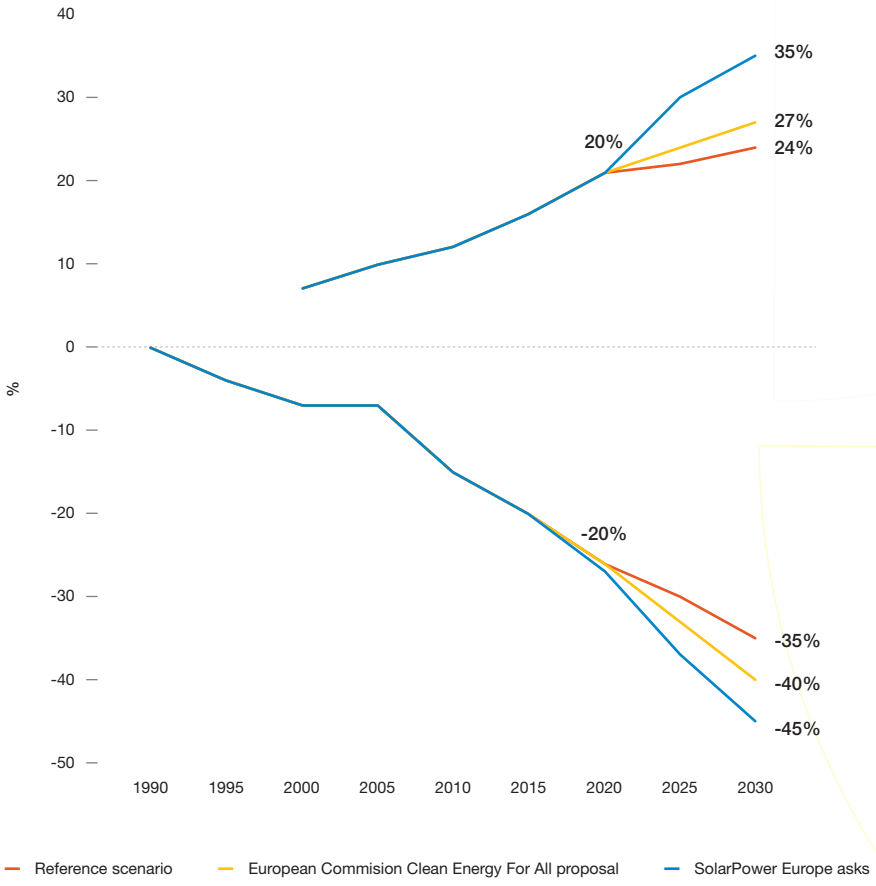
FIGURE 24 RES ADDITIONS TO GROSS FINAL ENERGY CONSUMPTION (MTOE) IN EU-28 UNDER DIFFERENT SCENARIOS



*Data based on European Commission projections performed in 2013

The analysis of the various scenarios shows that only a RES target of "at least 35%" would maintain the impetus for the renewable industry and be in line with the 2050 decarbonisation objectives of the EU (see Fig. 25).

FIGURE 25 PROJECTED RES PENETRATION (ABOVE) & GHG EMISSION REDUCTIONS (BELOW) IN EU-28 UNDER DIFFERENT SCENARIOS



Source: EC Reference Scenario 2016, SolarPower Europe

An EU enabling framework for solar power after 2020?

The European Commission presented a set of new legislative proposals in November 2016 known as the "Clean Energy for All Europeans" package, which sets out the post-2020 framework for the power sector in the European Union.

SolarPower Europe sees three strategic reforms that need to be pursued in parallel in order for solar to further penetrate the EU's energy mix:

1. A reliable governance framework to steer **investments in renewable energy** is needed, and Europe needs to organize the orderly retreat from inflexible polluting plants. Considering the long lead time of investments in the energy sector and the fact that literally all the investments compatible with the energy transition are capital intensive, attracting low-cost finance will be key. Besides the need for an ambitious EU binding target (see previous section), clear national binding targets will signal to the investment community the direction to take.

Such long-term visibility is crucial and needs to be made credible via the introduction of clear enforcement mechanisms in case the national 2020 targets are not met, or in case the trajectory towards the 2030 target is jeopardized by a lack of renewable deployment.

While it is expected that around half of the power in Europe will be generated by renewable energy sources by 2030, with solar playing a key role, it will be important to organise an orderly retreat from inflexible and polluting generation capacities over the next decade to create the space in the electricity market for solar plants. In parallel and during the same period, flexible assets need to be ramped up. The so-called "Governance" Regulation presented by the European Commission in 2016 provides a unique opportunity to precisely steer the development of flexibility and at the same time organise the corresponding exit of inflexible generation. This can be achieved by the introduction of "national flexibility roadmaps" which will provide visibility on the evolution of the energy system at the national level.

2. **Market rules which allow for a market-based energy** and which enable a flexible system to harness renewable energies. Compared to just 5 years ago, there is now a broad recognition that market rules and products need to be redesigned to reflect the specific characteristics of variable solar and wind generation. More liquid intraday and balancing markets are crucial, alongside appropriate rules for the development of storage, demand response and aggregation - three key enablers of further solar penetration.

To ensure the energy transition will be market-based, we need a system able to make the best of variable renewable energies when they are abundantly available. This requires a cross-sectoral approach where electricity will play an increasing role in mobility and heating and cooling, but also a specific regime to reduce the occurrence of periods during which solar electricity is curtailed to let more polluting, less flexible plants run. The current debate around capacity mechanisms is a perfect occasion to consider the potential lock-in effect of subsidising existing – or even worse – new generation capacities in high carbon emitting technologies or inflexible nuclear assets, which will not be in line with the EU's decarbonisation objectives and might further distort market price signals.

3. **A modernised framework for renewable energies** which supports the uptake of new business models and puts prosumers at the core of the energy transition. Large-scale solar generation is increasingly being deployed via tendering mechanisms across the globe and also in Europe. The extensive experience gathered over the last years in tenders should be used now to enshrine high-level principles on the design of such mechanisms in the upcoming Renewable Energy Directive. The right for EU Member States to run technology-specific tenders needs to be recognised.

In the small-scale solar segments, self-consumption business models emerge in an increasing number of European countries. Self-generation and consumption is a very concrete lever for households and businesses who want to control their energy costs. The proposal for a revised Renewable Energy Directive recognises for the first time at the EU level the right to self-generate, store and consume, either individually or collectively. All the models which will make solar accessible to a larger number of citizens (e.g. joint purchasing, cooperatives, leasing) need to be promoted as well, notably by building on the mechanisms for collective self-consumption very recently adopted in France, Germany and Austria.

Long-term signals for ensuring a vibrant home market, adjusted market rules for unlocking new business models and an enabling framework for renewables: these are three pre-requisites for ensuring a strong industrial basis for solar in Europe. Going forward, it will be important to ensure that any policy intervention will benefit the full solar European value chain, which is currently diversifying into new areas such as storage, buildings or digitalisation. **An industrial policy for solar in Europe** should be developed with the support of the European Commission, the European Parliament and the Member States to capture, in a dynamic perspective, the future growth and job potential.

The EU needs at least a 35% RES target by 2030 to meet its 2050 decarbonisation objectives

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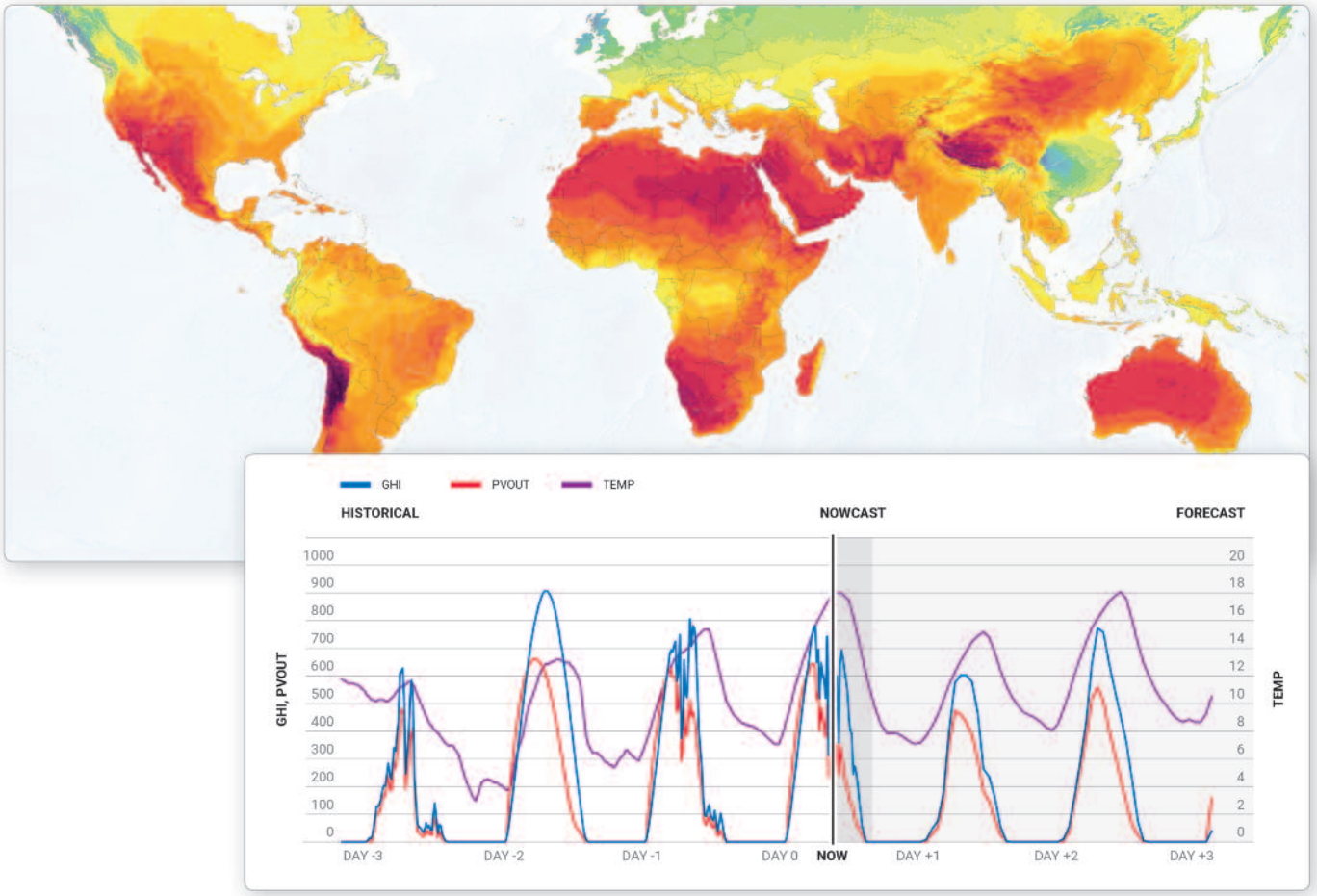

- Compare sites and technology options
- Reduce weather-related risks and get better financing
- Maximize efficiency of solar power plants
- Optimize power generation and storage

South Africa

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5 GLOBAL MARKET OUTLOOK FOR SOLAR POWER

The global market outlook for solar power is bright. Never before, was solar power as competitive as it is today. Utility-scale solar is cheaper than new fossil fuel plants and nuclear power generation plants in most regions of the world today. If retail electricity is not subsidised, it is usually more economic to produce solar on your rooftop and consume the clean power in-house. The costs for solar power continue to decrease, making this technology attractive for many users and investors around the world.

The attractive solar business case is reflected in the strong 50% annual global market growth rate in 2016. Our medium scenario anticipates continued growth over the next 5 years, though at lower levels. By 2021, the most probable market development will result in a total installed solar power generation capacity of 772 GW, after over 465 GW will have been added on top of the global 306.5 GW PV capacity at the end of 2016.

One caveat is that the world's solar development is still carried on the shoulders of very few countries. China alone was responsible for adding 45% of the total global solar capacity in 2016, and only 3 markets – China, the USA, and Japan - absorbed 75% of all installations. These countries are all relying mostly on traditional subsidy schemes: uncapped feed-in tariffs, net-metering and supportive investment tax credits. The extreme demand uptick in 2016, mostly in the solar utility-scale segment, was actually not on the original agenda of the Chinese government. This year's market size is likely to be similar. China takes its solar industry seriously – and the threats of climate change as well. However, if any of these large solar markets withdraw their subsidy policies abruptly, the solar industry will be in deep trouble.

As a solar pioneer Europe has been experiencing the winds of sudden subsidy changes for years, the latest example was the UK slashing its solar incentive programs, which was the main reason for the Continent's more than 20% market contraction in 2016. Now, the bottom seems to have been reached, and we believe a new growth phase is beginning. Brussels and several EU member states are progressing in their efforts to address the challenges of the energy transition from a large centralized system to a distributed one based on a flexible energy market with a high penetration of renewables. In addition, there are many new markets in Europe and many other regions that finally expand into solar to profit from its attractive price offering.

5 GLOBAL MARKET OUTLOOK FOR SOLAR POWER

/ CONTINUED

What Europe and other early solar markets are experiencing is something that most emerging solar countries won't be spared: At a relatively early point in the development of a renewables based system (solar in Germany produces on average only 7% of total annual electricity needs), daily demand peaks are mostly shaved, wholesale prices not only plummet but increasingly turn negative, and current transmission/distribution networks face challenges. If you want a relatively smoothly energy transition, it is key to think about intelligent new electricity market designs in a timely manner – and quickly put this into practice with a concerted effort.

A good example is the European Union, which reacted late to the challenges of the energy transition, because the EU is suffering from power generation over-capacities - as it has not been able to implement efficient measures for its member states to orderly retreat from dirty and inflexible coal. However, the recent 'Clean Energy For All' proposal of the European Commission is a step in the right direction, offering an appropriate toolset to master many barriers towards a renewables-based economy.

SolarPower Europe sees three key topics for the EU, that are similarly applicable for other countries that want to move to a clean and low-cost energy economy:

- The EU needs a **reliable governance framework** to navigate the economy towards renewable energy with ambitious and binding targets for renewables. Subsidies for dirty and inflexible power technologies must be eliminated and phase out plans set up.
- **Electricity market design** needs to enable profitable investments and operation of variable renewable energy sources, taking into account rules for storage, demand response and aggregation to provide new services. A cross sectoral-approach for the power, heating and transport sectors is required that will increasingly be based on renewables-generated electricity.
- **Modern renewable energy framework**s are needed to enable new business models for solar and storage that put active consumers in the heart of the energy transition, allowing self-consumption without the burden of prohibitive taxes or other barriers. While tenders are good mechanisms for efficient planning and deployment of utility-scale solar plants, their design is crucial to guarantee long-lasting, high-quality power generation.

If policy makers would take the characteristics for flexible solar and its renewable peers into consideration as they strive for clean energy security of their economies, the energy transition could proceed much faster and at much lower cost. Then, the global solar market outlook would be even brighter

Key for a smooth energy transition are:

good governance, right electricity market design, modern renewable energy frameworks

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