Global Market Outlook

For Solar Power / **2018 - 2022**

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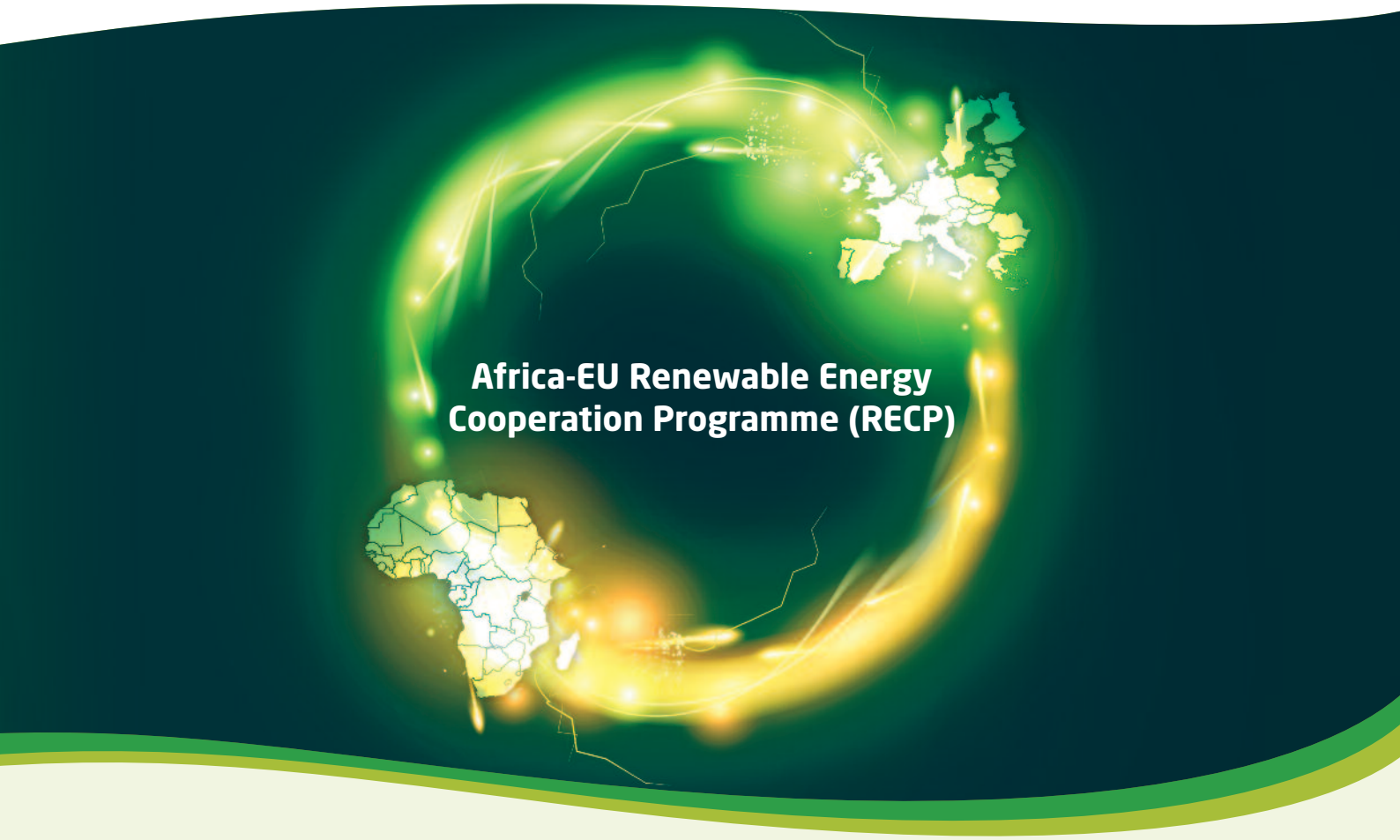

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FOREWORD

Welcome to SolarPower Europe's Global Market Outlook 2018 – 2022. We are very proud that our market intelligence team has been awarded the 'Winner for Best Provision of Industry Information and Intelligence' at the European Association Awards 2018. This award truly recognises the skill and value of this report for the solar sector, and the capabilities of our market intelligence team. Winning the award gives us the motivation to provide you with an even more comprehensive edition. We have again cooperated with the Global Solar Council (GSC) to address the development of solar in many new emerging markets. As the number, size and importance of solar markets is quickly increasing, we have invited partner solar associations, of the GW+ scale solar markets, to provide insights on their home countries.

The speed of current solar developments is truly amazing. It was only in 2016, that we celebrated Europe reaching the important milestone of 100 GW of grid connected solar power capacity. At that time, nobody had anticipated that only a year later, in 2017, the world would add nearly 100 GW of solar in just 12 months.

2017 was also a very special year, because solar deployed nearly twice as much capacity as wind. Solar also out performed traditional energy generation technologies, with almost 3 times as much solar compared to gas and coal, and around a factor of 9 times more than nuclear additions. Solar alone installed more generation capacity than all fossil fuels and nuclear together.

The reason for solar's popularity are manifold – it's unique in its flexible and distributed clean nature, which allows innumerable applications. It is now also increasingly the lowest-cost power generation technology. Researchers and industry have been doing a tremendous job of reducing solar costs.

Another record solar bid took place in 2017 in Saudi Arabia, bringing the tariff record down to 2.34 US cents/kWh. Even more impressive is that in that tender, 7 of the technical bids were below 2.9 US cents/kWh. In other words, a low 2 US cent tariff range is the new normal, when you want to win a solar tender under ideal conditions, with high irradiation and a stable policy framework.

This Saudi tender also included one bid that was as low as 1.79 US cents, which was disqualified in the end. This bid reportedly included bifacial technology, which enables power generation on both sides of a solar module and promises yield improvements of 10 to 30%. Bifacial solar is a simple and outstanding technology, though just one of many fascinating innovations in the solar field.

The solar industry has done its homework in bringing cost down and providing the facilities to deploy solar rapidly (in 2017, China alone installed 53 GW in one year). Now it's key that policy makers embrace this opportunity by quickly creating the right regulatory frameworks for solar and storage, and other relevant technologies, to help speedily accomplish the energy transition.

We are very glad that just before we went to print with this report, the European Union's three legislative institutions – the Commission, Parliament and Council – agreed on a 32% 2030 renewables target and empowered citizens, companies and communities with the right to produce, consume, store and sell power without being subject to punitive taxes or excessive red tape. That's the right direction – and what we've been lobbying for. A new solar dawn is breaking in Europe and SolarPower Europe are at the forefront of shaping the new framework for solar and delivering its potential for our members.

If you would like to get an idea of the manifold solar business opportunities, or the regulatory environment controlling solar deployment in Europe, please check the Trends chapter. Here we outline the key issues that SolarPower Europe is working on to enable solar to play the core role in the clean energy transition.

Enjoy reading our Global Market Outlook 2018 – 2022.

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Disclaimer: Please note that all historical figures provided in this brochure are valid at the time of publication and will be revised when new and proven figures are available. All forecast figures are based on SolarPower Europe knowledge at the time of publication. Please also note that forecast figures have been rounded.

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

EXECUTIVE SUMMARY

2017 was another historic year for the solar power sector. More solar PV capacities were installed globally than any other power generation technology. Solar alone saw more new capacity deployed than fossil fuels and nuclear combined. Solar added almost twice as much capacity as its renewable peer, wind power.

A total of 99.1 GW of grid-connected solar was installed in 2017. That's almost a 30% year-on-year growth over the 76.6 GW added in 2016.

In 2017, almost as much solar was installed in one year as the world had installed in total capacity in 2012 (100.9 GW). This led to a total global solar power capacity of over 400 GW in 2017, after solar exceeded the 300 GW mark in 2016 and the 200 GW level in 2015.

The boost in solar is to a large extent a result of its spectacular cost development. In February 2018, a 300 MW tender in Saudi Arabia was won at a new world record low solar power price of 2.34 US cents/kWh. Due to technical improvements, solar power cost and price will continue to quickly improve.

Global solar market demand in 2017 was driven by China. For the first time, China installed more than half of the world's solar capacity in one year – to be exact, 53.3%. But the low cost of solar has been attracting many countries to look seriously into this unique, flexible and distributed clean power technology. While in 2016, only seven countries installed over 1 GW, in 2017, the number has increased to nine (see p. 47, Chapter on GW-scale market overviews from national associations of these countries).

Europe has left its several-year long downward trend in 2017, adding 9.2 GW, a 30% increase compared to the 7 GW installed the year before. The European growth is primarily a result of Turkey's gigantic growth. When looking at the 28 members of the European Union, there was hardly any growth at all: the EU-28 added 5.91 GW in 2017, compared to 5.89 GW in 2016. This result still stems from the UK's 'solar exit' in 2016, which again halved new installations in 2017. Even though 21 of the 28 EU markets added more solar than the year before, the overall market performance was still sluggish.

Our Medium Scenario expects about 3.5% market growth to 102.6 GW new PV capacity additions in 2018, despite the recent subsidy cut announcement from China to restructure its solar incentive programmes.

Again, all Global Market Outlook 2018 scenarios show stronger growth than in the previous GMO edition. In 2017, we assumed a cumulative installed capacity of 471.2 GW for the Medium Scenario in 2018, this year we estimate 505.2 GW, which is about 7% higher. In the GMO 2018, we anticipate a range between 714.6 and 1,042.1 GW, with 871.3 GW forecasted for the most likely scenario in 2021 – that's about 13% higher.

Under optimal conditions, the world's solar generation plant capacity could reach up to 1,270.5 GW by the end of 2022, but we consider 1,026.2 GW more likely. Still, that means solar would reach the terawatt production capacity level in 2022.

Despite remarkable growth rates in recent years, there is still a **long way to go for solar and renewables** – RES total share reached 12.1% of total global power output in 2017.

The report and all figures can be downloaded at:

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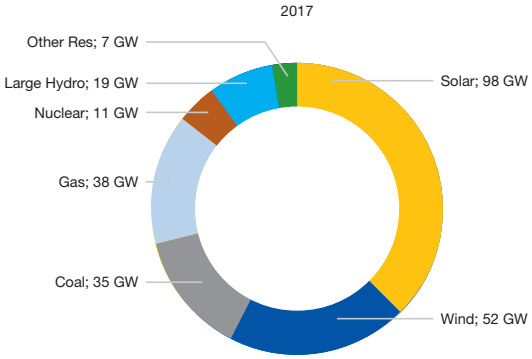
1 GLOBAL SOLAR MARKET

UPDATE 2000 - 2017

2017 was another historic year for the solar power sector. More solar PV capacities were installed globally than for any other power generation technology. In fact, solar alone saw more new capacity deployed than fossil fuels and nuclear combined. Solar even added nearly twice as much capacity as its renewables peer, wind power (see Fig. 1).

In fact, solar alone saw more new capacity deployed than fossil fuels and nuclear combined. Solar even added nearly twice as much capacity as its renewables peer, wind power (see Fig. 1). Despite remarkable growth rates in recent years, there is a long way to go for renewables – its total share reached 'only' 12.1% of total global power output in 2017 (see Fig. 2).

FIGURE 1 NET POWER GENERATING CAPACITY ADDED IN 2017 BY MAIN TECHNOLOGY



Source: Frankfurt School-UNEP Centre and BNEF (2018)

Solar is the fastest
growing power generation source

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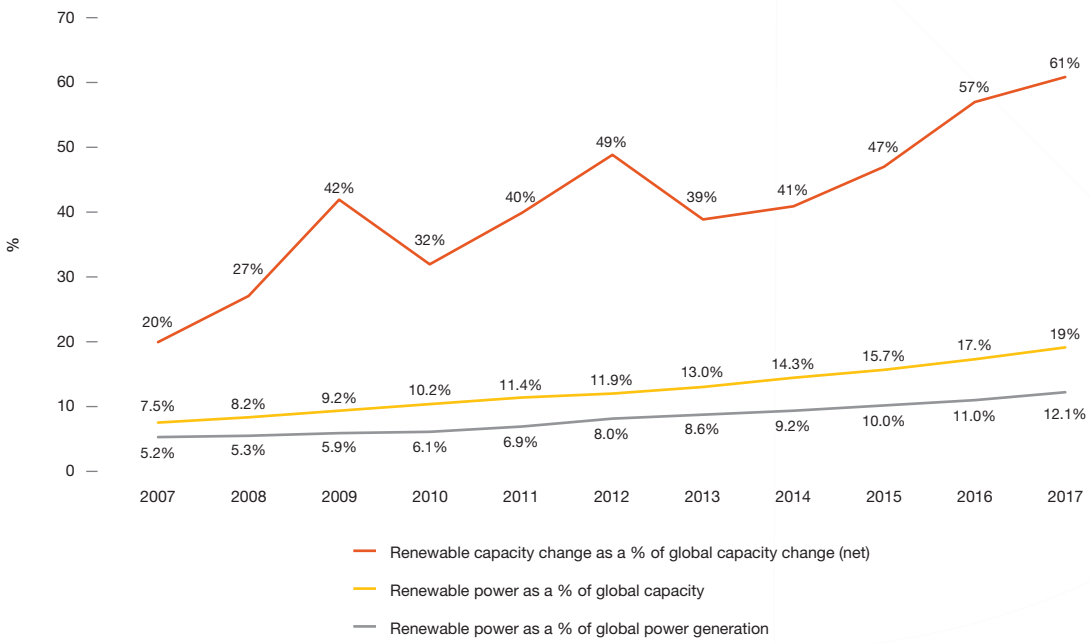
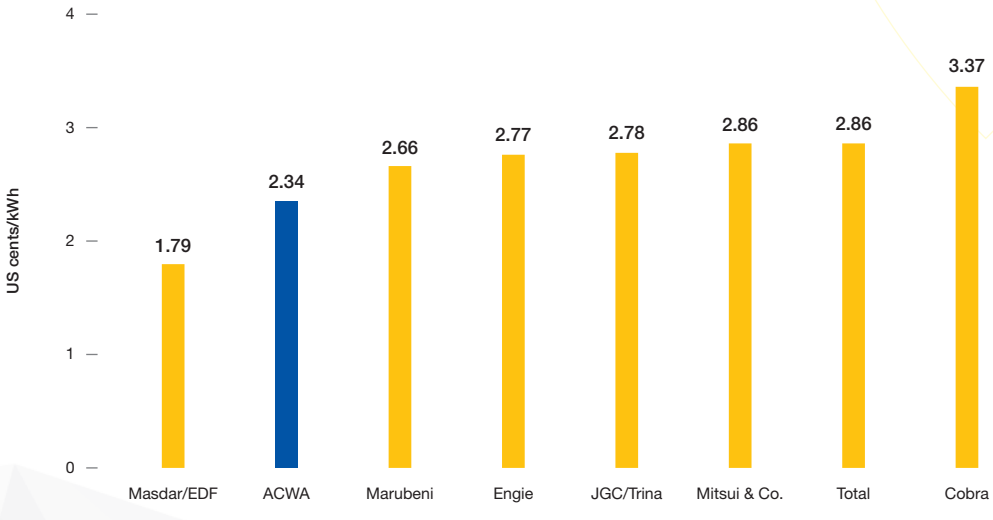
FIGURE 2 RENEWABLE POWER GENERATION AND CAPACITY AS A SHARE OF GLOBAL POWER, 2007-2017



Source: Frankfurt School-UNEP Centre and BNEF (2018)

The boost in solar is to a large extent a result of its spectacular cost development (see Fig. 3). The record low solar prices that were achieved in 2016 had caught many energy experts by surprise. That year, bids awarded in several tenders were below the 3 US cent per kWh level (2.95 US cents for a 800 MW project in Dubai, 2.91 US cents for a power supply contract in Chile, 2.42 US cents for the 'winter' supply part of the 1.18 GW plant PPA in Abu Dhabi). Discussions about sustainability of such low price levels became quickly obsolete as the price spiral has continued its way downwards. In February 2018, a 300 MW tender in Saudi Arabia was won by local company ACWA Power at a new world record low price of 2.34 US cents/kWh, while the first seven shortlisted bids were all below 2.90 US cents/kWh.

FIGURE 3 TOP 8 TECHNICAL BIDS FOR 300 MW SAKAKA PV PROJECT IN SAUDI ARABIA



This clearly indicates that solar in the lower 2 US cents range is the new benchmark that needs to be met to win tenders in the Middle East and other regions with 'ideal' conditions – that is stable policy frameworks, very high irradiation and a top financing environment.

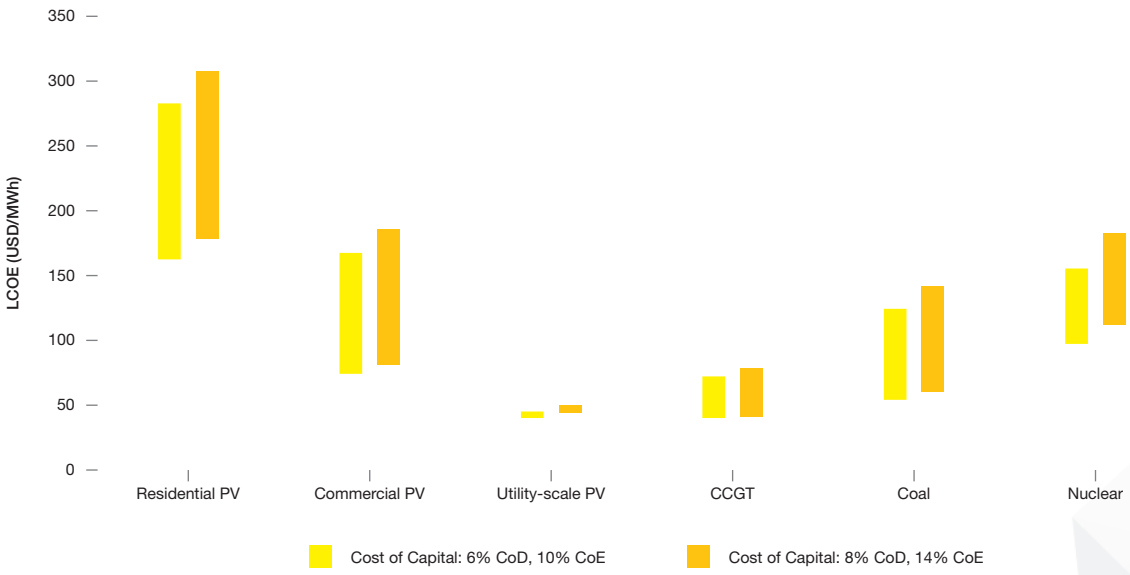
In most emerging markets where the business environment deviates from the ideal state, solar prices will remain considerably higher. However, development financing institutions can help significantly to cover risks on the financing side. The World Bank Group's Scaling Solar Programme has enabled a sub-5 US cents price for two projects in the 60 MW Senegal tender, which French utility ENGIE and its investment partner Meridiam won for 3.80 and 3.95 Euro cents/kWh in April 2018.

Due to technical improvements, solar power cost and price will quickly continue to decrease. A foretaste was already provided in the recent 300 MW Saudi tender, where the lowest bid of 1.79 US cents/kWh, which was later disqualified, was reportedly based on bifacial module technology. Such solar modules can generate power on both sides and come with the promise of 10-30% higher yields, depending on solar cell technology and location. The market share of bifacial technology is expected to grow from less than 5% in 2017 to nearly 40% by 2028, according to the International Roadmap of Photovoltaic (ITRPV).

Bifacial modules and other technology improvements on the crystalline side will further improve solar's cost advantage over other generation technologies. That's also true for the thin-film solar technology segment, where First Solar just introduced its high energy yield Gen6 module product.

In the Levelized Cost of Energy (LCOE) Analysis – Version 11.0, released in November 2017 by US investment bank Lazard, utility scale solar was again cheaper than nuclear and coal, and new combined cycle gas turbines (CCGT) (see Fig. 4). The lower the capital cost, the bigger is solar's cost advantage, which is the reason why the solar power purchase agreements (PPAs) signed in 'stable' countries like the United Arab Emirates are lower than in many other emerging solar markets in Africa or Asia.

FIGURE 4 SOLAR ELECTRICITY GENERATION COST IN COMPARISON WITH OTHER POWER SOURCES



Source: Lazard (2017)

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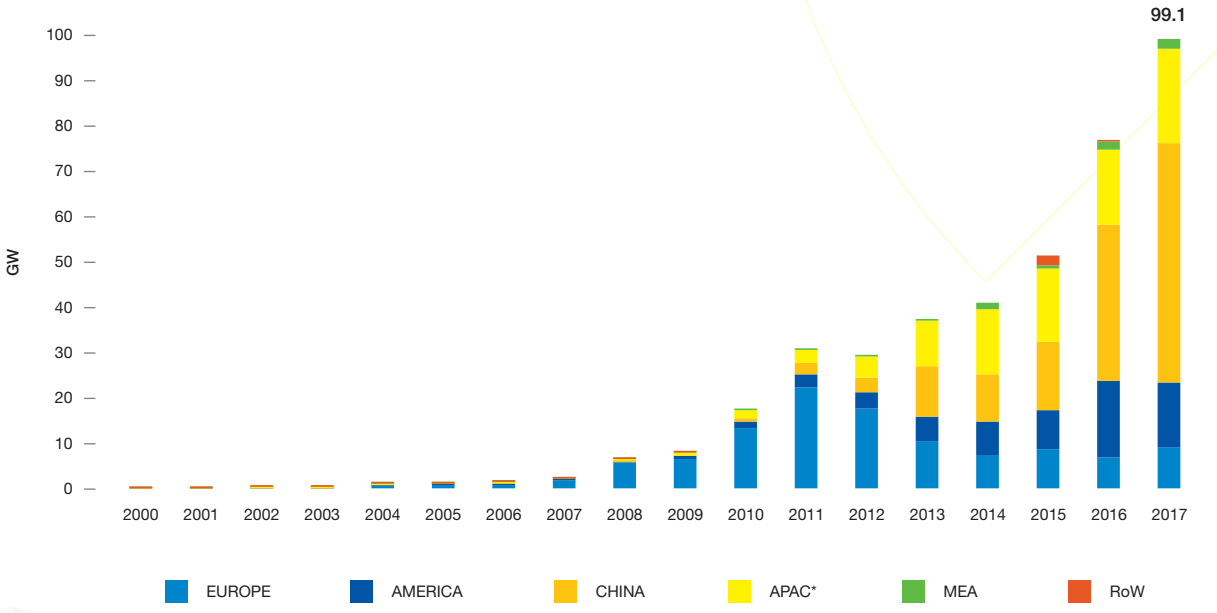
In 2017, a total of 99.1 GW of grid-connected solar was installed in 2017 (see Fig. 5). That's almost a 30% year-on-year growth over the 76.6 GW added in 2016. This is much lower than the 49% growth rate recorded in 2016, but much higher than the expectations of any solar analysts. After the exceptionally strong growth in 2016, most solar analysts had initially forecasted no growth at all. Our Medium Scenario, estimating a slight 5% growth rate to 80.5 GW was among the most optimistic forecasts for 2018. The actual 99.1 GW installation figure turned out be close to the upper end of our GMO 2017 High Scenario estimate of 103.6 GW.

Global solar market demand in 2017 was dominated more than ever by **China**. For the first time, China installed more than half of the world's solar capacity in one year – to be exact, 53.3%. This 52.8 GW of newly added capacity means a 53% increase over the 34.5 GW installed in 2016, when the Chinese market grew by 128% compared to the 15.1 GW deployed in 2015. While the huge growth in 2017 stunned almost everyone, in hindsight, the explanation is very simple: China's feed in tariff program was basically un-capped, the tariff levels for solar power plants were higher than in most other places in the world, and companies wanted to beat upcoming scheduled subsidy cuts. That's why Chinese module producers again prioritized the domestic market over demand from abroad.

Like the year before, the **United States** was the world's second largest PV market in 2017. It installed 10.6 GW, which falls 42% short of the record level of 15.1 GW reached in 2016. While utility-scale solar remained the largest segment, nearly the entire downturn stems from that part. However, this decline was largely expected, as many projects were finalized in 2016 to beat an expected expiration of the 30% federal Investment Tax Credit (ITC), which did not materialize in the end. On top, several projects were shelved due to uncertainty surrounding the Section 201 import tariffs.

2017 has been a record year for PV in **India**. Cumulative installed capacity exceeded 19 GW, with net yearly additions of 9.6 GW – a staggering 127% market growth from last year's 4.3 GW. Growth could have been even stronger, if it were not for price hikes of modules from China over the course of the year, a lagging rooftop segment and uncertainty regarding import taxes. However, in 2017 solar was the largest source of new capacity additions, constituting 45% of new added capacity. India took Japan's place as the third largest market worldwide and is on trajectory to become #2 in 2018.

FIGURE 5 EVOLUTION OF GLOBAL ANNUAL SOLAR PV INSTALLED CAPACITY 2000-2017



*APAC excl. China

The **Japanese** market continued its downturn, adding 7.2 GW in 2017, which is 9% less than the 7.9 GW installed the year before. The solar market is in the middle of a transition from its lucrative FIT scheme to auctions and self-consumption. But with a huge FIT pipeline waiting for installation, the 490 MW AC capacity companies bid for was lower than the 500 MW on offer. In the end, only 141 MW AC was awarded. The Japanese PV Energy Association (JPEA) expect the country's solar downturn to continue until 2024, before market design and infrastructure will be ready for further growth.

Unlike Japan, **Europe** has left its several-year long downward trend in 2017, adding 9.2 GW, a 30% increase compared to the 7 GW installed the year before. The European growth is primarily a result of Turkey's gigantic growth, adding 2.6 GW, from less than 1 GW in 2016. When looking at the 28 members of the European Union, there was hardly any growth at all: the EU-28 added only 5.91 GW in 2017, compared to 5.89 GW in 2016. This result still stems from the UK's 'solar exit' in 2016, which again halved new installations in 2017. Even though 21 of the 28 EU markets showed growth, this wasn't enough to compensate for the British losses.

Beyond Asia's solar leaders China, Japan and India, the region counts several fast growing solar markets, but only one other Asian country, South Korea, exceeded the gigawatt-level in 2017.

In Latin America, in particular Brazil stood out in 2017, which for the first time installed over 1 GW of solar, mostly from systems awarded in auctions. The region's No. 2 is Chile, where the market slightly decreased by 4% to 788 MW. While Mexico grew by 39% to 539 GW, the bulk of systems awarded in recent auctions are being grid-connected as of this year. Also Latin America is seeing emerging solar markets, like Colombia, which installed its first PV power plant in 2017.

After **Australia** dropped by 15% to 867 MW in 2016, it has shown a strong come back in 2017, when it exceeded the 1 GW level of new PV additions. The 1.3 GW installed capacity, mostly stems from residential self-consumption systems. With solar LCOE's now being increasingly competitive, commercial and ground-mounted systems are seeing huge interest. While commercial installations covered around 30% of the demand in 2017, the ground-mounting segment is starting as well – around 80 MW was installed – and is excepted to strongly grow in the next few years.

The **Middle East** region not only made headlines with record-low tariff solar tariffs, there were also new countries joining the local 'solar tenders club.' Next to Saudi Arabia, also Oman started to tender its first solar capacity, while the region's PV pioneers Abu Dhabi and Dubai have continued on their solar path. The biggest solar country in the region in 2017 was the United Arab Emirates, adding 262 MW.

The biggest surprise in 2017 in **Africa** took place in the continent's north – in Egypt. Although the actual installation volume was still below 100 MW, after changes for its FIT progamme and delays, the first PV power plant was installed. Egypt managed to win back confidence with the financial sector, with many banks now having given green light to support multiple projects for the 1.8 GW Benban Solar Park. As in the past, the continent's largest market was South Africa. But at 172 MW, it was much smaller than in the prior years, due to the solar pipeline logjam caused by national utility Eskom, which refused to sign PPAs with the winners of the latest RE programme bidding rounds. That has been solved in the meantime – and even a new bidding round was announced. However, the low cost of solar is attracting many African countries to look into on-grid solar as well. As financing is often an issue, the World Bank Group has established the Scaling Solar Program, which started in Zambia in 2017 and is quickly progressing and expanding in African countries. In 2017, in Zambia a second round was launched, Ethiopia announced two tenders for 125 MW each, Madagascar issued a tender for a solar plus storage system last year, and Senegal tendered 100 MW capacity.

In brief, in 2017, solar was even more dominated by China than ever. But the low cost of solar has been attracting many countries to look seriously into this unique flexible and distributed clean power technology. While in 2016, only seven countries installed over 1 GW, in 2017, the number has increased to nine. **Details on the leading solar markets can be found in Chapter 2, which provides overviews on those nine countries that installed more than 1 GW in 2017 (see p. 47).**

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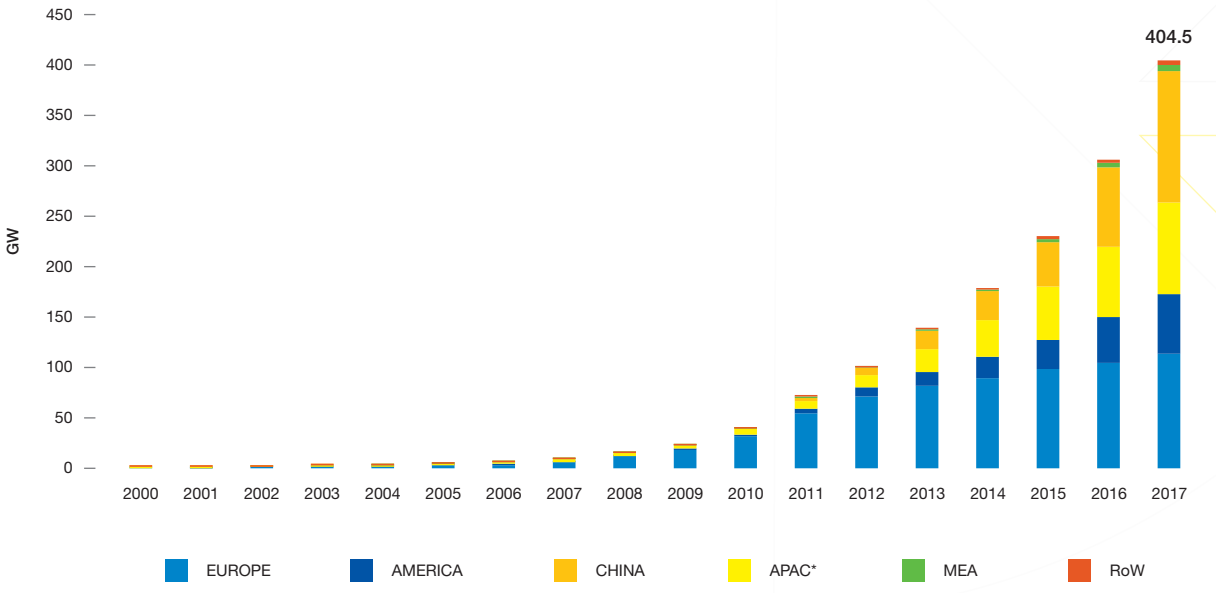
FIGURE 6 EVOLUTION OF GLOBAL TOTAL SOLAR PV INSTALLED CAPACITY 2000-2017



*APAC excl. China

In 2017, almost as much solar was installed in one year (99.1 GW) as the world had installed in total in 2012 (100.9 GW). This led to a total global solar power capacity of over 400 GW in 2017, after solar exceeded the 300 GW mark in 2016 and the 200 GW level in 2015.

The cumulative installed solar PV power capacity grew by 32% to 404.5 GW by the end of 2017, up from 306.4 GW in 2016 (see Fig. 6). In only 10 years, the world's total PV capacity increased by over 4,300% – from 9.2 GW in 2007. From the beginning of the century, when the grid-connected solar era began with the start of Germany's feed-in tariff scheme, total solar power has grown by nearly 255 times.

The Asia-Pacific region expanded its solar market leadership in 2017. After adding 73.7 GW in 2017, it had 221,3 GW of total installed capacity, equal to a 55% global market share (see Fig. 7). After Asia-Pacific had become the largest solar-powered region in the world in 2016, it now even owns more than half of the global power generation capacity. The European solar pioneers are still ranked second, but its share slipped to 28% based on a cumulative PV capacity of 114 GW. The American Continent remained on the third position – with a total installed capacity of 59.2 GW and a 15% stake. The Middle East and Africa lost again market share. After adding 2.1 GW in 2017, the total solar capacity of 6.9 GW equals a world market share of 1.7%.

China alone operates now nearly 1/3 of the world's solar power generation capacities (see Fig. 8). This 32.3% is a strong uptick from 2016, when China's share was 25% and it had taken over the No. 1 position as the country hosting the world's largest solar power generation fleet for the first time. Like in the previous year, China was trailed by the US and Japan. While the US overtook Japan, both lost market shares in 2017. The US' total installed capacity reached 51.5 GW, equal to a market share of 12.7%;

30% solar global market growth
Now at 100 GW a year

FIGURE 7 EVOLUTION OF TOTAL INSTALLED GLOBAL SOLAR PV CAPACITY 2012-2017

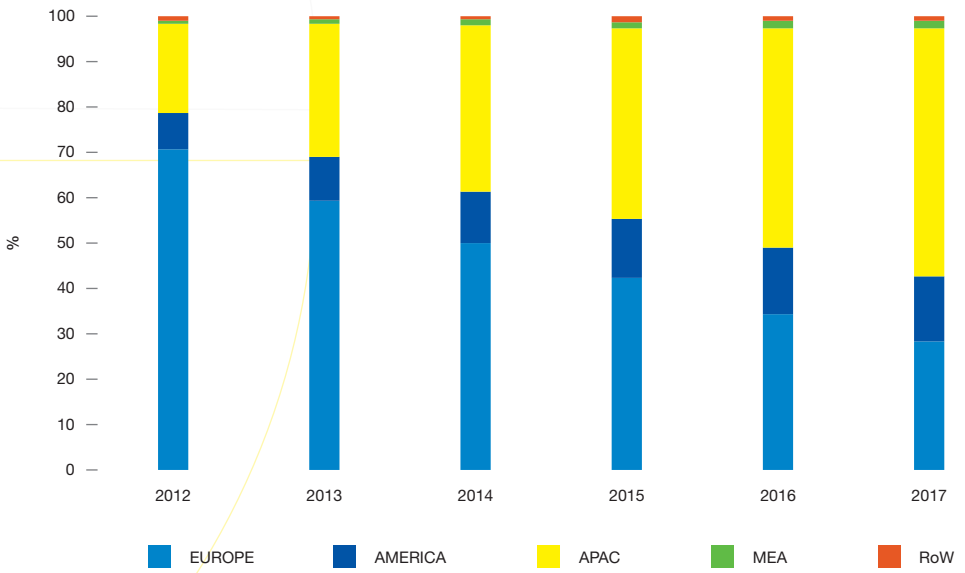
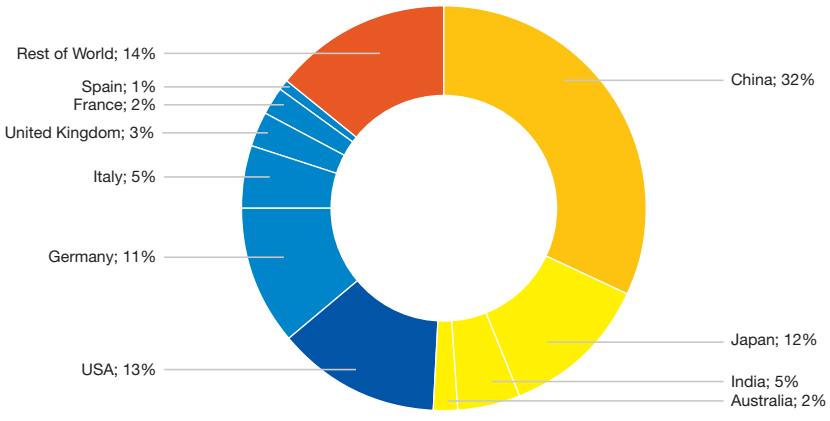


FIGURE 8 GLOBAL TOP 10 SOLAR PV MARKETS TOTAL INSTALLED SHARES BY END OF 2017



Japan's 49.3 GW resulted in a 12.2% global share, compared to 14% and 13.8% in 2016, respectively. In 2017, again no European country was among the top 3 solar power generating countries. Though Germany could defend its fourth rank as the only other country with a two-digit global share, its comparatively low 2017 installations of 1.8 GW mean a drop in market share down to 10.6%, from 13.4% in 2016. The new addition in the top 5 and first time above the 10 GW solar generation capacity level is India, which doubled its total PV capacity in 2017 to 19 GW and a 4.7% market share.

The further two countries with solar capacities exceeding 10 GW at the end of 2017 were again Italy at 19.4 GW and the UK at 12.7 GW. All other countries in the top 10 have installed volumes that are somewhat distant from the 10 GW mark – France (8 GW), Australia (7.3 GW) and Spain (5.6 GW) – and are unlikely to reach that level in 2018, according to our estimates.

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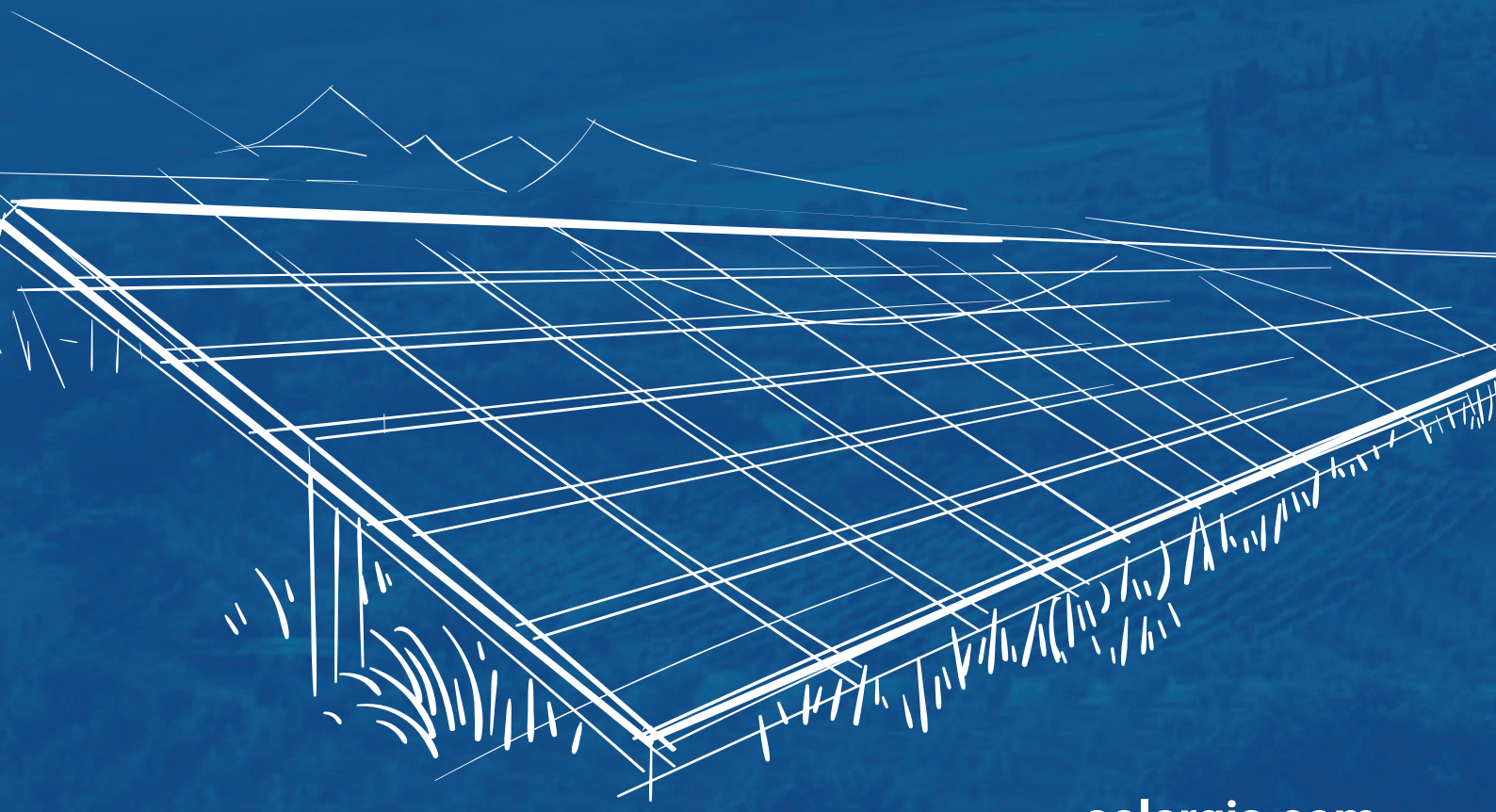

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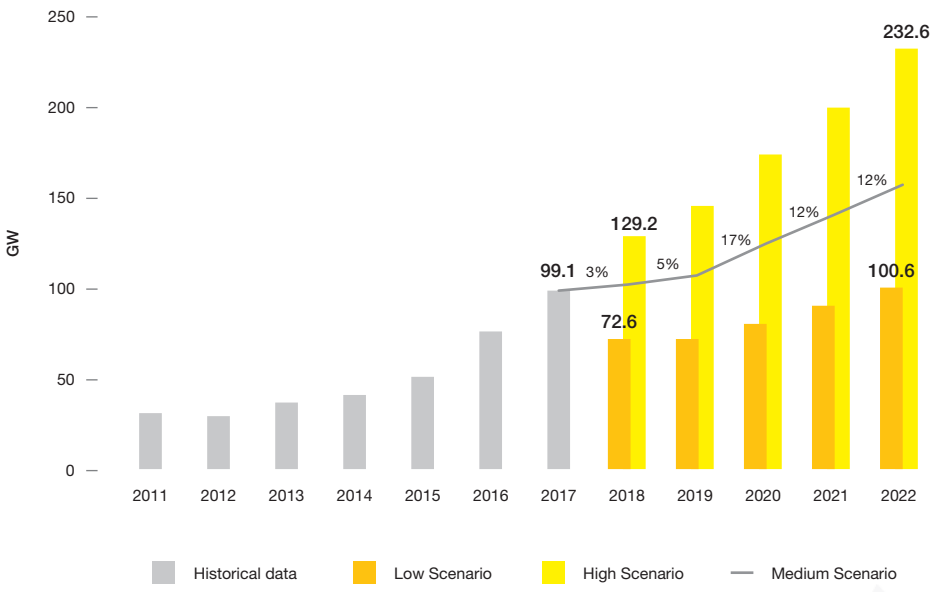
1 GLOBAL SOLAR MARKET
PROSPECTS 2018 - 2022

In mid-May, all solar analysts were expecting further market growth in 2018, even in their conservative scenarios. This changed abruptly after China's National Energy Administration (NEA) pulled the brake in early June, announcing strong subsidy cuts to slow down domestic solar demand that had been much larger than originally planned in 2016 and 2017. While several solar experts were quick to revise their forecasts from strong growth in 2018 to no growth at all, we still see a high probability for further global solar market expansion in 2018.

Our **Medium Scenario** expects about 102.6 GW new PV capacity additions in 2018 (see Fig 9). That would represent a 3.5% market growth compared to the 99.1 GW installed in 2017. The Low Scenario, which models major markets to withdraw their solar support, assumes a drop in demand as low as 72.6 GW, that's basically the 2016 level. This outcome is very improbable, when taking into account preliminary installation numbers for the first quarter in leading markets. The **High Scenario**, forecasting up to 129.2 GW of newly installed PV in 2018, this time appears extremely optimistic, but we already said that in the last GMO, and then it came true. It is too early to say how the market will develop in the second half – in China and the rest of the world. But price elasticity could play a big role this year to take up some of the capacities originally destined for China. While several projects were delayed in 2017 due to scarcity of low cost modules resulting from the China rush, the anticipated price drops following NEA's solar program 'restructuring' announcement could trigger installation of much bigger project volumes than planned to be built this year.

In any case, China's market size will define global solar deployment in 2018. However, after the world's largest solar market registered 22% YoY growth in Q1/2018, installing 9.65 GW compared to 7.1 GW in Q1/2017 and the lowest bid in the latest auction-based Top Runner Programme round reaching 0.31 RMB compared to much higher FIT levels ranging from 0.55 to 0.75 RMB, the Chinese administration's reacted quickly. On June 1, it announced a restructuring of its solar incentive program, which includes an immediate halt of further utility-scale power plant installations for the reminder of the year, a status change for full FIT distributed power generation systems, which are now reimbursed at the same levels as utility-scale power plants, and an FIT cut. However, our Medium Scenario assumes that the market will be still 39 GW, which would be a 26% decrease over 2017, but a 13% YoY growth compared to 2016. The simple rationale: China is a very large country with many administrational layers – and it will take a while until the message from Beijing will be heard everywhere, let aside that regions have their own agenda when it comes to supporting local players and jobs. Moreover, the Poverty Alleviation Programme

FIGURE 9 WORLD ANNUAL SOLAR PV MARKET SCENARIOS 2018 - 2022



continues untouched and local support for rooftop solar has triggered strong demand, which could result in several GW this year.

In the US, our medium scenario expects the market to decrease slightly to 10.1 GW in 2018, taking into account the impact of tariffs on system pricing from import tariffs and the impacts of the corporate tax reform on customers, developers and financing institutions. However, according to SEIA almost two thirds of the 2018 utility PV pipeline consist of relatively less-price-sensitive renewable portfolio standard projects, while projects currently in construction have already secured tariff-free modules, so that import tariff impacts will be somewhat mitigated that year.

India officially targets 11 GW, including 10 GW ground-mount and 1 GW rooftop systems, for its fiscal year 2018-19, which will end in March 2019. After the steep year-over-year 2017 growth, India is expected to take a breath in 2018. SolarPower Europe's medium scenario expects slight growth to 10.5 GW of newly installed capacity in calendar year 2018. The current project pipeline is lower, after fewer tenders were issued in the past year. Moreover, the first months of 2018, were governed by uncertainty stemming from a discussion on a 70% safeguard tax on imported solar cells, although this seems off the table for now. On the other hand, India's Ministry of New and Renewable Energy (MNRE) laid out its roadmap for future tenders to boost demand, announcing end of last year, to tender 20 GW in FY 2017/18 and 30 GW each in FY 2018/19 and FY 2090/20, which explains the very high tender activity over the first months of 2018.

In both Europe and the EU, we anticipate strong growth for 2018. While demand in the EU will be driven by the national binding 2020 renewables targets and low prices, the non-EU part of Europe will be propelled by Turkey's solar program and solar's attractive costs (for details, see Chapter 3).

However, in our Medium Scenario, we see the number of solar GW-level markets to increase by nearly 50% to 14 in 2018 and with new solar markets emerging, further global growth is possible this year.

As of **2020**, the global solar market is expected to show again 2-digit growth rates. By then China will have fully restructured its solar market, which will enable the administration to have much better control of solar deployment through low-cost auctions and capped incentive schemes. There will be also a notable volume of bilateral PPA-based systems. In our Medium Scenario, we expect China to significantly increase its solar demand again to around 40 GW in 2020, 45 GW in 2021 and 55 GW in 2022. These numbers are much higher than the targets formulated in the early 2017 published Photovoltaic Industry Roadmap of the China PV Industry Association (CPIA), which was looking for 10-20 GW additions between 2018 and 2020 and 20-30 GW in 2022. But the new tools to command incentive schemes on the one hand, and solar combined with storage being the cheapest flexible solution to reduce CO_2 emissions and fight air pollution on the other hand, will boost solar in China again.

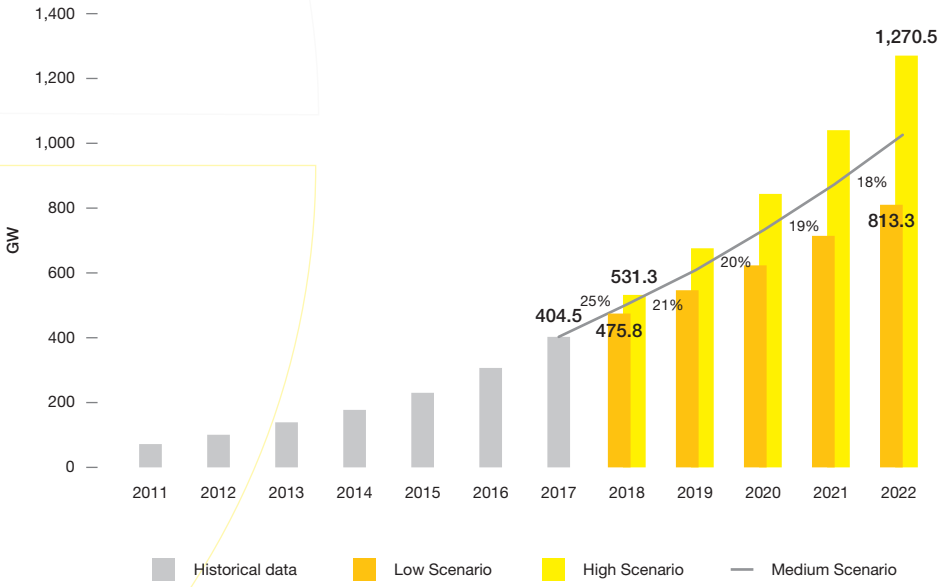
Despite China's anticipated next strong growth cycle for the 2020-2022 period, the rest of the world will continue to play a stronger role in the solar sector. While the US is expected to win on speed post 2020, seeing double digit-growth rates, due in 2023, Europe might see an opposite development. After a strong growth phase triggered by tenders in a number of countries to meet the EU national binding targets in 2020, unambitious final agreements for the 'Clean Energy For All Europeans' Legislative Package might lead to another standstill for solar in the EU post 2020, which will impact global growth rates during that period of time (see chapter 3). However, our Medium Scenario assumes global demand to increase 17% to 125.2 GW in 2020, 12% to 140.4 GW in 2021 and 12% to 157.8 GW in 2022. If the leading and most promising emerging market are able to change energy market design to the needs of flexible renewables, and electrification of transport and heat sector speeds up, the High Scenario assumptions could come true, resulting in an annual market size of up to 232.6 GW in 2022.

Over

1 TW

solar power by 2022

FIGURE 10 WORLD TOTAL SOLAR PV MARKET SCENARIOS 2018 - 2022



Again, all Global Market Outlook 2018 scenarios show stronger growth than in the previous GMO edition. In 2017, we assumed a cumulative installed capacity of 471.2 GW for the Medium Scenario in 2018, this year we estimate 505.2 GW, which is about 7% higher (see Fig. 10). The final year of the 5-year forecast in the GMO 2017, ranged between 623.2 and 935.5 GW with the most likely Medium Scenario resulting in 772.1 GW of cumulative operating solar power in 2021. In the GMO 2018, we anticipate a range between 714.6 and 1,042.1 GW, with 871.3 GW forecasted for the most likely scenario in 2021 – that's about 13% higher.

Under optimal conditions, the world's solar generation plant capacity could reach up to 1,270.5 GW by the end of 2022, but we consider 1,026.2 GW more likely. Still, that means solar would reach the terawatt production capacity level in 2022.

Reaching the 400 MW milestone already in 2017, we now expect in our Medium Scenarios the total global installed PV capacity to exceed 500 GW in 2018, 600 GW in 2019, 700 GW in 2020, 800 GW in 2021 and 1 TW in 2022.

Although solar is increasingly becoming the lowest cost power generation source in many regions, it needs a level playing field with the right market design to unleash its cost and technical advantages over inflexible power plants. Today, many barriers are still in the way for solar to tap its potential: Functioning emissions trading schemes for fossil fuels are usually missing, like in the EU; investments and operation of inflexible centralized power generation technology are often still being strongly over-subsidized, like the UK's Hinkley C nuclear plant; while self-consumed solar power is being inappropriately high taxed, like in Germany.

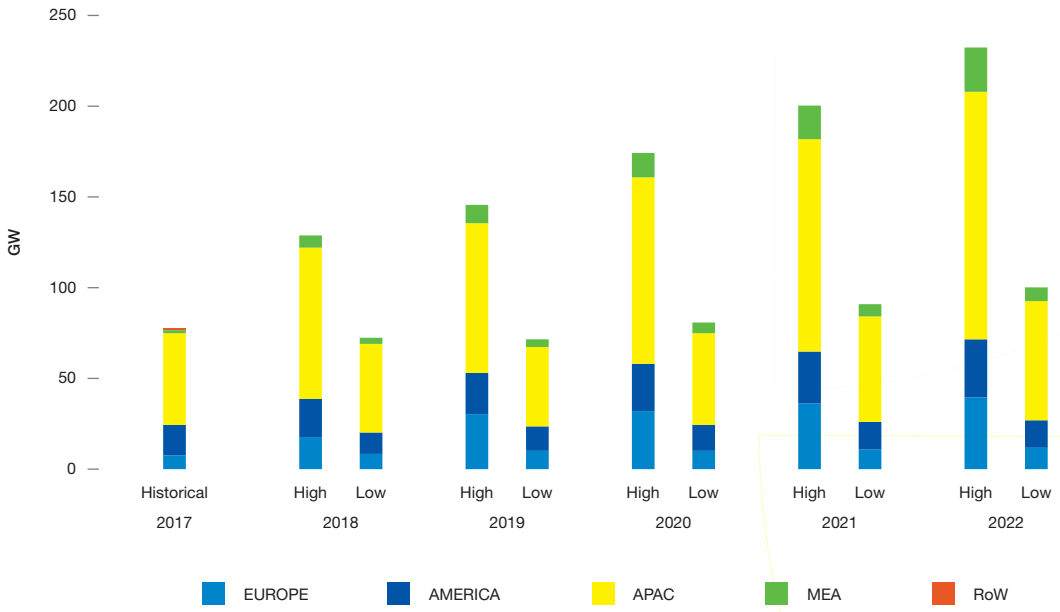
The solar sector's dependency on few markets is another issue that needs to be addressed: In 2017, only one country, China, was responsible for over half of global demand; the top 3 solar markets (China, US, India) even covered 74%. As we mentioned last year, it "needs only one major market making the wrong policy decisions to disrupt the entire solar sector." There is a reason why the solar sector is reacting very nervous on China's announcement to restructure its solar incentive program. When taking all these risks into consideration, our Low Scenario assumes a very unlikely development that results in an annual global market of only 100.6 GW in 2022, which would mean stagnation compared to 2017 additions.

1 GLOBAL SOLAR MARKET

PROSPECTS 2018 - 2022 / CONTINUED

Whatever the Chinese solar market development will look like in the next five years and whether global growth follows our Low Scenario or the High Scenario, Asia will continue to dominate the solar sector in the near future (see Fig. 11). We expect even higher shares for the future than in our previous GMO. In 2017, the Asia-Pacific region is assumed to absorb around two thirds of total installations and remain in the upper 50% to mid 60% range until 2022.

FIGURE 11 EVOLUTION OF GLOBAL ANNUAL SOLAR PV MARKET SHARES FOR HIGH AND LOW SCENARIOS UNTIL 2022



%	2017	2018	2018	2019	2019	2020	2020	2021	2021	2022	2022
	Historical	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
Europe	9.18	13.69	11.22	20.80	14.42	18.31	12.27	18.17	11.81	16.79	11.72
America	22.02	15.99	15.90	15.38	18.17	14.75	17.34	14.24	16.32	13.86	14.92
APAC	66.47	64.74	68.03	56.62	61.22	59.38	62.96	58.31	64.04	58.94	65.22
MEA	2.20	5.59	4.85	7.21	6.19	7.56	7.43	9.28	7.83	10.40	8.14
RoW	0.13	0	0	0	0	0	0	0	0	0	0

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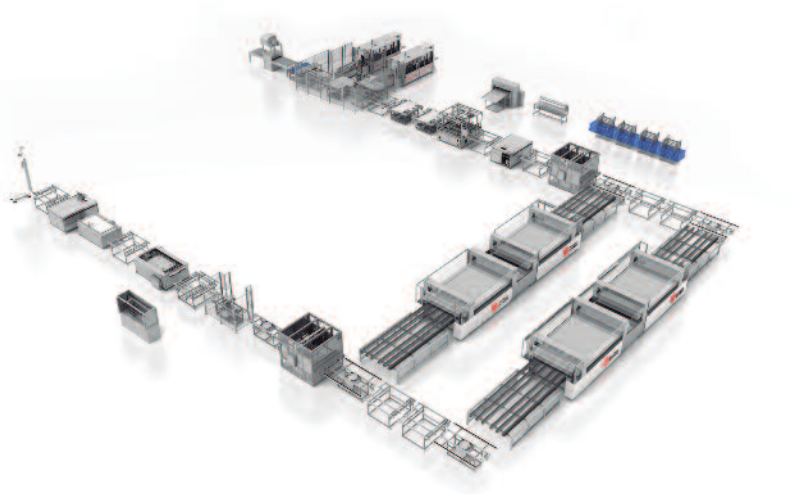
Turnkey solutions from 15MW to 1GW

- Training and know-how transfer
- Customized solutions
- Module development and certification



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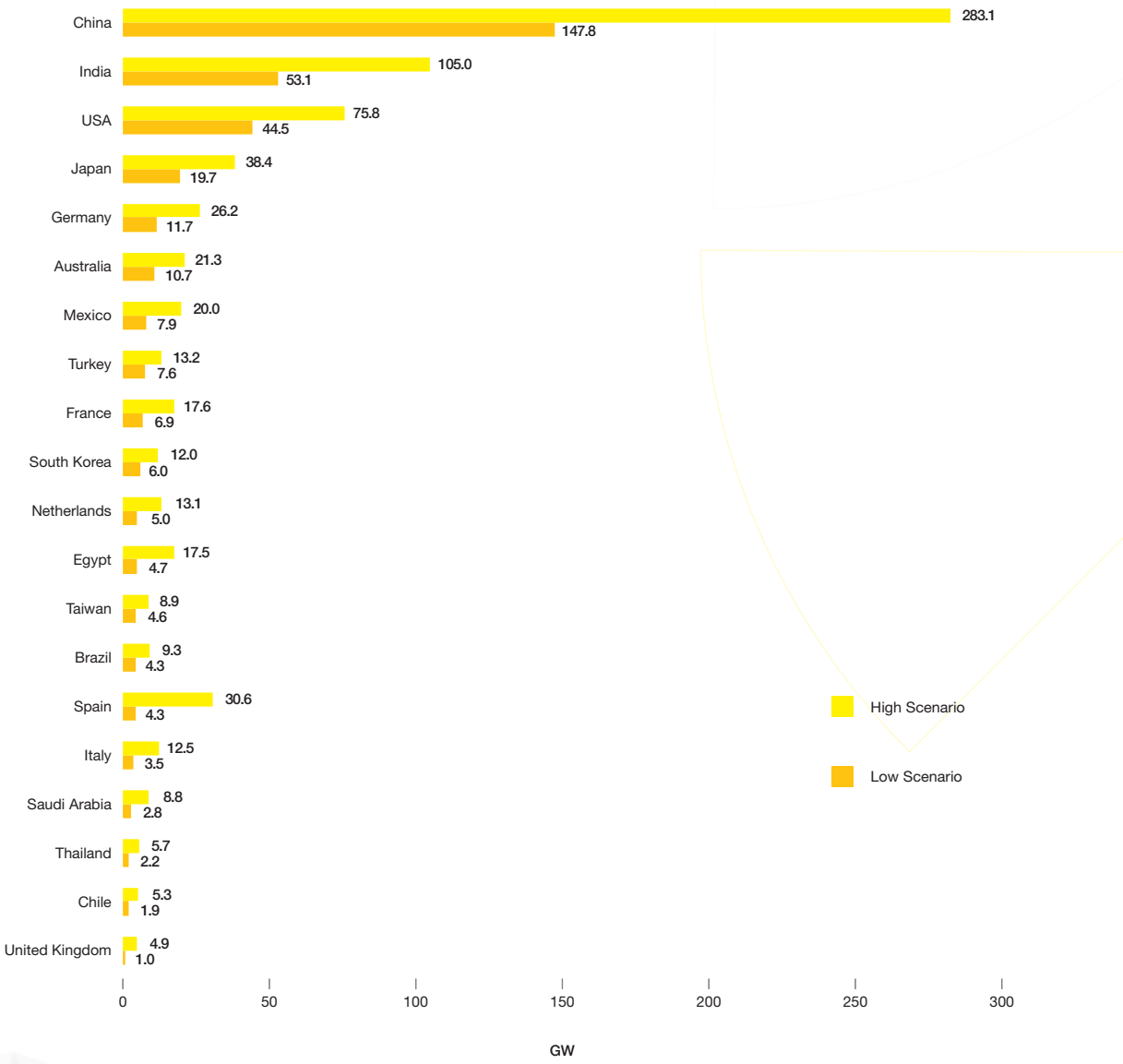
1 GLOBAL SOLAR MARKET

PROSPECTS 2018 - 2022 / CONTINUED

For the Top 20 global solar markets, the outlook is more optimistic, the installation volumes are much larger over the next five years (see Fig. 12). However, the pattern remains similar: few countries will install the bulk of all solar system capacity, though diversity is growing. This time, we expect for the High Scenarios two countries to install over 100 GW – China and India (last year it was only China) – and eight countries to add at least 20 GW - China, India, USA, Japan, Spain, Germany, Australia, Mexico (last year it was only four).

The Top 5 markets are expected to add 532.9 GW until 2022 in the High Scenario and 267.8 GW in the Low Scenario. In comparison, the Top 20 are supposed to install 729.2 GW until 2022 in the High Scenario and 350.6 GW in the Low Scenario. That's 224.6 GW and 87.3 GW more than the 5-year assumption in the GMO 2017 edition, respectively.

FIGURE 12 TOP 20 MARKETS' SOLAR PV ADDITIONS FOR HIGH AND LOW SCENARIOS 2018 - 2022



The prospects for the largest global PV markets will be overall very good over the coming years. Most of the Top 20 markets will likely see two-digit compound annual growth rates until 2022; two countries are supposed to grow even over 100% (Egypt, Saudi Arabia).

Despite China's sudden announcement to cut subsidies, there is no doubt that its government will continue to strongly support solar over the coming years. This is about a transition from way too high FITs to more cost-effective support mechanisms. China is expected to add 209 GW in our Medium Scenario, followed by India with 78.4 GW, and the US with 62.6 GW. While India's Prime Minister Modi is the master mind behind India's ambitious solar plans, the Trump administration is not considered solar-friendly at all. However, the US federal government's negative stimulus is countered by positive developments in many states. Japan is expected to add 29.3 GW until 2022, which would make it the fourth largest solar market over the next five years. Still, unlike for any other country on this list, annual demand is likely to decrease constantly as the country works on fixing its costly solar incentive scheme and infrastructure. The UK is the slowest growing market among the Top 20, expected to add only 2.1 GW until 2022. So except for the UK, the prospects for the leading solar markets are expected to be mostly sunny over the next few years.

FIGURE 13 TOP GLOBAL SOLAR PV MARKETS' PROSPECTS

	2017 **Total Capacity** (MW)	2022 **Total Capacity Medium Scenario by 2022** (MW)	2018 - 2022 **New Capacity** (MW)	2018 - 2022 **Compound Annual Growth Rate** (%)	**Political support prospects**
China	130,751	339,751	209,000	21%	
United States	51,527	114,170	62,643	17%	
India	19,047	97,431	78,384	39%	
Japan	49,251	78,551	29,300	10%	
Germany	42,973	63,237	20,264	8%	
Italy	19,392	26,924	7,533	7%	
Australia	7,308	22,969	15,662	26%	
France	7,999	19,702	11,703	20%	
Mexico	1,174	15,252	14,078	67%	
United Kingdom	12,676	14,742	2,065	3%	
South Korea	5,480	14,497	9,017	21%	
Spain	5,627	14,460	8,833	21%	
Turkey	3,420	14,320	10,900	33%	
Egypt	80	11,750	11,670	171%	
Netherlands	2,681	11,430	8,750	34%	
Brazil	1,147	8,442	7,295	49%	
Taiwan	1,733	8,386	6,653	37%	
Saudi Arabia	19	7,070	7,051	227%	
Thailand	2,697	6,159	3,462	18%	
Pakistan	894	5,787	4,892	45%	

1 GLOBAL SOLAR MARKET

PROSPECTS 2018 - 2022 / SEGMENTS

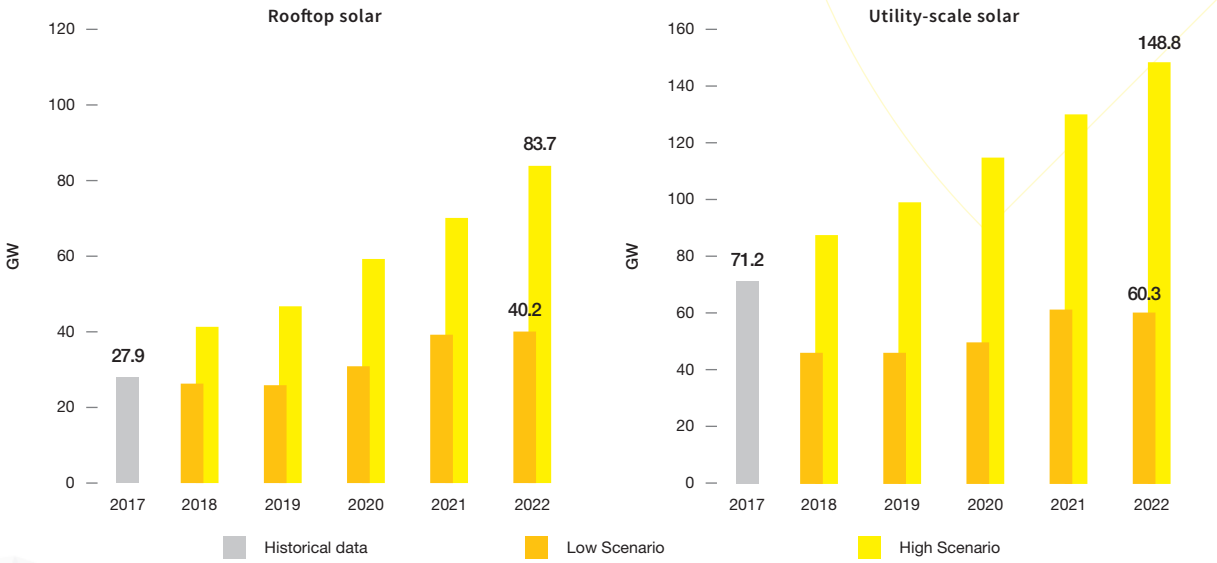
Ground-mounted utility scale solar power systems continue to clearly dominate the solar space – and this won't change much for the next five years. In 2017, the large-scale ground-mounted segment increased its shares along with the top markets expanding their global footprints. The growth of the major solar markets is primarily based on ground-mounted PV power, even though there are efforts to foster the rooftop segment as well. With electric vehicles and smart cities making stronger inroads after 2020, there is a lot of upside potential.

China not only strongly expanded its output to 52.8 GW in 2017 from 34.5 GW in 2016, but also its global market share to 53% from 45%. Its total installed capacity even increased to over 130 GW of which around 100.6 GW are utility scale plants. The other around 29.7 GW are what China calls distributed solar systems (now < 30 MW, earlier <50 MW), which are actually also mostly ground mounted systems, but installed closer to demand centres. The rate of distributed systems strongly increased over the last year, and we will see in the short run also a stronger run for rooftop systems after the Chinese government recently halted the utility-scale FIT programme.

However, deploying large volumes 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 begin their solar chapter with tenders for utility-scale solar and frequently 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 as it avoids any potential conflicts on land use. A good example for such a development is India. Its National Solar Mission officially targets 100 GW of solar by 2022, with 40 GW coming from rooftop solar. But of the 19 GW installed by end of 2017, only 1 to 2 GW are ground-mounted PV power plants.

Even in developed solar markets in Europe, the recent trend to tenders is triggering a new wave of ground-mounted PV power plants that will be installed in Spain, for example. The low cost of solar enabling the beginning of a merchant PPA based market will also push the ground-mount segment. On the other hand, consumers will evolve increasingly into prosumers, solar panels will turn into building materials, and smart cities will want to employ the advantages of distributed small-scale solar in combination with storage and digital solutions. In addition, more cities, states or even countries might follow the example of California to make it mandatory having solar as part of newly built homes – though all this is likely to happen after 2020.

FIGURE 14 SCENARIOS FOR GLOBAL SOLAR PV ROOFTOP AND UTILITY SCALE SEGMENTS DEVELOPMENT 2018 - 2022



TRENDS

WHAT'S HOT IN SOLAR

10 TRENDS THAT WILL SHAPE THE SOLAR POWER SECTOR IN THE COMING YEARS

Solar is ready to roll: In many countries it is the lowest cost power option today – both in residential and commercial applications, but also increasingly in the utility-scale field, even if external costs are not added to fossil fuels and nuclear power. Still, solar power's share is in most markets less than 5%. While decarbonisation through electrification of heat, transport and power sectors offer huge solar business opportunities, many obstacles need to be overcome.

SolarPower Europe has looked at 10 Topics & Trends that support the dissemination of solar power and outlines both the challenges and solutions. This chapter is mostly based on the work of different Task Forces of SolarPower Europe, where we co-operate closely with our members on business models and policy recommendations in the fields of Solar & Storage, Digitalisation, O&M or Corporate Sourcing to enable sector coupled Smart Cities as well as emerging countries to be powered smoothly by solar and other renewables.

1 **Small is beautiful: small-scale installations and the European energy transition**

2 **Solar smart cities: a great match**

3 **Solar mobility: choosing solar for the driver's seat**

4 **Solar & storage: unleashing the potential for the perfect partner**

5 **Sustainability & environmental footprint: taking care – solar generating truly green power**

6 **O&M: long-term high solar system performance with a little help from a friend**

7 **Solar PPAs: increasing leadership from private sector looking for green procurement**

8 **Tenders: controlling solar growth & cost**

9 **Solar in emerging markets: so much untapped potential**

10 **Technology update: how to cut cost even further**

1. SMALL IS BEAUTIFUL: SMALL-SCALE INSTALLATIONS AND THE EUROPEAN ENERGY TRANSITION

Solar is quickly becoming the cheapest source of electricity, outcompeting conventional power generation plants in several parts of the world. But it will only reach its full potential in a real decentralized energy system that enables integration of major shares of variable sources of electricity and recognizes appropriately the benefits of small scale, clean and local solar installations. These solar rooftop systems can compete on retail price with grid power at most places in the world; still only few countries, like Australia, have been truly tapping this attractive solar solution.

Small solar systems are the backbone of a digitalized, decarbonized, distributed and democratized energy system (4D), which empowers consumers and territories (e.g. households, hospitals, public buildings, hotels, etc.) with cleaner, cheaper and local electricity. They have the potential to support the competitiveness of local businesses, revive rural areas and foster sector-coupling synergies at all levels of society. Last but not least, small-scale solar provides three times more jobs than ground-mounted installations, as shown by the "Solar Jobs Study", published by SolarPower Europe and Ernst & Young (EY) in November 2017.

Today, there is no level playing field for small solar players in the energy world. Many obstacles hinder investors in rooftop solar solutions to reach their full economic potential in a smarter and cleaner energy system. In the European Union, a global pioneer in rooftop solar, the Clean Energy for All Europeans package, a set of legislative proposals currently in the final discussion stages in Brussels, could make the difference, but political leadership is lacking.

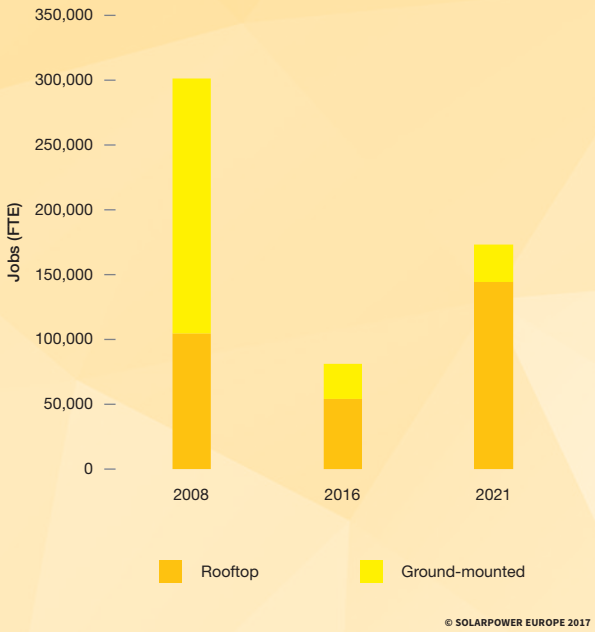
What is at risk? No less than the EU missing on the "renewable industrial revolution", a more complex yet much smarter energy system, building on the synergies provided by digital solar & storage to penetrate all sectors of the economy (sector coupling). From local to national level, small-scale solar is already today capable of reducing significantly CO_2 emissions, provide cheap and controllable energy and flexibility sources, and generate new business opportunities – if political framework conditions are set appropriately.

What's Next?

The epilogue for small-scale installations in the European Union isn't so far away, as negotiations between European institutions and national governments could be finalized by the end of 2018, with the enactment of a new EU legislation beginning 2019. Some of the following challenges remain crucial to ensuring a cost-efficient transition towards a cleaner and more decentralized electricity system that will unlock the economic and social potential of small-scale solar installations:

- **Markets "Fit-for-RES":** More liquid and short-term markets are needed to create a level-playing field between smaller and bigger power generators in Europe and integrate the participation of new players through storage and aggregation services. The implementation of markets fit for PV installations below 500 kW will be a crucial feature to develop new solar business models.
- **Creating a regulatory framework that truly incentivises small-scale PV installations:** Small-scale solar represents a significant opportunity for Europe in terms of economic and employment benefits – and could provide 150,000 jobs in 2021, according to SolarPower Europe's Solar Jobs study 2017. Until a level-playing field is met between smaller and bigger power generation players, small-scale solar producers need to be exempted from disproportionate financial and administrative burdens, such as bidding on the market (removal of priority dispatch) balancing responsibilities.

TRENDS FIGURE 1 DIRECT AND INDIRECT JOBS SUPPORTED BY THE PV INDUSTRY IN EU28, BY MARKET SEGMENT (ROOFTOP AND GROUND-MOUNTED)



- **Empowering renewable prosumers in Europe:** Self-consumption drives technological developments which provide European companies with the opportunity to maintain global industrial leadership. Future business models will emerge from the increasing penetration of small-scale renewables in all sectors of the economy: on-site generation combined with storage, digitalisation and home automation appliances will guarantee direct renewable supply to key sectors of the economy such as electro-mobility, or zero-emission buildings. Such installations will also procure valuable services to the electricity grids, setting the stage for the uptake of new services for energy supply and aggregation. Renewable prosumers should therefore be incentivized and not be exposed to disproportionate levies and charges, as it is the case if some EU countries.
- **A flexibility Roadmap for European Electricity markets:** All potential sources of flexibility should be optimized to transition towards a cleaner and more decentralized energy system. An adequate flexibility roadmap would enact the phasing out of the most inflexible and polluting generation capacities, foster the penetration of key enabling technologies (digitalisation, storage, electrical vehicles), and encourage transparency and competition for the uptake of new service providers (aggregation, prosumers).
- **Restrict the use of capacity remuneration mechanisms (CRM):** Subsidizing inflexible conventional capacities through capacity markets will increase the cost of the energy transition and hinder the uptake of more decentralized and flexible solutions, such as small-scale renewables and storage. The addition of a carbon criteria, excluding the worst environmental performers from capacity mechanisms, remains a crucial feature of the debate.

2. SOLAR SMART CITIES: A GREAT MATCH

Smart Cities are becoming a major trend in Europe and beyond. In Europe, the Covenant of Mayors, a European initiative to promote innovative energy transition in cities now gathers more than 7,755 European cities, covering around 250 million inhabitants. Worldwide, more than 9,000 cities have joined the Global Covenant of Mayors.

Today cities are responsible for around 75% of global energy consumption and 80% of greenhouse emissions. Urban areas will also face some of the most significant impacts of rising GHG emissions and air pollution, bearing much of the costs for adaptation and mitigation.

For the future, cities want to increasingly become smart, clean, sustainable - and solar appears as the perfect match to make this happen.

- First, solar is the most agile renewable technology. It is heavily decentralized and can basically be added to or integrated into each component of a sustainable urban area: carports, solar-powered urban lighting, solar-powered charging points, large buildings to single houses or sound barriers. Name it – solar offers a solution. Its ability to be installed very close to consumption points also avoids significant grid losses. This also includes large-scale distributed solar power plants to provide electricity for community solar solutions, for example.
- Then, solar is also already smart and quickly getting smarter. While digital solar & storage business models are taking off for residential and commercial consumers, smart building technologies reveal their potential to optimise self-consumption rates of the building stock and smoothen grid feed-in, which enables a cleaner yet reliable electricity supply.

A REAL SMART CITY MAKES USE OF SOLAR'S DISTRIBUTED AND FLEXIBLE NATURE BASICALLY ALMOST EVERYWHERE

What's Next?

According to the EU Covenant of Mayors, cities could be ready for creative actions when it comes to reducing their CO_2 emissions – if they have the will. Computed action plans show that over 49% of actions would be covering the buildings sector, while 20% would be devoted to increase local energy production and 23% for transport to develop cleaner transports. This all plays into the hands of solar.

- **Solar urban mobility:** While solar mobility business models are kicking off (see p. 27), solar will be particularly relevant to cover electrical consumption of low distance vehicles. This is a good thing, as cities plan to increase significantly their share of electric public transport and shared vehicles for their constituents. Solar again appears like a perfect match.
- **Solar smart buildings:** The modularity and versatility of building integrated solar solutions constitute a great chance for cities aiming at preserving their architectural identity, yet leading by example by developing not only passive but energy positive buildings. Covering all untapped building facades and rooftops spaces with solar could definitely help decarbonise Europe's building stock, still accounting for 36% of EU's total CO_2 emissions, according to the European Commission.[1]
- **Solar sector-coupling:** Solar is part of what will turn out to be a true energy revolution: enabling technologies, such as storage, digitalisation, smart homes and smart grids will play a key role in fostering solar's establishment as the main power source in our society. Sector coupling comes at the heart of every citizen's home - the keywords are on-site generation, EVs, smart home appliances. The more solar prosumers the better to foster the advent of the transformation towards a clean urban energy system.
- **Digital peer-to-peer trading:** While the policy frameworks for peer-to-peer power trading are often still missing, urban solar prosumers will soon increasingly be able to supply also neighbours, generating extra value from their PV installations. Tomorrow, cryptocurrencies based on blockchain technologies, such as SolarCoin, GenerCoin, EnergyCoin or others, might develop into the new vector to 'share' solar energy in urban areas.

1 IMPACT ASSESSMENT Accompanying the document Proposal for a Directive of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings.

3. SOLAR MOBILITY: CHOOSING SOLAR FOR THE DRIVER'S SEAT

Electro-mobility is a quickly emerging global trend that will open a world of new and exciting opportunities for solar.

The business case is strong as transport constitutes today around 1/3 of Europe's CO_2 emissions. Together with heating, it is the most emitting sector beyond the power sector itself, where the road towards renewables has been already paved unlike in transport. With the world now starting to engage seriously in e-mobility, it is key to ensure these increasing electricity volumes will be satisfied by additional renewable capacities.

2016 forecasts published by the European Environment Agency suggest that Europe's total electricity consumption by electric vehicles will increase from approximately 0.03 % in 2014 to 9.5 % in 2050. With EVs share supposed to grow much faster, it is crucial to add green power supply capacities quickly as well.

The Solar Mobility case is striking, when looking at sector coupling – solar is the perfect answer to electrification of transport.

The 'Residential Prosumers in the European Energy Union' study, carried out by a consortium including Cambridge Econometrics (CE) in 2017, found that an increase in the number of households with electric vehicles will lead to a projected 5% to 40% increase in installed solar PV capacity by 2030. But the potential goes far beyond the residential sector: while solar generates power over the day, equipping all public and private office buildings with solar and EV infrastructure could enhance even more the flexibility potential for the electricity system. On-site solar combined with digital software and smart battery charging can provide the system with ancillary services all day-long, while fellow citizens spend their day at work, and come back home with a fully solar-charged car.

Car manufacturers and utilities are increasingly beginning to engage in innovative solar mobility business models. From solar powered vehicles and solar powered charging stations to the development of innovative solar powered supply offers - solar will be a key for the electric mobility revolution.

In the future, you could even think about cars with 'solar skin.' While solar-power sunroofs are commercially available today, why not have more ambitious visions: If a typical car surface would be covered with today's solar module technology, this would result in an average of around 800 W per car and reduce 64% of CO_2 emissions from passenger cars in Japan, according to a study from Toyota.

What's Next?

- **Solar and cars:** EVs and solar through its fully distributed nature are a great fit – solar will contribute to higher shares of renewables in transport.
- **Sector coupling:** EVs will become part of a system combining decentralized generation with digital & storage technologies. Solar-powered vehicles and batteries will foster the integration of solar in the energy system, providing new flexibility services.
- **Scaling up solar:** The development of solar-powered charging infrastructure and solar supply offers will constitute a huge opportunity for the development of solar power in Europe.
- **Innovation and industrial leadership:** The combination of solar and electro-mobility will unlock new business models and value creation. Solar-powered hydrogen and batteries, solar powered cars, high-efficiency cells, next gen flexible solar cells for product integrations – the industrial opportunities are countless.

GLOBAL DEVELOPMENTS SUPPORTING SOLAR AND STORAGE	BARRIERS FOR DEPLOYMENT	SOLUTIONS
• E-mobility could increase global electricity demand by 10% by 2050, according to the Environmental Agency Bureau. • Major European cities such as Paris, London Oslo or Rome have decided to ban diesel by 2040 • European smart cities pioneer the development of solar-powered offers, like in the Netherlands (Wedrivesolar.nl)	• No concrete regulatory requirement linking the uptake of EVs with higher renewable capacities • Technical complexity to ensure that the electricity sourced "at the plug" effectively corresponds to injected solar energy • Accompanying the electricity demand stemming from EVs with solar electricity would require significant amounts of additional capacity at EU level • Key enabling technologies linked to the uptake of Solar Mobility (smart charging, vehicle to grid, high-efficiency cells) are still under development	• Development of Solar-powered vehicles building on high-efficiency and next-gen flexible cells • Mainstreaming of solar-powered infrastructure accompanying the uptake of EVs in Europe (carports, charging stations, roads) • Development of innovative offers combining on-site solar & storage and EVs • Developing a tracking system (certification of origin) for the electricity supplied to electric vehicles

4. SOLAR & STORAGE: UNLEASHING THE POTENTIAL FOR THE PERFECT PARTNER

While solar covers around 5% of the European Union's electricity demand today, its contribution could easily increase up to 15% by 2030; it would only take around 20 GW of newly installed PV capacity per year. A major trend linked to the deployment of solar is its co-location with battery storage. Storage adds flexibility and allows increasing system integration of solar PV. European examples can be found in the UK, where the first subsidy free utility solar & storage installations are being developed. Or in Germany, where around 50% of all residential solar installations in 2016/2017 were coupled to battery storage.

From an energy system perspective, storage represents an important flexibility tool, since it:

- injects and absorbs electricity very fast and with very high accuracy;
- smoothens short-term variability;
- eliminates production and load peaks;
- makes solar fully dispatchable.

In addition, solar & storage bring economic advantages: Storing solar electricity when prices are high and using it when prices are low allows stabilizing energy prices to reduce future grid upgrades and expansion cost.

Finally, solar & storage bring social benefits, such as:

- local job creation;
- avoided CO_2 emissions;
- true consumer empowerment.

To capture the full potential of solar & storage in the future, politics must set the right conditions now. SolarPower Europe's Solar & Storage Task Force is calling on the EU institutions to ensure that the following policy asks are strengthened and fully reflected in the new Market Design Directive (whereas these points need to be addressed similarly anywhere in the world for solar & storage to thrive):

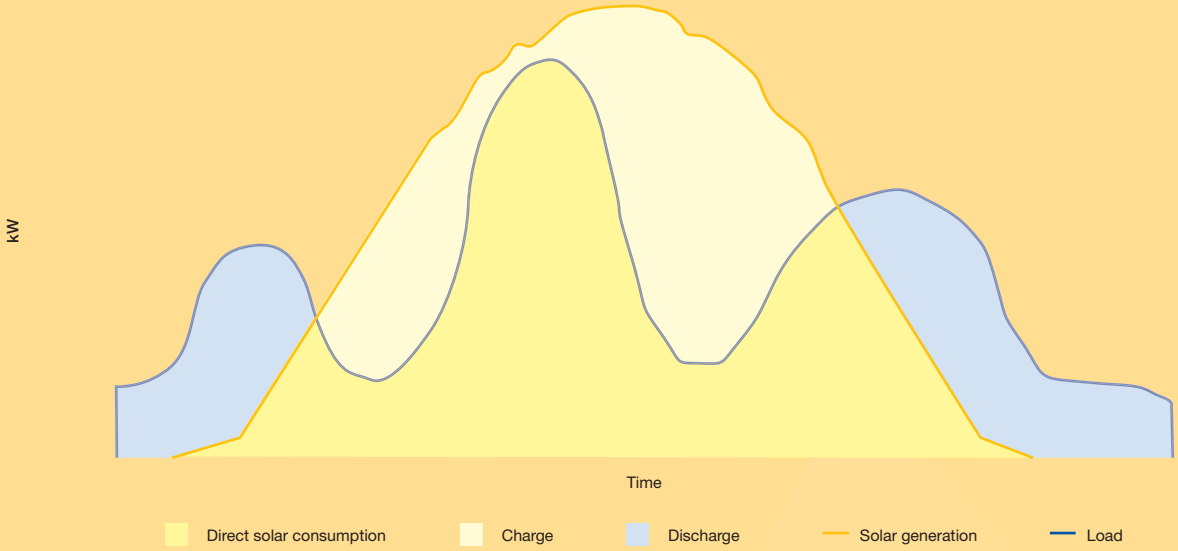
POLICY ASK	EXPLANATION
"Free movement of kilowatt-hours"	Grid fees should only be levied once on every kWh fed into the grid
"Storage can absorb and release electricity when required"	As storage can both absorb and release energy, typical taxes, surcharges, fees, licensing requirements etc. usually levied on consumption and or generation should not apply
"Stacking of services"	Provision of several services simultaneously, e.g. self-consumption and ancillary services, are beneficial to the system and should be allowed
"Right to self-generate and store electricity" "Right to grid connection"	Every household should be allowed to install and connect Solar & Storage systems without any burden
"Maximum asset monetization"	Solar & Storage should have access to all markets, especially those for flexibility and ancillary services, with products that value fast and accurate services
"Fair consumer metering costs"	Consumers should not bear unreasonable costs for metering or billing services from DSOs and TSOs
"Solar & storage is a new flexibility tool"	Storage should be considered as a viable alternative to traditional grid expansion
"Green cannot turn grey"	Stored solar electricity should be treated as other solar electricity

Solar & Storage provides several benefits:

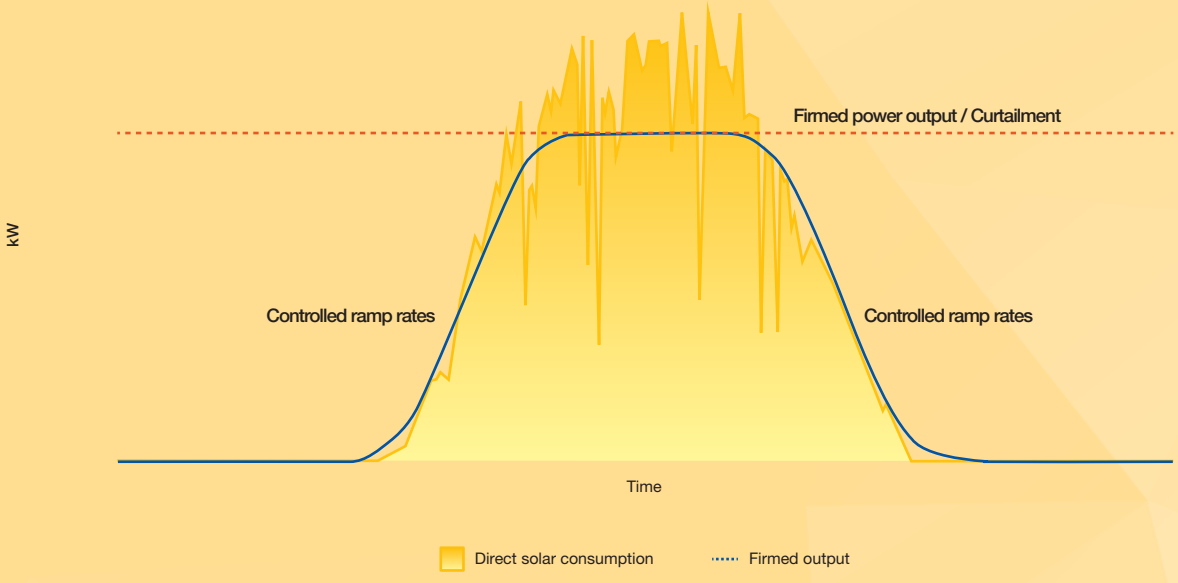
Storage optimizes solar supply (Figure 2)

The solar supply curve (yellow) is variable and coincides only partially with the typical electricity demand curve (blue). Combining solar & storage allows to absorb the surplus generation (white area) and inject the stored solar electricity back into grid when demand is high (blue area). These capabilities make it possible for Solar & Storage to operate with the functional equivalence to fossil-based generators. To make the maximum use of its technical potential, storage should be considered neither as a consumer nor generator.

TRENDS FIGURE 2 STORAGE OPTIMIZES SOLAR SUPPLY



TRENDS FIGURE 3 STORAGE FIRMS SOLAR OUTPUT



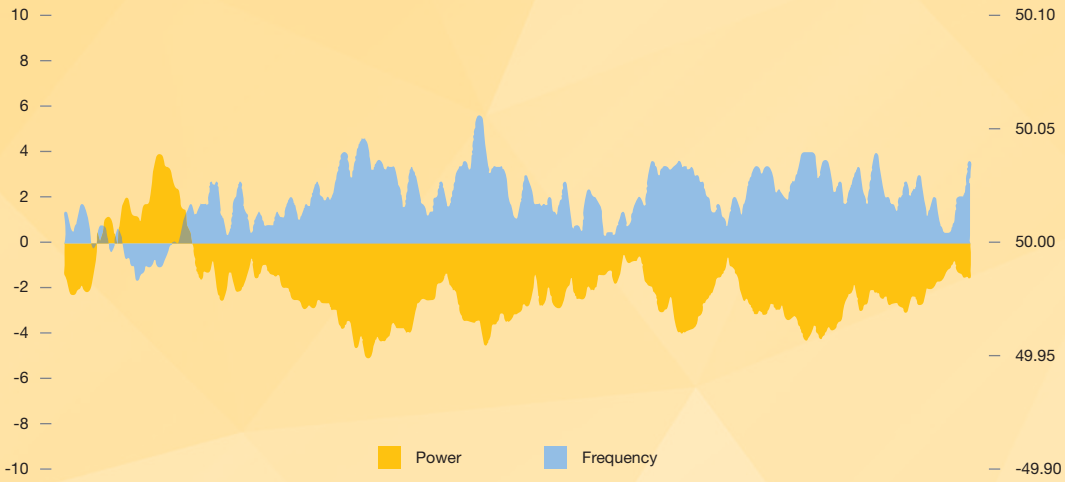
Storage firms solar output (Figure 3)

Firming means that a PV system's output does not increase or decrease too quickly. The advantage of having a solar & battery system working in synergy is that short-term supply and demand variations can be stabilized. Storage can even make the PV system's output completely dispatchable, i.e. available on demand. **Solar & Storage must be recognized as a new flexibility tool that makes solar fully dispatchable.**

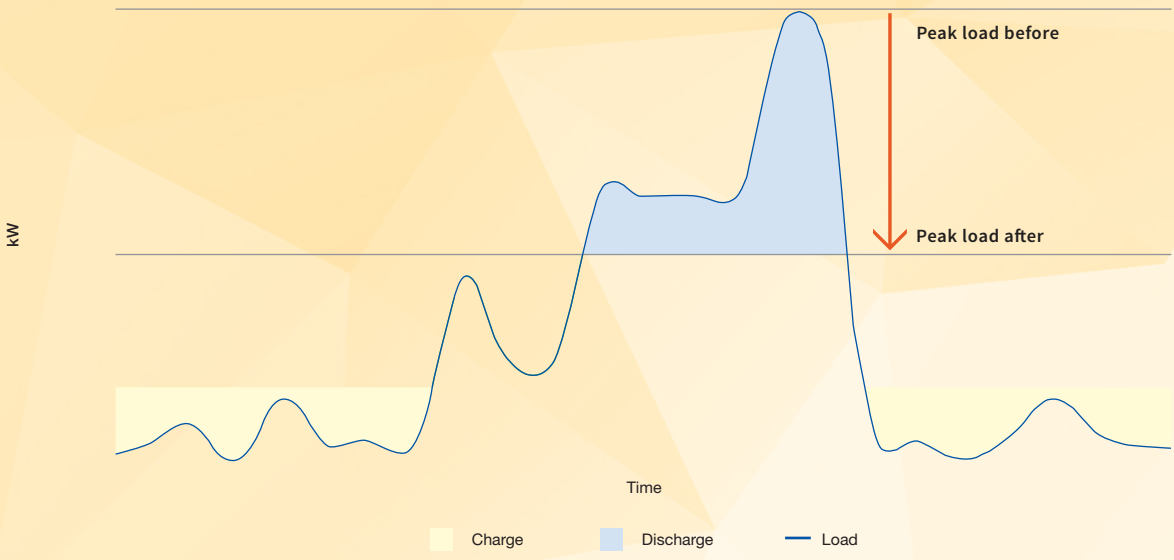
Storage provides ancillary services (Figure 4)

Ancillary services allow the energy system to cope with variability up to an hour. To provide such services, generators must respond quickly to signals to help correcting fluctuations in frequency. The high flexibility of Solar & Storage allows to provide much faster and more accurate services to TSOs and DSOs than other flexibility sources. **Solar & Storage must be recognized as a new flexibility tool that can stack services and access all markets for maximum asset monetization.**

TRENDS FIGURE 4 STORAGE PROVIDES ANCILLARY SERVICES



TRENDS FIGURE 5 STORAGE REDUCES NETWORK COST



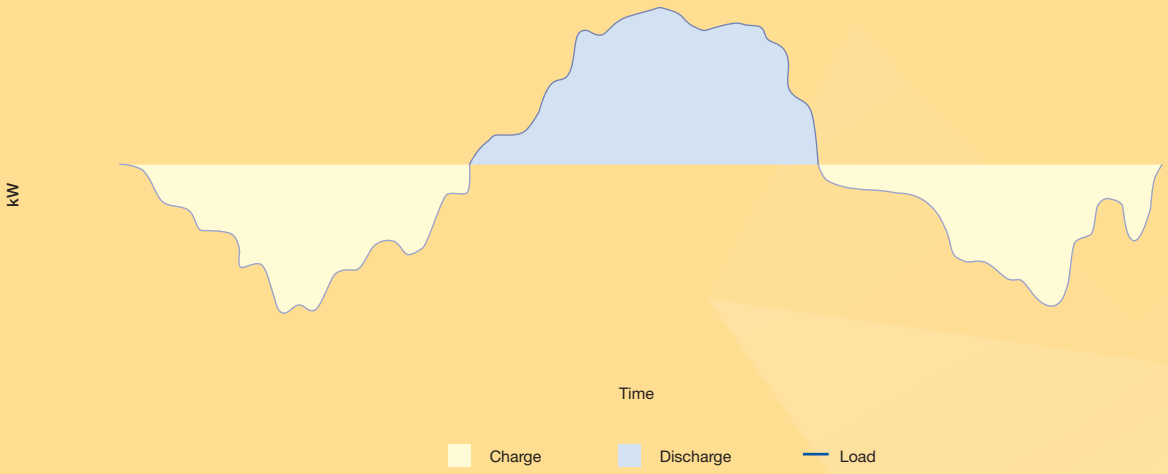
Storage reduces network costs (Figure 5)

Historically grids are designed to only deal with demand peaks. However, with increasing variable generation grids face both: peaks in demand and peaks in generation. Solar & Storage systems allow to reduce peak generation significantly. In Germany, a market introduction program for residential storage systems limits the feed-in behaviour of PV systems to 40% of its maximum output. Due to this limitation, the feed-in during peak generation is reduced. Applying an optimized generation and storing strategy allows to increase the existing grid capacity for PV power. This allows to integrate more renewable electricity within the same grid design, avoiding network upgrades. **Solar & Storage shall have a right for grid connection and fair, consumer contract level metering costs.**

Solar & Storage provide more stable energy prices (Figure 6)

Arbitrage can be provided with Solar & Storage systems by using storage systems to absorb power from the grid at times of overproduction and low power prices. By injecting this electricity back into the grid when prices are high, overall price fluctuations can be reduced while system reliability and operation are improved. This is feasible on system and residential level. Regarding the latter, different types of 'Time of Use' tariffs are applicable, e.g. i) fixed, depending on hours of the day or ii) variable, depending on intraday market developments. To make this a viable business case on its own, power prices must fluctuate more, but more **importantly, grid fees should only be levied once on every kWh fed into the grid.**

TRENDS FIGURE 6 SOLAR & STORAGE PROVIDE MORE STABLE ENERGY PRICES



5. SUSTAINABILITY AND ENVIRONMENTAL FOOTPRINT: TAKING CARE – SOLAR GENERATING TRULY GREEN POWER

Solar solutions provide the most sustainable power generation source of electricity! Really? Increasing rumors spread in the public domain that point to an alleged "dark side" of solar. Indeed, even solar power plants have an environmental footprint on a lifecycle basis. Production of PV system components and the construction and installation of the system itself do have environmental impacts in the life cycle of a solar power system. But those impacts (called 'hotspots') are comparatively small and can be even significantly reduced through the use of recycled materials, renewable electricity for manufacturing and high value recycling at end of life.

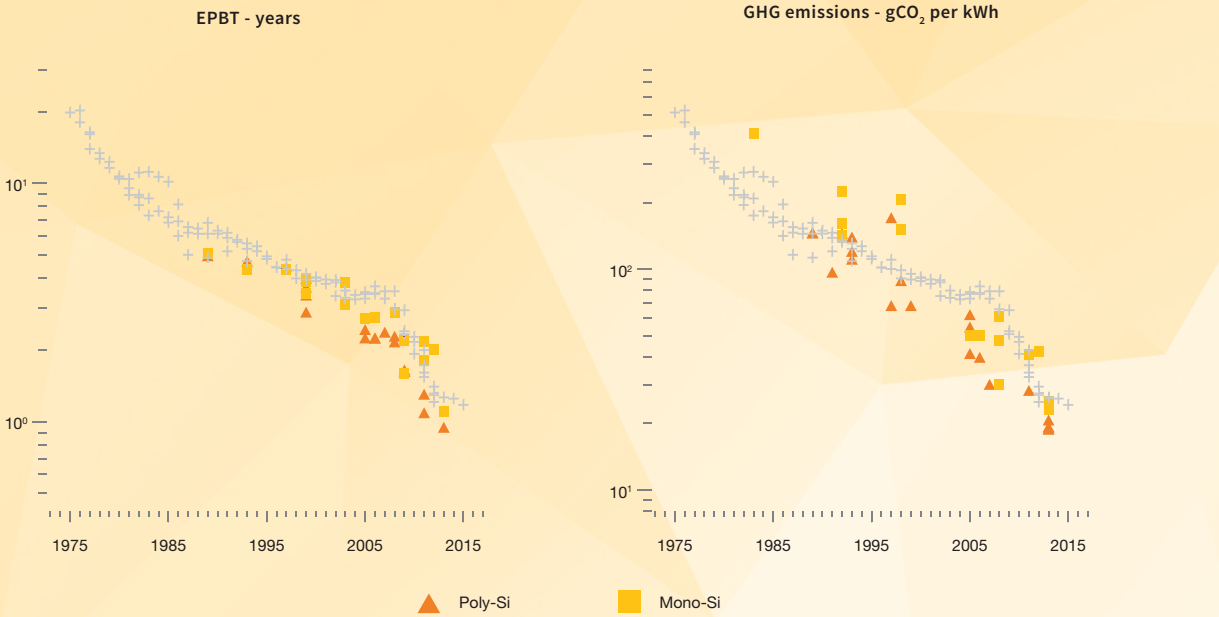
The key takeaway is: the environmental footprint of a unit of solar power generated remains a tiny fraction of conventional fossil technologies, offering one of the most cost-efficient means to decouple electricity generation from environmental and health impacts.

Thanks to continuous efforts in research and innovation from the solar industry, both the environmental footprint of solar and payback time have been continuously improved in the evolution of solar becoming one of lowest cost power generation technologies that is also growing faster than any other of its peers. Since 1975, the environmental impact of PV production has been reduced dramatically - for every doubling of installed PV capacity, energy use decreased by 12 to 13% and greenhouse gas footprints by 17 to 24% (see Fig. 7).

To shed some 'sun' light on the environmental impact and latest technological development of solar technologies, SolarPower Europe's Environmental Footprint Task Force and Solar & Storage Taskforce are currently developing a series of 'Solar Sustainability Factsheets,' which will be published in the second half of 2018. These factsheets will cover a variety of topics from carbon footprint of solar modules and battery recycling to panels' cost and efficiency as well as raw materials' availability.

In summary, yes, solar power systems are industrial products, and as such its manufacturing entails certain environmental impacts, but these are negligible when taken into account a solar system's product itself - renewable power generation for around 30 years, whereas it takes an energy payback time of less than 1 year for a typical multicrystalline solar system in a sunny place like Sicily to generate the power that was needed to make a solar panel. Over a lifetime of 30 years, this means it produces 30 times the electricity that was needed to make it.

TRENDS FIGURE 7 IMPROVEMENTS OF ENERGY PAYBACK TIME AND CARBON FOOTPRINT OF SOLAR PANELS SINCE 1970s



Source: Louwen et al. (2016)

Outlook

The solar industry is constantly improving its cost efficiency and is strongly committed to enhancing its environmental performance.

Globally, the industry-led NSF 457 Sustainability Leadership Standard for Photovoltaic Modules, launched in December 2017, promotes voluntary international standards to track and improve a set of sustainability performance objectives for solar panel manufacturers.

In the EU, the European Commission's Joint Research Centre launched in October 2017 a preparatory study to assess the necessity of sustainable product policy tools - including Ecodesign and Ecolabel - for solar panels, inverters and systems. These tools might have a decisive impact on Europe's solar industrial policies and business models:

- Products covered by the EU Ecodesign Directive can only access the European market if they fulfil minimum requirements related to energy efficiency and circular economy.
- The EU Ecolabel is a voluntary label promoting environmental excellence by identifying products and services with reduced environmental impact.

The overall objective of the initiative is to increase general awareness on the environmental performance of PV systems and support the further decarbonisation of the EU energy system in line with the Paris Agreement.

Whether a sustainable product policy will be introduced for solar in the EU is currently under discussion, and therefore subject to the outcome of a preparatory study expected in late 2019. From the beginning of the consultation process, SolarPower Europe's Environmental Footprint Task Force has been actively involved and will keep providing insights and recommendations to the European Commission on behalf of the solar industry.

GLOBAL DEVELOPMENTS OF SOLAR SUSTAINABILITY & ENVIRONMENTAL FOOTPRINT	CHALLENGES	SOLUTIONS
• Constantly improving cost efficiency and environmental performance are making solar one of the cheapest and lowest environmental impact power generation source • Increasing demand for environmentally friendly and sustainable power generation sources, such as solar, in light of the Paris Agreement • Decision makers are increasingly exploring options for environmental performance requirements related to solar and other renewable products • With battery technology quickly maturing, they will play a key role in future energy systems	• Tackle emerging myths about solar's environmental "dark side" • Assess the need for environmental performance requirements for solar, while the impact on solar industrial policy needs to be thoroughly considered • Necessity to decouple electricity generation from environmental and health impacts • Assess the effect of batteries on solar systems' environmental performance	• Communication and pedagogy to raise awareness of the environmental impact of solar and other sources of power generation • Consultation with stakeholders before introducing environmental performance requirements • A new market design that takes environmental aspects of power generation sources into account • Solar module recycling solutions are available • The automotive industry is driving the development of lithium battery technology and is working on using second-life batteries for stationary storage

6. O&M: LONG-TERM HIGH SOLAR SYSTEM PERFORMANCE WITH A LITTLE HELP FROM A FRIEND

Europe is the continent with the oldest fleet of PV power plants, which made stakeholders realise comparatively early that they needed proper “health care” for their assets to meet performance expectations. Today, O&M has become a standalone segment in the solar value chain with many companies specialising exclusively in that field. Yet, quality issues remain due to increasing price pressure, lack of standardisation and minimum requirements, non-specialist staff and insufficient use of available digital data analytics tools.

To address these challenges, SolarPower Europe’s O&M Task Force has developed and published its O&M Best Practices Guidelines. The second edition, which was released in December 2017, incorporates extended industry experience and expert input, and addresses additional topics, such as technical asset management and cybersecurity.

The ‘Contractual Framework’ chapter also gains more international weight: it is aligned with the global O&M template contract developed by SolarPower Europe together with law firm Bird & Bird, the International Renewable Energy Agency (IRENA) and Terrawatt Initiative, as part of the Global Solar Energy Standardisation Initiative.

Best Practices Mark

In 2018, Solar Power Europe strives to bring best practices and standardization for solar O&M even further: Together with leading European companies active in O&M, we have created the solar O&M Best Practices Mark, a self-certification-based label to promote transparency and excellence in the solar O&M market. The mark makes it possible for all O&M contractors to formally declare adherence to the requirements of the O&M Best Practices Guidelines, proclaiming the excellence and reliability of their solar O&M services vis-à-vis potential clients.

The Solar O&M Best Practices Mark

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 • Deepening our understanding of O&M requirements for solar systems of all sized, by developing specific guidelines for distributed solar

7. SOLAR POWER PURCHASE AGREEMENTS: INCREASING LEADERSHIP FROM PRIVATE SECTOR LOOKING FOR GREEN POWER PROCUREMENT

2017 was another record year for renewable corporate PPAs, with over 5.4 GW installed globally (see Fig. 8). In 2018, the cumulative volume of corporate renewable PPAs could reach 20 GW.

The US is still leading the game, by having developed more than 3.1 GW of renewable corporate PPA volumes in 2017. However, the new trade restrictions for solar products by the Trump government will slow down expansion in the world's most promising market – to what extent remains to be seen once the exact measures are all in place.

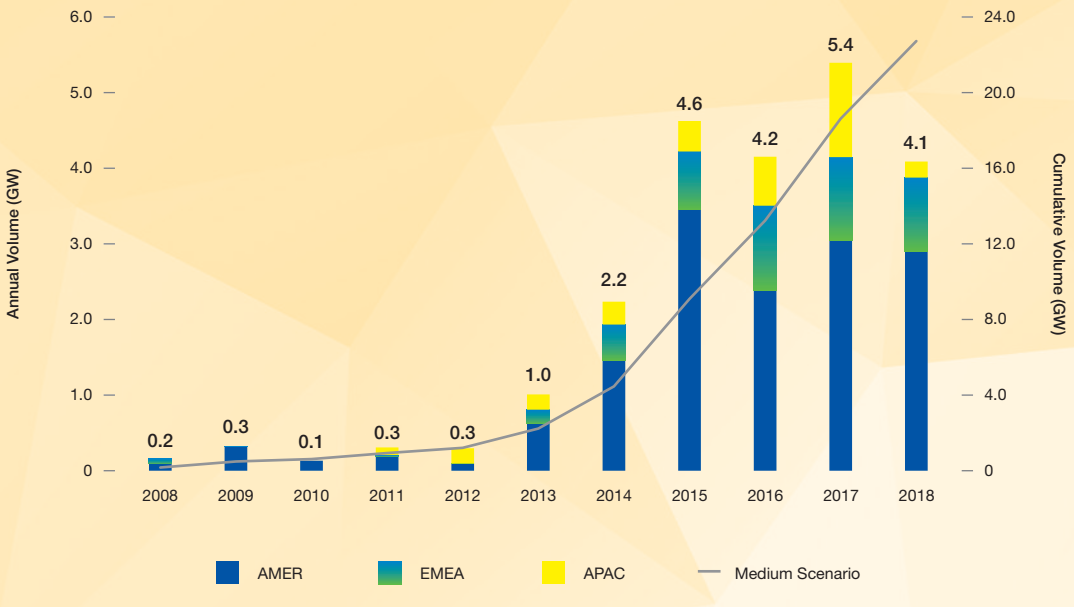
Will Europe be ready to take over?

The potential for corporate sourcing of renewable energy is significant and largely untapped in Europe, despite some progress in the past two years, mainly reflected in the Nordic countries, the UK, and the Netherlands. As predicted, the scalability and ever falling costs of solar started to pay off, with 1.1 GW contracted in 2017 . With the right regulatory framework in place, renewable corporate sourcing should have a bright future in Europe as well: Bloomberg New Energy Finance estimates that RE100 companies - a group of global corporates targeting to source their power from 100% RES - would need at least 67 TWh of additional renewable energy production to meet their 2030 renewable supply commitment (see Fig. 9).

To unlock this potential, it is for EU countries to acknowledge the value of PPA contracts, providing their businesses with clean and competitive energy supply, and complementing public investments in clean energy technologies. The main obstacles to further renewable corporate PPAs in the European Union is the lack of an "enabling framework" to clarify the conditions under which corporate PPAs and self-consumption are possible, existing regulatory barriers, and the lack of guidance on subsidy compatibility with corporate PPAs. A key problem in the EU is that in particular Germany and France are not willing to let corporates get access to the so-called "guarantees of origins" (GO) for subsidized green power.

Despite these obstacles, an important milestone for corporate green power sourcing in Europe, is the European Commission's newly created first European Industry Platform dedicated to the uptake of corporate renewable PPAs in Europe, the Re-Source platform, which was launched in early June 2018.

TRENDS FIGURE 8 GLOBAL CORPORATE PPAs, BY REGION



TRENDS FIGURE 9 EUROPE-DOMICILED RE100 SUPPLY-DEMAND FUNDAMENTALS

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What's next for corporate sourcing at EU / global level?

- The future EU-wide rules on the issuance of guarantees of origin could have a decisive impact on the development of solar corporate procurement market in Europe. Despite the new EU Re-Source industry platform, a strong political will at EU level is generally missing. The European renewable corporate PPA boom is more likely to emerge from the increasing use of tenders correlated with public support, as it has been seen in recent auctions in EU member states. Clarifying regulatory and administrative conditions for project developers and corporates remains crucial.
- US contributions to the global renewable corporate PPA volumes could decrease in the coming years. Trade measures could have a strong negative impact on the world's leading renewables PPA market, and the underlying uncertainty will likely also influence business decisions to procure more renewable energy.
- While new business models are cooking, the lack of market integration and reluctance to develop a common energy tracking system at EU level still constitute a major barrier to the scaling up of corporate PPAs in Europe. As digital technologies make a striking entrance in all sectors of the economy, blockchain is identified by leading corporates as a promising technology to bring corporate PPAs to the next level.

GLOBAL DEVELOPMENTS SUPPORTING CORPORATE RES SOURCING	CHALLENGES	SOLUTIONS
• 5.5 GW RES corporate PPAs were developed in 2017 • Corporates and SME's express a growing interest for bilateral power sourcing contracts • Smart cities in Europe and beyond look at opportunities for sourcing their own renewable power • The European Commission has proposed to develop cross border renewable PPAs in the EU	• Scaling-up • Corporate PPAs in Europe are limited to a selected group of countries • Inclusive market barriers for small and medium sized enterprises to implement corporate PPAs: • Standardisation and harmonization of processes to contract renewable power purchase agreements in Europe • Regulatory constraints or legal restrictions (ie Restrictions on third party ownership of onsite renewable installations, on the number of buyers per installation or the number of suppliers per metering point) • Compatibility of support schemes with corporate PPAs • Traceability of renewable electricity	• Find innovative formulas to involve medium and small corporates (improve bankability, aggregation, financing…) • Harmonize administrative and legal processes to facilitate the development of renewable PPAs in all EU countries • Remove regulatory barriers from the development of corporate renewable PPAs in Europe • Implement a functioning and harmonised EU-wide Guarantees of Origin system, to ensure the traceability of green electricity for corporate renewable PPA contracts • Free market following well established power market rules • Pursue more flexible PPA contracts to cater the different needs of SMEs and account for the fact that many businesses may have difficulty forecasting their energy demand 10 or more years into the future.

8. TENDERS: CONTROLLING SOLAR GROWTH & COST

Tenders or auctions have been gaining popularity in the solar sector all around the world in recent years. The key drivers are usually two-fold: controlling growth while keeping expenditure as low as possible. This is in stark contrast to traditional uncapped feed-in tariffs (FiT), which have been the preferred means of incentivising solar in the past, but bear the risk of unlimited expansion and high costs, if not properly designed. This was shown in China in 2017, when nearly 53 GW were installed, while the country was looking for a range between 20 and 30 GW. While China was offering feed-in tariffs for utility-scale plant between 0.65 and 0.85 RMB/kWh in 2017 (in June 2018, the FITs were cut to 0.4 to 0.6 RMB), its third Top Runners Programme auction round resulted in a lowest winning price of 0.31 RMB/kWh.

By mid-2016, 67 countries across the globe were using tenders to develop renewable energy capacities, according to IRENA.[3] This number has increased in the meantime. While in Sub-Saharan Africa, Ghana, Mauritius, Uganda, South Africa and Zambia have all run renewable energy auctions, at least 15 more countries in that region are developing such programmes for competitive procurement.[4] The World Bank Group's Scaling Solar Programme is a helpful tool to implement tenders in new markets.

Probably the most prominent solar market entering the field of tenders in 2017 was Japan. One of the world's largest PV markets mostly due to its lucrative feed-in tariffs, Japan held a first pilot PV tender in October 2017, with two more trials scheduled for August and December 2018. The lowest awarded bid of 17.20 Yen/kWh was significantly lower than the 21 Yen/kWh FIT level at the time. But with a huge FIT pipeline waiting for installation, the 490 MW AC capacity companies bid for was lower than the 500 MW on offer. The takeaway: as long as there are more attractive FIT schemes available, companies are primarily opting for these alternatives, which offer higher returns and avoid the risk of not being awarded a PPA.

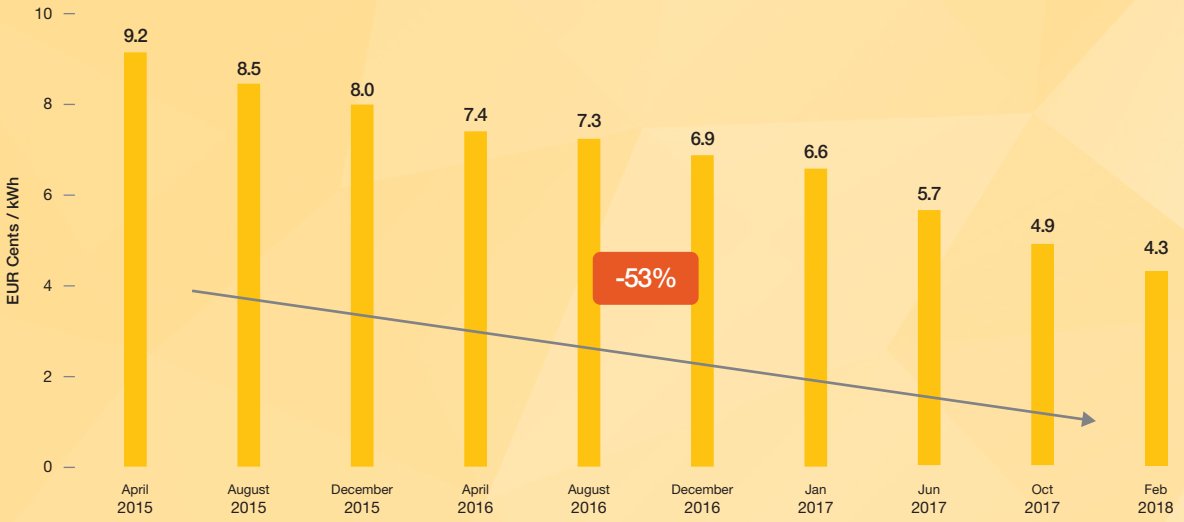
Without doubt solar auctions have been the major tool to drive down LCOEs over the last few years. 2017/2018 have been again remarkable years in this regard so far. While bid prices have been decreasing all around the world, the 300 MW tender in Saudi Arabia stood out, as it was won for a new record low 2.34 US cents per kWh in February 2018. In fact, it could have been even lower, but the lowest $1.79 US cents per kWh bid from Masdar/EdF was disqualified. Reportedly, this bid was based on new bifacial module technology, which promises to increase yield by 10-30% and shows what solar record price level are to be expected in the near future.

In Europe, the requirement stemming from the European Commission's 'State Aid Guidelines' to use tenders as of January 2017 for plants above 1 MW provided the framework for changes in national support schemes. First, Germany, France and the Netherlands have successfully implemented regular solar tenders. In Germany, the December 2017 round led to another record level, bringing down the average winning price by over 50% since the start of the solar tender program in April 2015. The average level of the winning bids was 4.33 Euro cents per kWh, while the lowest successful bid was even 3.86 Euro cents. In Spain, solar won 3.9 GW in a technology neutral renewables tender in mid 2017, outcompeting wind, which only secured 1.1 GW. In a technology neutral RES tender in Germany, solar even scored 100% in April 2018. While technology neutral renewable tenders are preferred by the European Commission, SolarPower Europe is in favour of technology specific tenders, as only this offers visibility for the solar sector on upcoming tendered volumes, and offers the regulator a clear planning horizon for the different flexible RES technologies that have all distinctive features.

3 IRENA (6/2017), 'Renewable Energy Auctions: Analysing 2016'.

4 IRENA (4/2018), 'Renewable Energy Auctions: Cases from Sub-Saharan Africa.

TRENDS FIGURE 10 AVERAGE WINNING BID SOLAR POWER PRICES IN GERMAN TENDERS



Source: German Federal Network Agency

GLOBAL DEVELOPMENTS SUPPORTING THE USE OF TENDERS	BARRIERS	SOLUTIONS
• Policy-makers aim for control of solar capacities deployed in their countries • Tenders have proven their ability to decrease solar power prices • Need to provide solar sector with visibility • Market-based mechanism reducing needs for financial public support	• Technology-neutral tenders do not offer any planning visibility – neither for solar sector, nor for regulators • Faulty and non-transparent tender designs prevent the optimal outcome regarding cost and quality • Projects smaller than 1 MW provide unnecessary overhead cost for bidders (like in France) • Opportunistic, tactical 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

9. SOLAR IN EMERGING MARKETS - SO MUCH UNTAPPED POTENTIAL

Solar is one of the cheapest sources of electricity and this is especially true for emerging solar markets, many of which are located in the sunniest regions on this planet. Solar is also one of the most equitably distributed energy resources in the world. Contrary to fossil fuels, all countries in the world have access to sunlight regardless of population, land or economic wealth.

Solar therefore is a key enabler to contribute to the energy transition of emerging markets and regions. This is not a scoop, as many emerging markets are already on their way to outpace developed solar markets such as Europe and the US – just look at India, which has become the third largest PV market in the world in only a few years. Many other solar newcomers are following on the heels of India.

PV additions in emerging markets could reach 207 GW of total installed capacity within 5 years - with the highest potential in South Asia (112 GW) and in the Middle East and Africa (51 GW) (see Fig. 11). This offers a huge business opportunity for solar companies to export their know-how and scale up investments in these new markets.

Several challenges stand in the way from tapping into these new "Solar Eldorado's", including policy and regulatory stability, administrative and procedural processes in developing countries, as well as financial and bankability challenges. Industry-led initiatives, such as the French Terrawatt initiative and the Global Solar Council, are working on concrete standardisation and market facilitation projects to unlock the investment potential in the most promising regions.

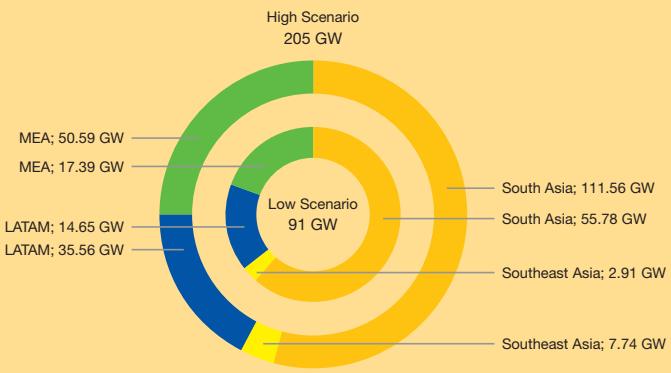
Under the initiative of its member ENI, Solar Power Europe has launched a Solar Emerging Markets Taskforce in March 2018, aiming at developing market specific approaches and tailor-made recommendations brought by major solar stakeholders to local governments.

Outlook

In 2018, Solar Power Europe strives to bring best practices and standardization for solar O&M even further: Together with leading European companies active in O&M, we have created the solar O&M Best Practices Mark, a self-certification-based label to promote transparency and excellence in the solar O&M market. The mark makes it possible for all O&M contractors to formally declare adherence to the requirements

- Developed countries should continue working together with emerging countries' and use the know-how of the Solar industry to unlock the untapped potential, and make sure Solar will play its full part in contributing to socio-economic development around the world
- Developed countries' decision makers should make sure, in consultation with the solar industry, that public money flowing into financing facilities is used in the most effective way possible: fostering industrial synergies and cooperation between local and international companies

TRENDS FIGURE 11 SOLAR POTENTIAL IN EMERGING MARKETS, 2018 - 2022



- Public sector and industry should cooperate on awareness raising about existing financing facilities and initiatives, one of the core objectives of Solar Power Europe's Emerging Markets Task Force
- The European Union, together with the US have been pioneering the energy transition at global level: they should seize this industrial opportunity and engage in "Energy Diplomacy", to promote both the uptake of Solar in developing regions and sustainable business opportunities for all solar companies

10. TECHNOLOGY UPDATE-HOW TO CUT COST EVEN FURTHER

As solar increasingly has to compete with other renewables in technology neutral tenders and even with fossil fuels as its strives to enter the merchant market segment, the cost pressure across the solar system value chain remains huge. When looking at cost distribution in a solar system little has changed - the module is still the biggest cost contributor with nearly half of total system capital cost. Thus the focus on how to lower the cost is primarily on the panel, though there are big efforts in this regard taking place with inverters, mounting technology and system design as well. These are the key technology trends SolarPower Europe has seen to reduce solar system cost in the last 12 months:

WAFERS

All about mono: The trend toward mono has accelerated over the last year. Several analysts even expect monocrystalline wafers to take over the leadership position from the multicrystalline variant already in 2018. Multi has been clearly dominating the solar market for many years, but mono technology started to win shares after manufacturers began switching towards lower-processing cost and higher yield diamond-wafer technology while processing equipment suppliers began offering tools for low-cost high-efficiency cell designs.

CELLS

PERC is the new cell standard: Today, nearly all mono cell lines are capable to produce Passivated Emitter Rear Contact (PERC). The technology brings 0.5-1 percentage points efficiency improvements with little more cost for additional production equipment. PERC is also on the hit list of record efficiencies. In the last 12 months, the world record was broken 6 times. In May 2018, the latest record efficiency PERC cell of 23.95% was announced by JinkoSolar, followed by a 23.6% cell from LONGi Solar. Now the question is: What comes next? PERC, PERL, heterojunction or even passivated. Or will PERC simply dominate for a few years?

GLOBAL DEVELOPMENTS	CHALLENGES	SOLUTIONS
• Solar has become one of the cheapest sources of electricity • Access to energy in developing countries is one of the biggest global challenges • Solar is now booming in some developing countries, but even these countries are looking for investment & know-how in building up sustainable markets • There is still a huge untapped solar potential in several countries and regions	• Access to financing for project development in emerging markets • Political stability and willingness to develop renewable energies • Optimal use of public funds by financing instruments • Availability of information regarding existing financing instruments for companies and public authorities • Access to up-to-date market information and local stakeholders	• Coordination and consultation between public sector and industry • Awareness raising and streamlining of existing financing instruments for solar companies • Development of tailor-made approaches adapted to the specificity of each market, within a regional context • MoU between developed and emerging countries, fostering industrial cooperation and the exchange of best practices and know-how

MODULES

Half cells – less is more: Half cut cells is a simple but very effective means to increase module power. By cutting a fully processed cell into two parts, resistance losses can be reduced, providing a power boost of about 5 to 6 W on the module level. First used in China as part of the Top Runner Programme, which requires panels with high power ratings, such half-cell modules are now starting to be seen more and more outside China as well.

The shingle connection: Shingle style modules are, like half-cut cells, also based on cell slicing – not into two pieces but several strips. The process completely changes cell interconnection of the solar module by eliminating traditionally used ribbon. Here, cell strips are connected in as shingle manner, similar to roof tiles, which can improve module efficiency by up to nearly 2% absolute compared to standard ribbon interconnected panels. On the heels of two US pioneers, SunPower and Solaria, several Chinese companies have presented shingled modules at recent trade shows as well.

Going thin: Thin film technology has shown considerable improvements with First Solar introducing its Series 6 of its CdTe solar modules, which comes with a much larger form factor and offers superior temperature coefficients, better spectral response, and reduced soiling - all resulting in superior energy yields.

Bifacial – power from both sides: Bifacial technology unveils the rear side of a PV module for sunlight absorption. The gain varies between 5 and 30%, depending on various aspects, such as device design, site albedo, mounting conditions. With the new generation of high-efficiency cells being capable of bifacial power generation, this technology is expected to gain quickly market shares.

Glass cover all around: Glass-glass modules have been around for a while – and advertised with 30-year performance warranties, but their share is for a number of reasons still very small compared to glass-backsheet modules. That might change with the advent of bifacial modules, which need transparent back covers to generate power on the rear side. A glass cover seems to be the natural fit, though newly developed transparent backsheets are an option for bifacial modules as well.

INVERTERS

Going digital: Inverters are the brain of a solar system – and with storage coming increasingly into play, the O&M market under cost pressure, and houses & cities expected to become smarter – their importance will significantly grow. The advent of bifacial modules in power plants and a larger rooftop market with a focus on safety will provide the grounds for stronger growth of module-level power electronics.

TRACKING

Following the sun: Single-axis tracking systems have become basically a standard for utility-scale PV plants in southern regions. They operate reliably, and the little higher investment over fixed mounting systems is more than compensated by lower LCOEs.

SOLAR SYSTEMS

Storage: Stationary battery storage is quickly establishing itself in an increasing number of markets, where the technology already supports the dissemination of solar, and soon will be crucial to bring it to the next penetration level. According to a recent study from consultancy EuPD, in Austria and Switzerland, for example, already around 95% of solar installers are offering battery storage systems as part of their product portfolio.

Floating Solar: Water bodies and solar power plants are often good fits. While the water keeps the modules cool, which has a positive effect on power yields, the solar panels can protect the surface of drinking water reservoirs from air pollutants or evaporation. Moreover, there is often no competition on space usage on water bodies. While still very small, there is huge interest in floating PV, in particular in Asia. Installed system capacity doubled to around 200 MW in 2017. The world's largest floating system - a 40 MW plant - was installed in China in 2017.

Towards higher voltages: The move towards higher DC voltages of up to 1,500 Volts for modules and other components for solar system is taking longer than anticipated. However, this solution for large rooftop and utility-scale installations will come as it offers a significant cost reduction potential for solar systems, because it allows to decrease the number or combiner boxes and simplifies installation.

BIPV – integral thinking: We are still waiting and hoping for building-integrated photovoltaics to become mainstream. But except for a few lighthouse projects, solar is still an add on product. The presentation of Tesla's Solar Roof in the fall of 2016, caused a huge response in global media, but even this very aesthetic product hasn't kick started the BIPV market so far. With California's decision to make it mandatory for all new houses to include solar power systems as of 2020, there is a good chance this will mark the start of the BIPV era in solar.

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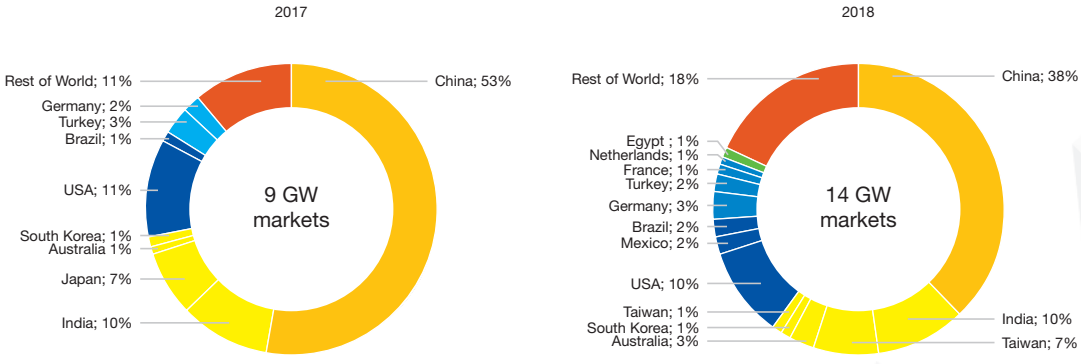
2 GW-SCALE SOLAR POWER MARKETS IN 2017

In 2017, nine countries installed more than 1 GW, compared to seven countries in 2017. The number will again increase to 14 this year, according to our Medium Scenario. For this chapter, we have invited partner solar association from the nine GW-scale markets in 2017 to present local expert views on their 'home' markets (even if they sometimes differ from our estimates).

Most of these associations are also members of the Global Solar Council (GSC), which is a supporter of the Global Market Outlook. For those GW-scale countries, where we did not receive contributions from the local solar association, we have written the overviews based on SolarPower Europe research.

1	China	China Photovoltaic Industry Association (CPIA)
2	United States	US Solar Industries Association (SEIA)
3	India	SolarPower Europe
4	Japan	Japan Photovoltaic Energy Association (JPEA)
5	Turkey	GÜNDER Turkish Solar Energy Society
6	Germany	SolarPower Europe
7	Australia	Smart Energy Council
8	South Korea	SolarPower Europe
9	Brazil	Brazilian Photovoltaic Solar Energy Association (ABSOLAR)

FIGURE 15 WORLD GW-SCALE SOLAR MARKETS, 2017 AND 2018



1. CHINA

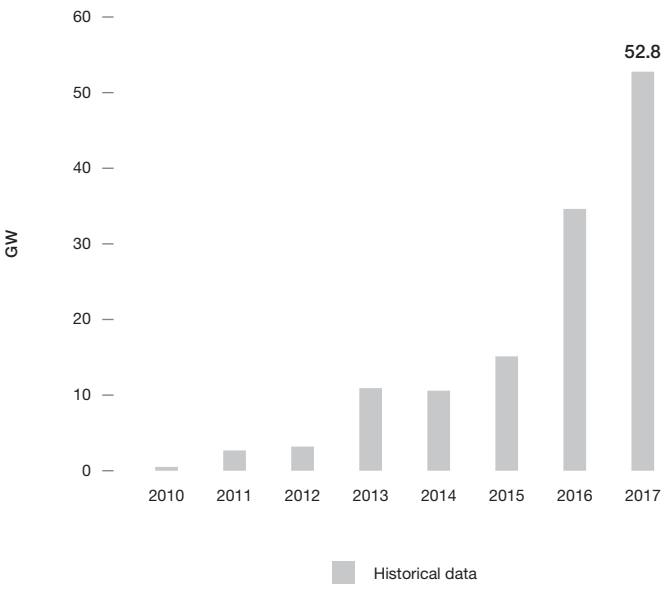
The Chinese solar market showed exceptional growth in 2017.

Chinese Solar Targets

According to the "13th Five-Year Plan for Solar Energy Development" issued by the National Energy Administration (NEA) at the end of 2016, the installed capacity of photovoltaic power generation was planned to reach 105 GW by 2020. However, by the end of 2017, the above target has been exceeded – China had installed 130.8 GW at that time. For this reason, the National Energy Administration (NEA) issued "Guidelines for the Implementation of the 13th Five-Year Plan for the Development of Renewable Energy" in 2017 and stated a 130 GW target for cumulative grid-connected PV utility plants capacity target by 2020. Such target has not yet been calculated for distributed PV, poverty alleviation solar, and the Top Runner Program projects.

In order to control the pace of development and avoid excessive growth of the domestic PV market, subsidy policies were adjusted in June 2018, when the "2018 Solar PV Generation Notice" was published. The feed-in tariff for utility-scale plants was reduced by 0.5 RMB. Further installation of large-scale projects was stopped for the reminder of the year. The FIT for the feed-in part of distributed PV plants (<30 MW) with a self-consumption component was cut by 0.5 RMB, while full feed-in DG systems now receive the same reimbursement levels as utility scale solar power plants. No changes were announced for the Poverty Alleviation Programme.

FIGURE 16 CHINA SOLAR PV MARKET SCENARIOS 2010 - 2017



Drivers for Photovoltaic Growth in China

- **Feed-in Tariff:** The feed-in tariff is the main driver for solar in China. In early June, NEA adjusted the tariffs with immediate effect (see Table 1):
- **Top Runner Program:** In 2015, the National Energy Administration (NEA), the Ministry of Industry and Information Technology (MIIT) and the National Certification and Accreditation Administration jointly issued the "Opinions on Promoting the Application and Industrial Upgrade of Advanced Photovoltaic Technology Products", and implemented the "Top Runner Program"- on the one hand to promote application of advanced PV products and on the other hand resulting in the closing of outdated production facilities. By the end of 2017, a total of 3 "Top Runner Program" plans were approved, with a total scale of 12.5 GW. The lowest bid was awarded in Qinghai province at a level of 0.31 RMB/kWh.

  In 2017, a Technology Top Runner Demonstration Project for innovative products was launched, and the total scale of the first phase of the project was 1.5 GW; that aims to create a market place for ultra-efficient cells.
- **Poverty Alleviation:** At the end of 2017, the first batch of PV poverty alleviation projects under the "13th Five-Year Plan" was issued with a total scale of approximately 4.18 GW. In 2018, the second batch of photovoltaic poverty alleviation plans will be issued in due course.

Solar Market in China 2017

In 2017, China new installed photovoltaic grid-connected capacity reached 53.06 GW, 54% year-on-year growth. The cumulative photovoltaic installation capacity reached 130.25 GW, an increase of 69% over the same period of last year. Among them, the cumulative utility plants scale is 100.59 GW, the distributed plants is 29.66 GW, The annual photovoltaic power generation amounted to 118.2 billion kWh, accounting for 1.8% of China's total annual power generation.

In the first quarter of 2018, China installed 9.65 GW, a 22% year-on-year growth. While utility scale PV capacity reached 1.97 GW, which was a drop of 64% year-on-year, the volume of distributed PV installations, comprising systems up to 30 MW, increased by 217% to 7.69 GW year-on-year. Photovoltaic power generation improved by 64% to 35.1 billion kWh.

Challenges

The challenges lying ahead of the Chinese photovoltaic players are late FIT payments, curtailment, missing transmission, and uncertainties regarding the new subsidy policy guidelines. The Chinese government is working on addressing all these issues.

Author: *China Photovoltaic Industry Association (CPIA)*

TABLE 1 2018 NATIONAL PHOTOVOLTAIC POWER GENERATION ON-GRID FIT PRICE LIST

RESOURCE ZONE	PV UTILITY PLANTS BENCHMARK ON-GRID PRICE		DISTRIBUTED GENERATION FIT STANDARD	
	ORDINARY UTILITY PLANTS	VILLAGE POVERTY ALLEVIATION PLANTS	ORDINARY PROJECTS	DISTRIBUTED POVERTY ALLEVIATION PROJECTS
Class 1 Resource Zone	0.5 (0.55) RMB	0.65 RMB		
Class 1 Resource Zone	0.6 (0.65) RMB	0.75 RMB	0.032 (0.37) RMB	0.42 RMB
Class 3 Resource Zone	0.7 (0.75) RMB	0.85 RMB		

2. UNITED STATES

In 2017, the US solar market installed 10.6 GW of solar PV capacity, or about the equivalent of the amount of electricity used by 2 million homes. Despite installing 30% less solar than was installed in a record-breaking 2016, the market still exceeded 2015 levels by 40%.

In line with previous years, 59% of the installed capacity last year came from the utility PV segment, while distributed solar accounted for 41% of installations.

Last year bucked many historical trends in what proved to be a transitional year for the solar market. All segments experienced role reversal, as residential and utility PV – long the growth segments of the solar market – both saw installations fall on an annual basis for the first time since 2010, marking a "reset" year for both segments. Meanwhile, the long-beleaguered non-residential PV segment was the only market to experience growth in 2017.

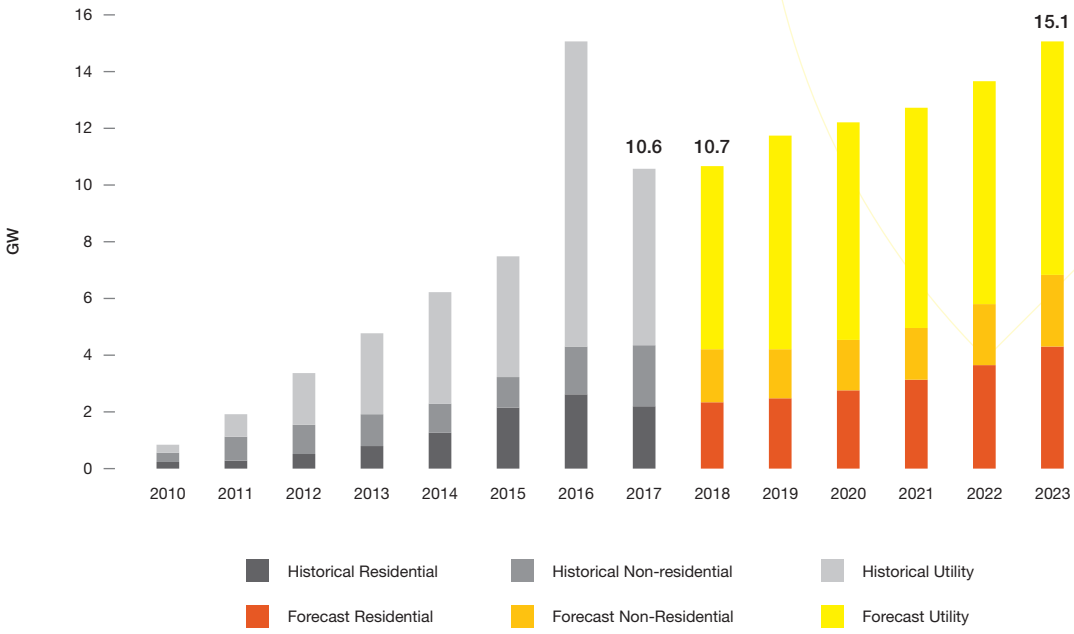
For residential PV, the downturn in 2017 stems from segment-wide customer acquisition challenges that are constraining growth across most major state markets.

Meanwhile, the year-over-year downturn for utility PV in 2017 was largely expected, due to the massive influx of projects trying to leverage the 30 % federal Investment Tax Credit (ITC) in 2016. However, uncertainty surrounding the Section 201 tariffs caused many projects to be shelved in 2017, while PURPA project cancellation and interconnection delays resulted in many projects spilling over into 2018.

Finally, both closing regulatory windows and the realization of a robust community-solar pipeline drove substantial growth in non-residential solar in 2017. This is the second consecutive year for such growth after the space essentially remained flat from 2012-2015.

With President Trump's decision to impose tariffs on imports of cells and panels now final, GTM Research reduced its forecasts to account for the impact of tariffs on system pricing, in tandem with the impacts of corporate tax reform on customers, developers and financiers.

FIGURE 17 USA SOLAR PV MARKET SCENARIOS 2018 - 2023



Source: SEIA / GTM Research

Flat Demand in 2018, Slight Growth in 2019

With that in mind, SEIA with the support of GTM Research forecasts US solar to be essentially flat in 2018. With nearly two-thirds of the 2018 utility PV pipeline consisting of relatively less-price-sensitive renewable portfolio standard projects and projects currently in construction that secured tariff-free modules (either crystalline-silicon PV delivered before the tariffs went into effect or non-subject thin-film modules), tariff impacts on 2018 will be somewhat mitigated.

The non-residential market will fall as a pipeline of projects grandfathered in under a more favorable policy and incentive environment wanes in 2018.

Residential PV will see a slight rebound after falling 16% in 2017, with a more robust rebound blunted somewhat by the tariffs. This is especially true in major markets that faced higher costs of customer acquisition in 2017, which on net see essentially no growth in 2018.

In the medium term, the post-2018 utility pipeline has been reduced as more price-sensitive procurement drivers such as PURPA (Public Utility Regulatory Policies Act) and voluntary procurement (i.e., projects made viable due to their economic competitiveness) are unable to pencil out under increased price assumptions.

Though the utility segment is still expected to grow 17% in 2019, growth will be relatively flat from 2020-2022 as tariffs push out projects that were initially slated for completion in 2020-2021. Going forward, utility PV's recovery will continue to be driven by procurement outside renewable portfolio standards, with more than 75% of the current pipeline coming from voluntary procurement, PURPA, off-site corporate procurement, and California-based community-choice aggregators.

For residential PV, the widespread customer-acquisition issues in major state markets that afflicted the segment in 2017 are only exacerbated in an increased pricing environment. This is especially true for large national installers scaling back expensive sales channels and transitioning to lower-cost customer-acquisition strategies in pursuit of profitability. These challenges are expected to continue in the near-term for large national installers, though 2017-2018 is expected to be the bottoming out of this trend as national installers exert less influence on the market 2018 than they did in 2017.

Growth is therefore expected to remain in the sub-10% range through 2020 as the market aligns to the expectations of small and medium-sized installers leveraging less expensive customer-acquisition channels, with upside contingent on the extent to which national installers can sustainably scale new customer acquisition strategies and sales channels.

Next 2-Digit Growth Period Expected as of 2020

Growth rates exceeding 10% are expected to resume in the early 2020s as emerging markets begin to account for a larger share of the residential market.

Meanwhile, the non-residential PV market is expected to experience two consecutive down years as the grandfathered project pipeline wanes in 2018 and the market acclimates to a reduced incentive environment across major state markets in 2019.

However, this will be incrementally offset in 2020 as the next wave of states with robust community solar mandates – New York, Maryland, Illinois – begin to see the realization of those pipelines while the viability of solar-plus-storage spreads beginning in the next decade.

By 2020, growth will resume across all segments, with 28 states in the US expected to be 100+ MW annual solar markets, and with 25 of those states being home to more than 1 GW of operating solar PV.

Authors: *Dan Whitten & Justin Baca, US Solar Energy Industries Association (SEIA)*

3. INDIA

2017 has been a record year for solar photovoltaics in India. Cumulative installed capacity exceeded 19 GW, with net yearly additions of 9.63 GW – a staggering +127% market growth from last year's 4.25 GW. The Indian market took Japan's place as the third largest market worldwide and is on trajectory to become the second largest, perhaps already in 2018. The Indian Government's strong commitment to solar has its effects on other power sources: In 2017, solar was the largest source of new power generation capacity additions, constituting a 45% share.

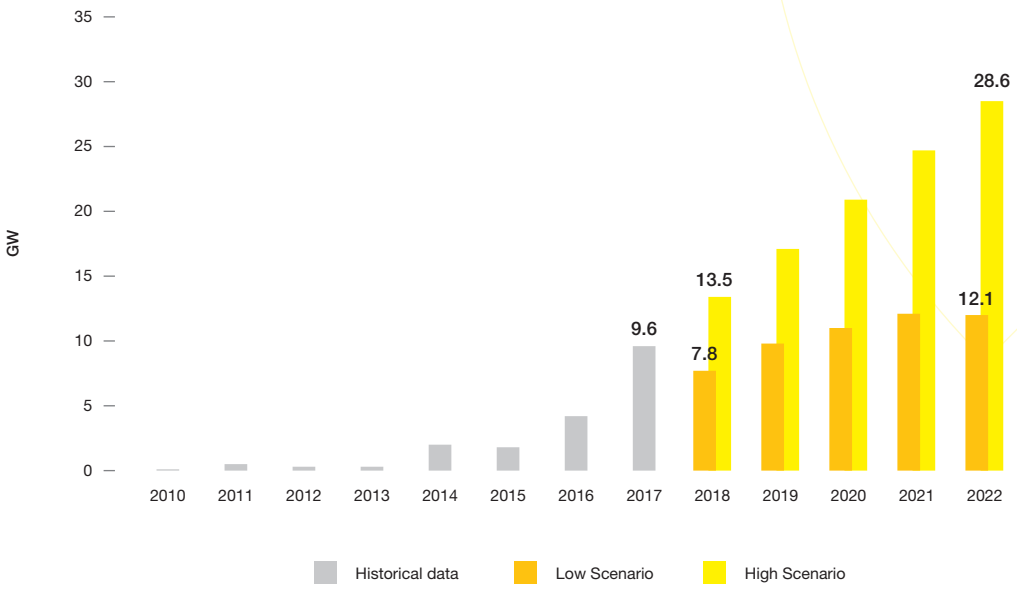
After the steep year-over-year 2017 growth, India is expected to take a breath in 2018. SolarPower Europe's medium scenario expects slight growth to 10.5 GW of newly installed capacity this year. The current project pipeline is lower, after fewer tenders were issued in the past year. Moreover, the first months of 2018, were governed by uncertainty stemming from a discussion on a 70% safeguard tax on imported solar cells, although this seems off the table for now.

In November 2017, India's Ministry of New and Renewable Energy (MNRE) laid out its roadmap for future tenders to boost demand and make sure its 2022 National Solar Mission goals are met. MNRE plans to tender 20 GW in FY 2017/18 and 30 GW each in FY 2018/19 and FY 2090/20. This explains the extraordinary high tender activity over the first months of 2018.

Indian Solar/RE Targets

A profound transformation of the energy sector in mind, the Indian government has set out ambitious renewable energy targets in which solar plays a paramount role. In 2015, India announced a RE target of 175 GW by 2022, a net growth of 150 GW from the installed RE capacity at that time. Solar installed capacity was planned to total 100 GW by 2022, while wind power was supposed to contribute 60 GW. Rooftop PV is targeted to contribute 40% to the solar total. While several experts have had doubts if these targets can be reached, in early June 2018, India's minister of power and renewables even announced to up the 2022 RE goal by 52 GW to 227 GW.

FIGURE 18 INDIA SOLAR PV MARKET SCENARIOS 2018 - 2022



Drivers for Solar Growth

A number of policy measures have been set in place by MNRE to support the achievement of India's 2022 solar goals.

An amendment to the National Tariff Policy includes provisions for Renewable Generation Obligations (RGO) and Renewable Purchase Obligations (RPO). The policy requires state-owned power distribution companies to purchase 8% of their energy from solar by 2022, and mandates thermal power plant operators to have a certain amount of renewable components in new installed capacity.

Besides these quota obligations, several economic incentives such as generation-based incentives, viability gap funding, capital and interest subsidies, concessional finance and fiscal incentives have been set in place. India is supporting large-scale solar through the development of industrial solar parks, which has resulted in PV projects that belong to the largest in the world. A key tool to push solar in India are competitive tenders, which have pushed tariffs down to 0.031 €/KWh.

In order to match increased generation capacity with adequate network expansion and to establish smart grids that integrate renewable energy into the national grid, the government has planned a growth of network infrastructure with the support of the Green Energy Corridor project. Through the project, financial and technical assistance is provided to the power grid corporation and state transmission utilities.

Under the Sustainable Rooftop Implementation for Solar Transfiguration of India (SRISTI), the residential, commercial, industrial and institutional sectors are provided financial assistance for their rooftop installations. This subsidy scheme, allocating more financial resources and covering more customers than the previous version, is expected to play a central role in the achievement of the target of 40 GW of rooftop solar capacity by 2022. A "rent a roof" policy is also being planned by the government, allowing developers to take rooftops on rent, freeing households from responsibilities of installation and maintenance of the system.

Utility-scale vs Distributed Solar Development

The bulk of installations added in 2017 consisted of utility-scale systems. In particular, industrial solar parks constitute the backbone of Indian PV expansion. Ultra mega power plant (UMPP) construction is facilitated by state governments or local distribution companies bearing the risks for land acquisition and benefitting from economies of scale.

Installed rooftop capacity is between 1 and 2 GW, falling significantly short of the originally 5 GW target by March 2018. Under the current trajectory, the goal of reaching 40 GW of rooftop solar installations seems out of range. However, growth prospects are bright, as solar has become cheaper than grid power for most of commercial and industrial users. In combination with batteries, solar is also able to provide a solar power back-up solution, which all companies use anyway.

Challenges

While the Indian market expansion follows an exponential trajectory, lagging behind schedule can be explained by a number of factors beyond financing:

- First, the goals are very ambitious. India started from scratch and had to move quickly on many fronts to establish infrastructure and energy policy frameworks.
- Local content and trade protection measures have been looming over solar expansion and created large uncertainties across the market.
- Many Indian utilities have been having financial difficulties. Solar has not been high on their agenda, unless pushed through obligations to purchase renewable electricity.
- Rooftop solar, especially in the residential sector, needs more policy support to tap its huge growth potential. Policy harmonisation across states and clearing ambiguity related to net metering or other support policies is necessary for further rooftop development. Otherwise the 40 GW rooftop target will not be reached by 2022.

Authors: *Raffaele Rossi, Michael Schmela, SolarPower Europe*

4. JAPAN

In November 2009, the feed-in-tariff (FIT) scheme for residential rooftop PV was introduced in Japan. This Japanese FIT supported remarkable growth of residential PV market to some 1 GW in 2010 and onwards. In July 2012, the new FIT scheme started for renewable energy (RE), also covering non-residential PV systems over 10 kW. The new FIT scheme strongly boosted the non-residential PV market, including utility scale PV.

According to statistics from the Ministry of Economy, Trade and Industry (METI), annual capacity additions recorded 9.8 GW AC (equal to 10.8 GW DC) in 2015. Since 2016, the Japanese PV market has been trending downwards. This is mainly due to grid constraints (e.g. limited grid capacity and curtailment risks) and FIT reductions (i.e. from \40/kWh in 2012 to \18/kWh in 2018 for non-residential systems).

The Japan Photovoltaic Energy Association (JPEA) estimates that around 6.0 GW AC (7.2 GW DC) was installed in 2017, resulting in a cumulative installed PV capacity of 49.2 GW DC end of 2017.

According to the "PV OUTLOOK 2050" published by JPEA in 2017, the Japanese PV market will bottom at 4 GW in 2024, before it trends upward again. This will be after overcoming grid constraints and improving cost competitiveness (see Fig. 19).

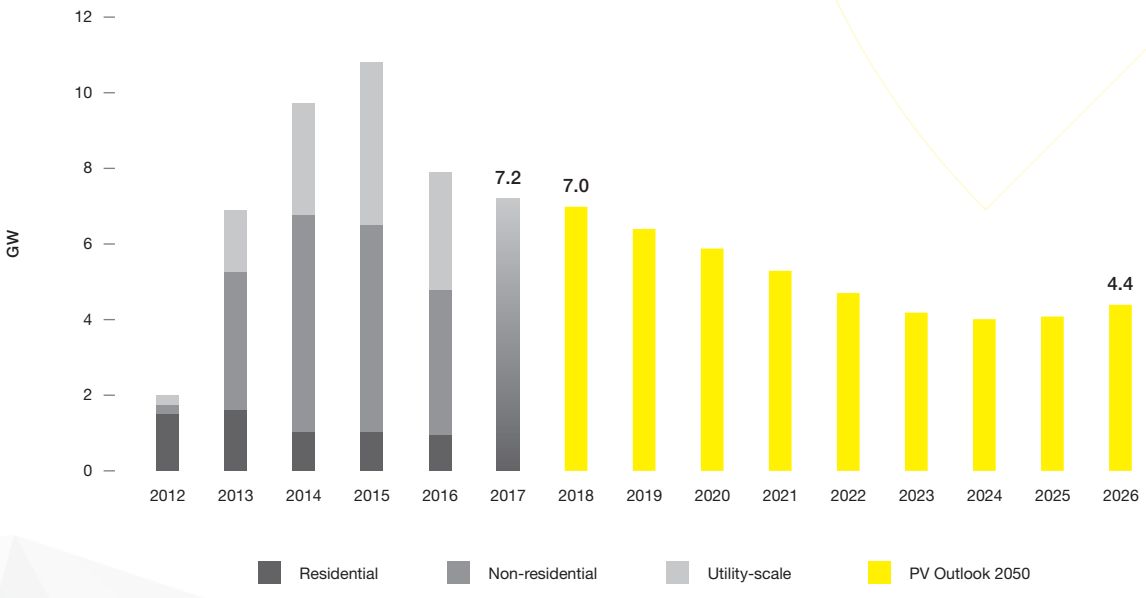
Japanese Solar/RE Targets

- **The government target:** According to the 'Long-term Energy Supply and Demand Outlook' (Energy Outlook) published by METI in 2015, the cumulative installed PV capacity in 2030 will be 64 GW AC (74 GW DC).
- **JPEA's vision:** It is expected that this 64 GW will be achieved in the early 2020s. As stated in the 'PV OUTLOOK 2050', JPEA expects that the cumulative installed PV capacity in AC will be around 100 GW AC (120 GW DC) in 2030 and 200 GW AC (240 GW DC) in 2050.

Drivers for Solar Growth in Japan

- **The FIT** scheme has been and will be the strongest support for the solar PV growth in Japan until LCOE of solar PV becomes lower than other energy sources.
- **Self-consumption business model:** In the coming years, the "self-consumption business model" for commercial and industrial users is expected to grow in Japan. As the LCOE of solar PV is getting closer to retail electricity prices for commercial and industrial users, on-site self-consumption PV system will become an attractive option for companies to reduce CO_2 emissions.

FIGURE 19 JAPAN SOLAR PV MARKET SCENARIOS 2018 - 2026



Source: JPEA

- **Net-Zero Energy House:** Promotion of net-zero energy house (ZEH) by the government is expected to support the growth of residential PV market towards 2030. According to the 'ZEH Roadmap', the government's ambitious target is to achieve net-zero energy on average for newly built houses by 2030.

Challenges

- **Expiry of FIT for residential roof-top users:** In Japan, the FIT for residential PV system (less than 10 kW) is set for 10 years from its first on-grid day. As of November 2019, this 10-year FIT will expire for the first residential systems installed as part of this support scheme. By the end of 2020, the cumulative PV capacity dropped out of the FIT will be around 3 GW, which means some 700,000 users will need to become smart prosumers to maximize the value of their assets, e.g. to increase self-consumption and/or to find reliable aggregators. This challenge will provide business opportunities for solution providers in the residential market segment.
- **Grid constraints:** Limited grid capacity and curtailment risks are the primary causes of the downward market trend in Japan. These issues need to be overcome with the highest priority. The Japanese government has started several mitigation measures, such as the "connect and manage" programme to maximize grid capacity with existing assets by learning good practices from Europe.
- **Cost competitiveness:** The cost of solar PV in Japan is higher compared to average international levels, mainly due to expensive construction and soft costs. The FIT for non-residential PV (10 kW to 2 MW) was set in fiscal year 2018 at \18/kWh. To achieve grid parity in Japan, solar LCOE needs to be reduced to the level of electricity wholesale market prices that is currently around \10/kWh. Although, this is a real big challenge for the PV industry in Japan, JPEA expects that grid parity will be achieved by 2030. The government targets PV LCOE of \7/kWh in 2030.

Author: *Japan Photovoltaic Energy Association (JPEA)*

5. TURKEY

Turkey is one of the fastest growing energy markets in the world. Turkey's total energy demand has been increasing rapidly. Imported fossil fuels dominate Turkey's total primary energy consumption by 75%. However, one of the government's priorities is to increase the ratio of renewable energy resources to 30 % of total energy generation by 2023.

As seen in Table 2, Turkey had 85.2 GW of installed electricity generation capacity end of 2017. The breakdown by generation sources is as follows: 55.08% fossil fuels (natural gas, coal, liquid fuels etc.), 32.01% hydro, 7.65% wind, 4.01% solar and 1.25% geothermal. Almost all natural gas and around 40% of coal were imported. Therefore, Turkey needs to boost its power self-sufficiency by handling its rich potential of renewable energy sources.

TABLE 2 BREAKDOWN OF INSTALLED CAPACITY BY ENERGY RESOURCES IN 2016 AND 2017

POWER RESOURCES	INSTALLED CAPACITY (MW) (2016)	INSTALLED CAPACITY (MW) (2017)	ADDED CAPACITY (MW) (2016-2017)	INCREASE (%) (2016-2017)
Fossil fuels based thermal power plants	44,411.7	46,926.5	2,514.8	5.7
Hydroelectric	26,681.1	27,273.1	592	2.2
Wind	5,751.3	6,516.2	764.9	13.3
Solar PV	832.5	3,420.7	2,588.2	310.9
Geothermal	820.9	1,063.7	242.8	29.6
Total	**78,497.5**	**85,200.2**	**6,207.7**	**8.5**

National PV Support Programmes and Legislation

Solar energy is the most important renewable energy source, which is still untapped in Turkey with a potential of at least 500 GW. The photovoltaic installations started to take off in 2014 with 40 MW installed capacity and a fivefold increase to 208 MW in 2015 and 580 MW in 2016 and reached 832.5 MW at the end of 2016. By the end of 2017, the cumulative installed power reached 3,420.7 MW with a newly installed capacity of 2,588 MW equal to a 311% year-on-year growth.

According to Turkey's Renewable Energy General Directory (YEGM), the PV target for 2023 was 5,000 MW. In September 2017, the Turkish Ministry of Energy and Natural Resources (ETKB) announced that the new target is 10,000 MW for the next 10 years, which is divided into 4,000 MW for residential rooftop PV applications and 6,000 MW for industrial and commercials systems. First Renewable Energy Designated Areas (YEKA) tender finished last year and the tendered power plants may be installed in 2019, the second YEKA power plant tender will be announced this year while the installations are expected to be up and running in 2021.

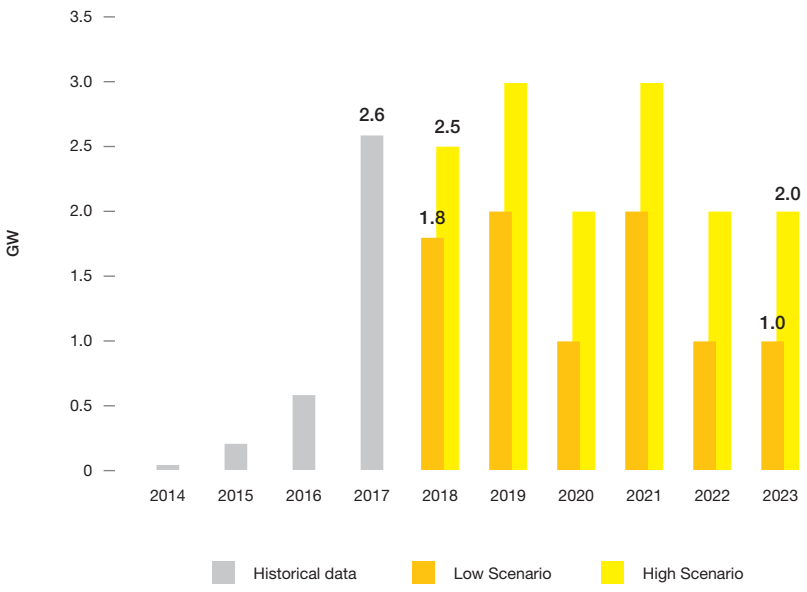
Drivers for Solar Growth

According to Law 6094, a purchase guarantee of 13.3 US Cents/kWh is offered for solar electric energy production for 10 years. The incentives are available for PV power plants that are or will be in operation before December 31, 2020. Some supplementary subsidies for local equipment products for the first five years of operation are as follows:

- PV module installation and mechanical construction (+0.8 US Cents/kWh),
- PV modules (+1.3 US Cents/kWh),
- PV cells (+3.5 US Cents/kWh),
- Inverters (+0.6 US Cents/kWh),
- Material focusing solar energy on PV modules (+0,5 US Cents/kWh).

The YEKAs are defined under a separate regulation issued in Law 5346. YEKA identify the feasible areas for large-scale renewable energy projects on privately or state-owned land. The YEKA tender for the Karapinar Renewable Energy Resource Area was won in March 2017 by the Kalyon Enerji-Hanwha Q Cells consortium that submitted the lowest bid, 6.99 US Cents/kWh, to construct the largest PV power plant with a total capacity of 1,000 MW (AC) in Turkey. The purchase guarantee price is valid for 15 years. As part of the award criteria, the consortium has to build a fully integrated 500 MW solar cell and module factory within the next 21 months, which was inaugurated in Dec. 2017.

FIGURE 20 TURKEY SOLAR PV MARKET SCENARIOS 2018 - 2023



Source: Günder Turkish Solar Energy Society

At the end of 2017, the Turkish Energy Market Regulatory Authority (EPDK) published a draft net metering regulation for rooftop PV installations with a power range of 3 kW to 10 kW. The new rules for residential PV will likely come into force in the second half of 2018, while other net metering rules for commercial and industrial solar power systems may be issued at a later stage.

Also there are many special projects that support the government and different EU funds. The Agricultural and Rural Development Support Agency (TKDK) projects, agricultural irrigation projects, Forest Ministry PV projects, municipality applications and ILBANK support are other main drivers for PV the Turkish PV market.

Industry and Market Development

By the end of 2017, there were 3,616 PV power plants (equal to 3,420.7 MW in total) in operation, of which only three (17.9 MW in total) are in the licensed segment. In Q1I2018, a total capacity of 1,170 MW was a installed. The share of rooftop applications was 15% of total PV power.

Regarding PV manufacturing activities, currently there is no manufacturer of feedstock, ingots and wafers in Turkey. While 3 companies produce solar cells, there are more than 30 PV module manufacturers in Turkey with an annual production capacity of more than 3,500 MW. Turkey also hosts a few manufacturers of PV module materials (glass, frames, etc).

The PV market in Turkey is growing very fast and development can be seen in all dimensions - from production to installation - with support and raising awareness in all levels of society.

Challenges

The FIT is currently the same for all PV segments – no matter whether if rooftop or utility scale. For the rooftop market to thrive, it would need extra support, like higher FIT, local content and low-interest lending facilities. An annual target for rooftop PV capacity needs to be set for a sustainable growth of the industry. Also bureaucracy needs to be reduced for all rooftop PV applications. Moreover, special incentives are needed for industrial and commercial rooftop PV.

While the Turkish industry has very big experience in exporting solar thermal products to Europe and MENA region, this needs to be expanded to the PV sector as well.

Author: *Faruk Telemcioglu, Günder Turkish Solar Energy Society*

TABLE 3 TURKEY'S INSTALLED PV POWER 2017-2018

	END OF 2017	JAN 2018	FEB 2018	MARCH 2018
LICENSED	17.90	22.90	22.90	22.90
UNLICENSED	3,402.80	3,455.80	3,919.20	4,567.40
TOTAL	**3,420.70**	**3,478.70**	**3,942.10**	**4,590.30**

6. GERMANY

A total of 1.76 GW of solar capacity have been installed in Germany in 2017 - that's the best performance since 2014. After over 800 MW was installed in the first 4 months of 2018, SolarPower Europe expects the German solar market to be significantly stronger. The Medium Scenario expects a 2.6 GW of new capacity in 2018, which would mean that the country will meet its annual 2.5 GW solar installation target for the first time in years.

As Germany will significantly miss its self-acclaimed 2020 CO_2 targets, the new government coalition agreed to issue additional tenders for PV and wind power, with both technologies getting additional annual volumes of 2 GW each in 2018 and 2019. While this will not lift demand to the record installation numbers of the 2010-2012 period of high and un-capped FITs, SolarPower Europe estimates that the market could exceed the 5 GW level in 2020/2021, depending on installation periods specified in these special tenders.

German Solar/RE Targets

Germany will not only fail to meet its 2020 40% CO_2 emissions targets; it is also expected to miss the EU 2020 climate goal in the so-called non-Emission Trading System (ETS) Segment. However, the new government coalition agreed to set a target aiming at a 65% renewables share by 2030. The long-term goal of fully decarbonizing the electricity mix by 2050 is also being debated. Matched with the decision to close all nuclear plants by 2023, these targets might provide a push for stronger solar development.

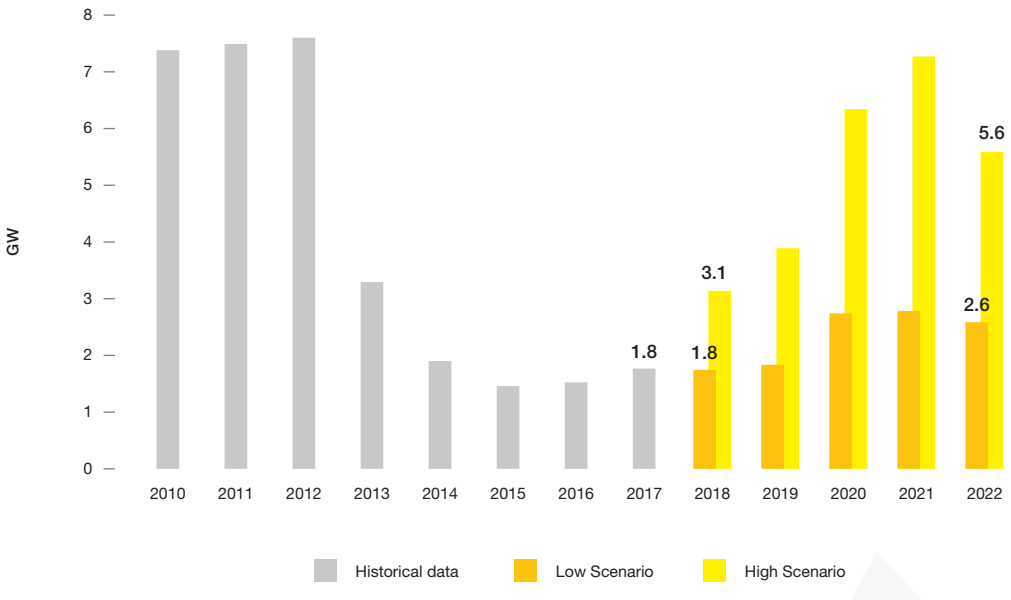
Drivers for Solar Growth

The Renewable Energy Sources Act (EEG) outlines the support to renewable electricity production, offering a feed-in tariff/self-consumption scheme for plants up to 100 kW, a feed-in premium for systems between 100 and 750 kW, and a tendering scheme for systems between 750 kW and 10 MW. According to the regulation, PV systems below 10 kW are fully exempted from EEG levies on self-consumed power, while larger systems are subject to 40% of the EEG levy, the surcharge on electricity prices that finances renewable energy deployment.

The latest EEG from 2017 sets a solar growth target between 2.3 and 2.5 GW annually. Depending on growth levels, feed-in tariffs rates are decreased or increased (breathing cap).

Regular tenders take place three times per year with a volume of 200 MW each. Although the maximum system size is generally only 10 MW, bids are very low and have been constantly decreasing since the start of the scheme in 2015. In the December 2017 tender, the lowest awarded bids were less than € 0.04/kWh for the first time.

FIGURE 21 GERMANY SOLAR PV MARKET SCENARIOS 2018 - 2022



Looking at the financial aspects, a number of investment support options in the form of grants and low-interest loans are provided by German Development Bank (KfW), which also offers a special scheme for energy storage. In 2017, nearly half of all newly built residential PV systems were built with battery storage systems.

Ground-mount versus Rooftop Solar Development

As the maximum PV system size is generally 10 MW in Germany, it is fair to say that the country doesn't really support 'utility-scale' systems today. However, around one fourth of solar capacity added in 2017 were ground-mounted systems above 750 kW, with the remaining share evenly distributed between residential, commercial and industrial installations. Looking at cumulative figures, almost half of the total capacity stems from commercial systems. Self-consumption and neighbor on-site tenant power schemes (Mieterstrommodelle) are encouraged through fiscal and regulatory schemes.

Challenges

The EEG law stipulates that further feed-in tariff systems won't be allowed once total PV installations in the country reach 52 GW. At the end of April 2018, Germany had 43.8 GW PV installed. Under the current trajectory and with the 'special tenders' for PV, this cap could be reached already in 2020. The German Solar Industry Association (BSW) warned in a position paper published in April 2018, that reaching the cap would result in an immediate collapse of PV demand from the rooftop segment, as new systems operators would not get a premium tariff for the not self-consumed power anymore, but only the very low wholesale prices. For this reason, removing the 52 GW cap is the most crucial action to ensure further solar growth in the German market.

BSW also asks for a 5 GW target per year and an exemption for rooftop systems larger 750 kW from the tender system. The new Mieterstrommodel, the scheme governing solar supply and sales between neighbours, is only attracting little interest so far.

Authors: *Raffaele Rossi, Michael Schmela, SolarPower Europe*

7. AUSTRALIA

After a two year hiatus in 2014-16 caused by an attempt by conservative Federal politicians to shut down the Renewable Energy Target (RET) to abolish the Australian Renewable Energy Agency (ARENA) and the Clean Energy Finance Corporation (CEFC), the Australian market took off in 2017. In 2017, Australia installed just over 1.3 GW of PV – around 80 MW was utility scale (>5MW), while around 30% of the total was small business and commercial systems with a new boom occurring in residential rooftop solar. The total installed base at end of March 2018 was 7.8 GW.

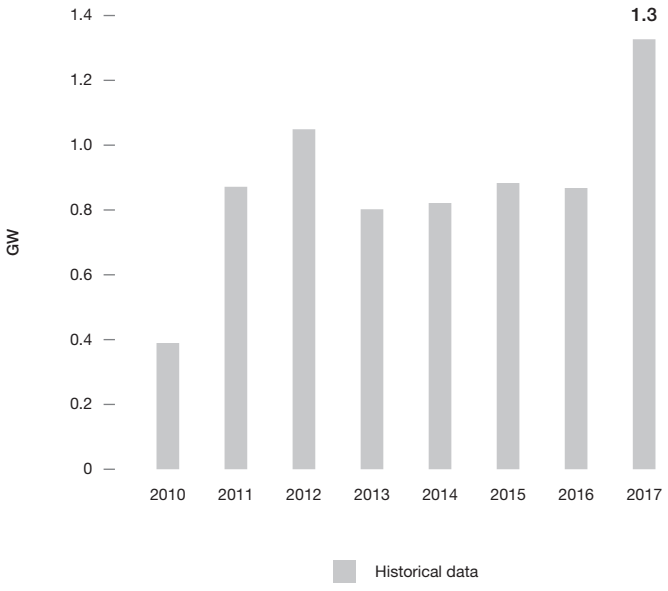
Australian PV Support & Export Payments

Although there are many rooftop PV systems still getting some generous premium feed-in tariff (FiT) payments from State & Territory schemes, all have been closed to new entrants since 2014 and many have ended. Various export payment schemes are available in every jurisdiction - varying from AUD 4.8c to AUD 15c-16c, but the primary savings comes from self-consumption offsetting retail power prices, which range from 19c-46c per kWh depending on location.

With a highly competitive rooftop market, PV systems are being installed from AUD$0.72/W to AUD$1.97/W with a median price of AUD$1.27/W. The average system size is now over 6 kW, although some of that is a reflection of larger commercial rooftop systems being installed with residential rooftop systems sitting around 5 kW. System design and specification for all classes has moved from maximising PV output to matching output to consumption patterns and increasingly to include battery storage systems.

The small scale systems, up to 100 kW, have access to an upfront payment from the Small Technology (renewable energy) Certificate (STCs) trading scheme under the RET which is a carbon price mechanism based on the offsetting of emissions in the grid by the PV output. This is declining annually from 2017 out to 2030, but is still a capital reduction on purchase of around 25%. Large scale PV arrays operate with the Large Generator (renewable energy) Certificate (LGCs) also under the RET trading lately at AUD$85/MW – but paid on measured generated output into the grid.

FIGURE 22 AUSTRALIA SOLAR PV MARKET 2010 - 2017



Source: Smart Energy Council

Potential for Growth & Risks in Australia

Critically the primary national support scheme, the RET, ends in 2020 for new entry large scale systems and already the signs are that the LGC prices will fall dramatically before then. There is currently no national replacement policy that would support large scale PV, or other renewable energy deployment beyond 2020. There are major policy changes being considered the primary one of which is the proposed National Energy Guarantee (NEG) – a significant policy risk for proposed large scale deployment after 2020 and being planned now.

The NEG is an attempt to link emissions policy with energy policy that had a fraught start with little detail, but has made some improvements in its design. The major sticking points remain unresolved: the lack of robust science based emissions reduction targets; the low level of the target for the electricity sector at 26-28% by 2030; and the lack of the States to have higher targets and their own renewable energy programs. The consequences if the NEG is agreed as it now drafted are that Australian emissions goals are unambitious and unaligned with the Paris less than 2 degrees aim and the low electricity sector target means that no large scale new generation of any type is likely to be built out to 2030.

The Small Scale Emissions Reduction (SRES) component of the RET, due to end in 2030 was saved by the action of the Smart Energy Council and other civil society participants in 2014 and is unlikely to be under any new political threat, although the value of the STCs is an unknown. The strong interest of consumers, largely drive by increasing retail prices for electricity, and the high efficiency of the Australian approvals and installation processes along with continued component price drops has the rooftop market booming.

Outlook 2018

The Australian market remains bullish for rooftop PV with more than 1.8 million homes having solar PV with the highest per capita penetration in in the world. The first few months of 2018 have again broken records not seen since the sunny days of premium FiTs in 2011-12. This suggests a possible 1.4 GW rooftop PV install this year with ~30% being businesses, >46,000 of which already have > 1GW installed and opportunity increasing in that space.

The future beyond 2020 has some uncertainty, but the existing RET is driving some massive deployments of utility scale PV with around 800 MW already commenced in 2018 and another tranche of around 1 GW for 2019. We have two State renewable energy programs that might drive the roll-out even higher. Victoria has already run its first reverse auction for its Renewable Energy Auction Scheme which sought up to 550 MW of large scale, technology neutral renewable energy, and up to 100 MW of large scale solar-specific renewable energy. This first round had more than 15 proposals come through the door, offering 3,500 MW of new wind and solar projects! The Queensland government is proposing a similar scheme for solar only of an initial 400 MW due out this year. It is worth noting that these are opportunities for PV industry players with no single large player or players in the market – the top 20% of companies have just 30% of sales – so come down under!

Author: *Steve Blume, Smart Energy Council*

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8. SOUTH KOREA

In 2017 around 1,100 MW of new PV installations were added in South Korea, up from 886 MW in 2016. The country has now reached a total cumulative capacity of 5.5 GW at the end of 2017, an amount that SolarPower Europe in its Medium Scenario expects to more than double to 14.5 GW. Since 2014 Korea is steadily among the top 10 PV markets, but is likely to lose that position in 2018 as several other countries are more ambitious in the short run.

Korean Solar/RE Targets

Under the governmental strategy set out by the Ministry of Trade, Industry and Energy (MOTIE) at the end of 2017, renewables are targeted to generate 20% of South Korean electricity by 2030. The new energy plan envisions 58.5 GW of total installed renewable capacity by the end of this period, compared to 11.3 GW currently installed. This would correspond to 33.7% of the nation's total installed energy capacity in 2030, a strong leap from the current 9.7%. Solar PV is expected to take the lion's share of renewable deployment, with over 50% of the new additions equal to 30.8 GW. By contrast, Korea targets wind power capacity to reach only 16.5 GW by 2030. Overall, solar power is planned to cover 63% of the renewable electricity generation.

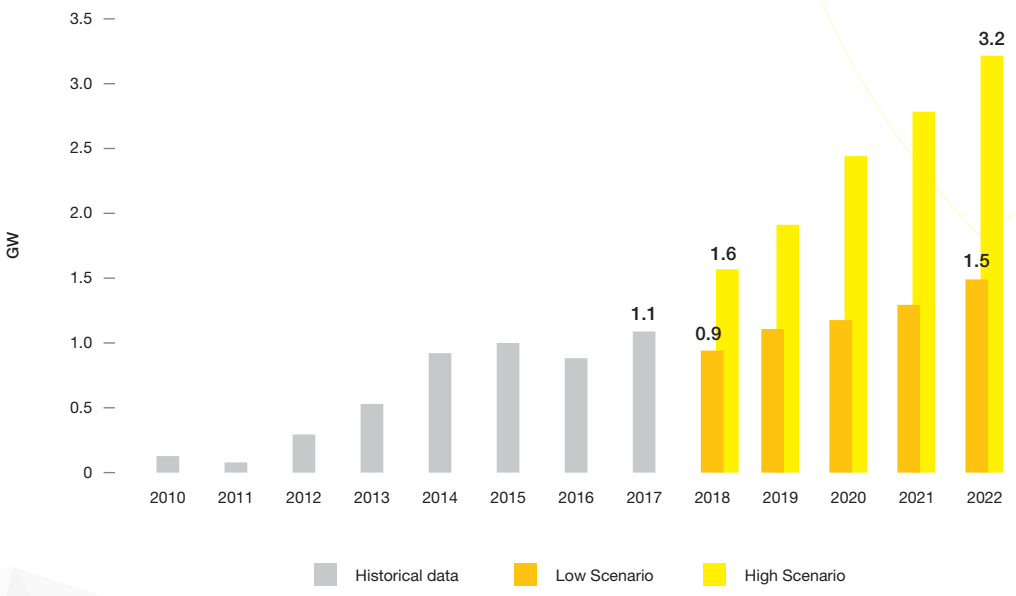
Drivers for Solar Growth

A series of financial and non-financial incentives and programmes have been set in place to support PV development to meet South Korea's solar targets.

The Renewable Portfolio Standards (RPS) scheme, launched in 2012 to replace the Korean feed-in tariff and active until 2024, is the major driving force for PV installations in Korea, especially small-scale systems. It mandates that utilities exceeding 500 MW are required to supply 10% of their electricity from new renewable sources by 2024 (from 2% in 2012). The bulk of PV installations in the country (68%) have been installed under this programme.

The 2014-started 4th Basic Plan for the Promotion of Technological Development, Use, and Diffusion of New and Renewable Energy sets out various subsidy measures promoting, among others, eco-friendly energy towns, energy-independent islands and PV rental programs in which households paying a low rental fee can use PV systems without investment and maintenance costs. Subsidies for regional development support renewables deployment in remote areas such as islands and systems owned or operated by local authorities.

FIGURE 23 KOREA SOLAR PV MARKET SCENARIOS 2018 - 2022



Incentives for solar PV in buildings exist under the Home Subsidy Programme, the Building Subsidy Programme and the Public Building Obligation Programme. The first has the goal of equipping one million homes with renewable sources; 60 to 100% of the upfront costs are covered for PV systems with a capacity up to 3 kW. The Building Subsidy Programme targets PV installations in large buildings (below 50 kW) through grants that cover up to 50% of installation costs. Lastly, the Public Building Obligation Programme sets out sustainability requirements for large public buildings stating that more than 15% of their energy consumption has to come from renewable sources in 2016, with the target reaching 30% by 2020.

Focus on Distributed Solar Generation

Facing an issue with its mountainous terrain that makes it difficult to find areas for real large utility-scale PV plants, the South Korean government has identified distributed power production as one of the key policy goals for its energy planning. According to the national energy plan, distributed power generation should contribute to 15% of total generation by 2035 compared to the current 5%. Due to its characteristics, solar will play a central role in the development of distributed generation. Currently, small utility-scale installations account for roughly 90% of the total cumulative installed capacity, with distributed PV systems slightly above 10% of total installations. The government's commitment to developing smart grid technologies, including smart meters, energy storage systems and infrastructure for electric vehicles is another reason for the focus on distributed solar.

Challenges

Korea Electric Power Corporation (KEPCO) still enjoys a monopoly over transmission, distribution and also remains the sole purchaser in the power sales business. Given this structure, there are no mechanisms available for private companies to purchase renewable energy power directly from independent solar power producers.

Authors: *Raffaele Rossi, Michael Schmela, SolarPower Europe*

9. BRAZIL

In 2017, Brazil reached a new landmark in solar PV installed capacity, with 1 GW connected to the national grid and in operation. This amount includes both centralized (large-scale, above 5 MW) and distributed (equal or below 5 MW) solar PV generation market segments, respectively 935 MW and 120 MW in terms of new installations. These historical numbers indicate the vast potential of solar PV in the country, as well as the growing competitiveness of the technology amongst electricity sources available.

By the end of 2018, the Brazilian Photovoltaic Solar Energy Association (ABSOLAR) projects the cumulative solar PV installed capacity will more than double and reach close to 2.4 GW of cumulative installed capacity in operation in the country. ABSOLAR estimates that a total of 1.25 GW will be installed in 2018, with 1,100 MW coming from centralized solar PV plants and 150 MW from distributed projects. The consistent growth in Brazil's solar PV market is linked to the successful engagement the solar sector has been developing with government officials, decision makers and the public opinion. There have been many positive developments in Brazil in the legal and regulatory frameworks, tax incentives and new financing lines, amongst others.

Solar PV Targets in Brazil

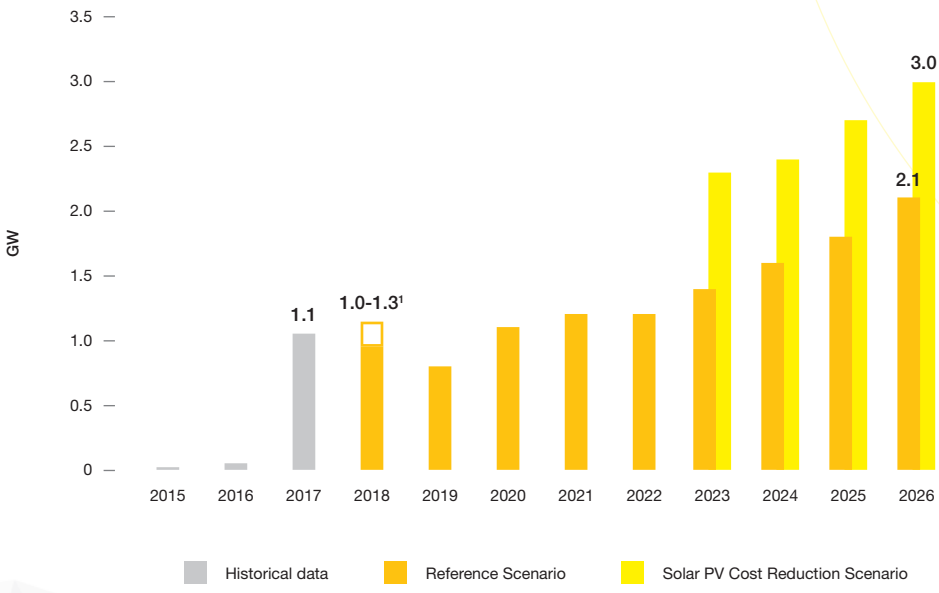
The Brazilian Nationally Determined Contribution (NDC) to the Paris Agreement defines a target share from non-hydro renewables (i.e. solar PV, wind and biomass) of at least 23% of the national electricity matrix by 2030. The country has not defined specific targets per energy source, however the Brazilian Energy Research Office (EPE), forecasts in its PDE2026 (10-Year Plan) solar PV will reach a cumulative installed capacity of 13.3 to 16.8 GW by 2026, in its reference and optimistic scenarios, respectively. In terms of new installations this growth means a yearly solar PV added capacity of between 1 GW and 2 GW from 2020 onwards.

ABSOLAR's considers these numbers to be a low estimate and conservative projection, and recommends a national PV target of at least 30 GW by 2030.

Drivers for Solar Growth

- **Reserve Energy Auctions (Leilão de Energia de Reseva – LER) and New Energy Auctions (Leilão de Energia Nova – LEN):** Brazil has approximately 3.7 GW of already contracted solar PV power plants, 1.25 GW of which are already operational and connected to the grid, as of Q1/2018. The year of 2017

FIGURE 24 BRAZIL SOLAR PV MARKET SCENARIOS 2018 - 2026



Source: ABSOLAR
Footnote 1: 1.0 from ABSOLAR, 2018. 1.25 from ABSOLAR, based on official data from EPE, 2017.

represented an important year for the delivery of new projects, as well as execution of investments planned by the sector, as several solar PV power plants contracted by the Federal Government thorough electricity auctions during 2014 and 2015 reached completion and started operations. The New Energy Auction held at the end of 2017 (LEN A-4/2017) was a milestone for the Brazilian PV market, as solar PV projects were contracted for the first time at an average selling price lower (US$ 44.31/MWh) than that of hydro, biomass and fossil fuel power plants. This brought solar PV to a new level of competitiveness compared to other electricity sources in Brazil. Solar PV's competitive pricing was reinforced in the following auction, held in April 2018, when the technology reached a record-low average selling price of US$ 35.25/MWh.

- The Brazilian Net-Metering (Sistema de Compensação de Energia Elétrica – SCEE): allows net-metering of renewable electricity produced directly by the end consumer (99.3% of which are solar PV systems up to 5 MW), and has experienced fast growth of more than 100% per year for the last 4 years, driven by an increase of more than 50% in electricity tariffs in recent years. Brazil's net-metering model was improved in 2015 with the direct engagement of ABSOLAR representing the PV sector, currently allowing not only local electricity generation and consumption, but also virtual net-metering and community solar mechanisms. As a result, this market segment is seeing the development of several innovative business models for distributed generation PV, such as direct sales, solar communities, cooperatives, leasing, third-party ownership, amongst others.

National Solar PV Value Chain

The PV value chain in Brazil also shows signs of strengthening. There are currently more than 30 locally-established manufacturers in the country (including national companies and international subsidiaries), more than 400 companies supplying raw materials, components, equipment and services to manufacturers, as well as more than 2,750 companies directly serving the end consumers, the majority of which are small installers operating in the distributed generation solar PV market segment. Regarding the local industrial environment, Brazil currently hosts manufacturers of PV modules, inverters, fixed-tilt racking structures, trackers, cables and batteries. Since 2013, with the gradual construction and activation of new PV module factories, Brazil has increased its national production capacity to approximately 1 GW/year as of the end of 2017.

Challenges

Despite the positive growth, the cumulative solar PV installed capacity currently represents less than 1% of the national electricity matrix. In order to become a "solar PV superpower", as its potential would certainly allow it to be, Brazil has to strengthen its legal and regulatory frameworks, accelerating new investments from the end consumers, as well as new national and international players, in this vast and promising emerging market. To that end, ABSOLAR has been working to bring forward strategic propositions and recommendations from the solar PV sector to key decision makers of the federal, state and municipal governments, in segments such as centralized generation, distributed generation and local value chain, directly contributing to the establishment of progressive regulatory, financing and tax programs capable of bringing the Brazilian solar PV market and sector to the next level in terms of scale, competitiveness, professionalism and market opportunities.

Authors: *Dr. Rodrigo Lopes Sauaia, CEO; M.Sc. Stephanie Betz, Technical and Regulatory Analyst, ABSOLAR*

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3 THE EUROPEAN SOLAR MARKET

2000 – 2018 UPDATE

At first glance, 2017 was a good year for solar in Europe. Newly installed capacities on the continent grew by 31% to 9.2 GW. This strong up rise follows a several year downturn trend that began in 2012 and bottomed in 2016. But when looking only at the European Union, there was no growth at all – it basically stagnated at 5.9 GW. While European solar was lifted by strong solar demand in Turkey, the EU-28 still suffered from the UK's solar 'exit.'

The growth of the European market was even stronger than SolarPower Europe had forecasted in the Medium Scenario of last year's GMO. While we had anticipated a 1.8 GW market increase, it actually improved by 2.2 GW to 9.2 GW. However, without Turkey, which surprisingly boosted its market to 2.6 GW in 2017, Europe would have actually decreased by 6%.

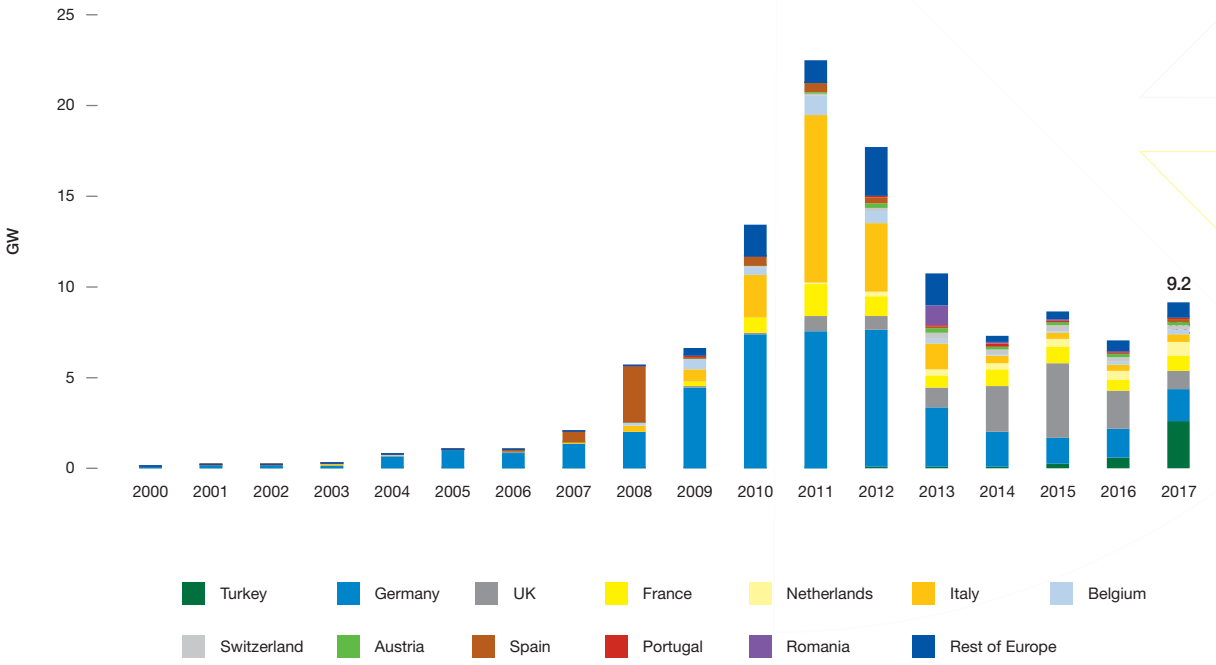
Europe's new No. 1 solar market is actually only partly European – from a geographical perspective **Turkey** is obviously both a European and an Asian/Middle Eastern country; but in this survey it has been traditionally included in the European segment. However, Turkey's solar market performed remarkably in 2017, rising nearly 4.5 times or 343% to 2.6 GW, compared to the 584 MW added in 2016, when it also made a very strong jump from only 191 MW in 2015. While there was some confusion about the 2018 numbers, discussing if actually only 1.8 GW was grid-connected and the rest 'only' installed or under development; but in the end we went with the official 2017 number from Turkey's national electricity transmission company TEIAS – and that was 2.6 GW, resulting in a total installed PV capacity of 3.4 GW. Turkey's rapid recent solar development is even more noteworthy when taking into consideration the political turmoil following the failed coup d'état in 2016. In the end, the feed-in tariff for the so-called 'unlicensed' solar systems at 12.3 US cents/kWh, which can be even combined with additional subsidies, has been so attractive, that primarily local financing has enabled this long-awaited impressive Turkish solar boom.

Germany stayed distant second. But at 1.8 GW, the market grew 15% year-on-year, after it added almost the same capacity in the two years before – 1.52 GW in 2016 and 1.45 GW in 2015. Solar tenders for systems have been a very successful tool to drive down solar tariffs in Germany. Although the maximum system size is generally only 10 MW, bids are very low and have been constantly decreasing since the start of the scheme in 2015. In the December 2017 tender, the lowest awarded bids were less than €0.04/kWh for the first time. Around one fourth of solar capacity added in 2017 were ground-mounted systems, with the remaining share evenly distributed between residential, commercial and industrial installations, whereas nearly half of the new residential systems were installed together with a battery storage system. However, despite the decent 2017 growth, Germany again missed its annual 2.5 GW solar installations target.

3 EUROPEAN SOLAR MARKET

2000 – 2018 UPDATE / CONTINUED

FIGURE 25 EUROPEAN SOLAR PV ANNUAL GRID CONNECTIONS 2000 - 2017



The UK continues its steep downhill trip, after its government slashed its solar support in 2016. While the final big batch of the form subsidy pipeline was installed by March, for the rest of the year monthly PV additions remained mostly below 20 MW. In total, only 954 MW was installed, down over 50% from 1.97 GW in 2016, after it had already dropped 52% from 4.1 GW in 2015. The only positive solar headline from the UK in 2017 was about a subsidy free 10 MW solar plus 6 MW storage system. However, even this special project is yet waiting for a wave of followers as a level regulatory playing field still needs to be established.

While the French market increased by 56% to 873 MW in 2017, from only 559 MW in 2016, it has not reached the 2015 level of 895 MW. But after regulatory changes regarding self-consumption systems, which had been hindered by levies and complicated regulatory frameworks and a number of solar tenders issued and awarded, the stage finally seems to be set to enter the gigawatt level in 2018.

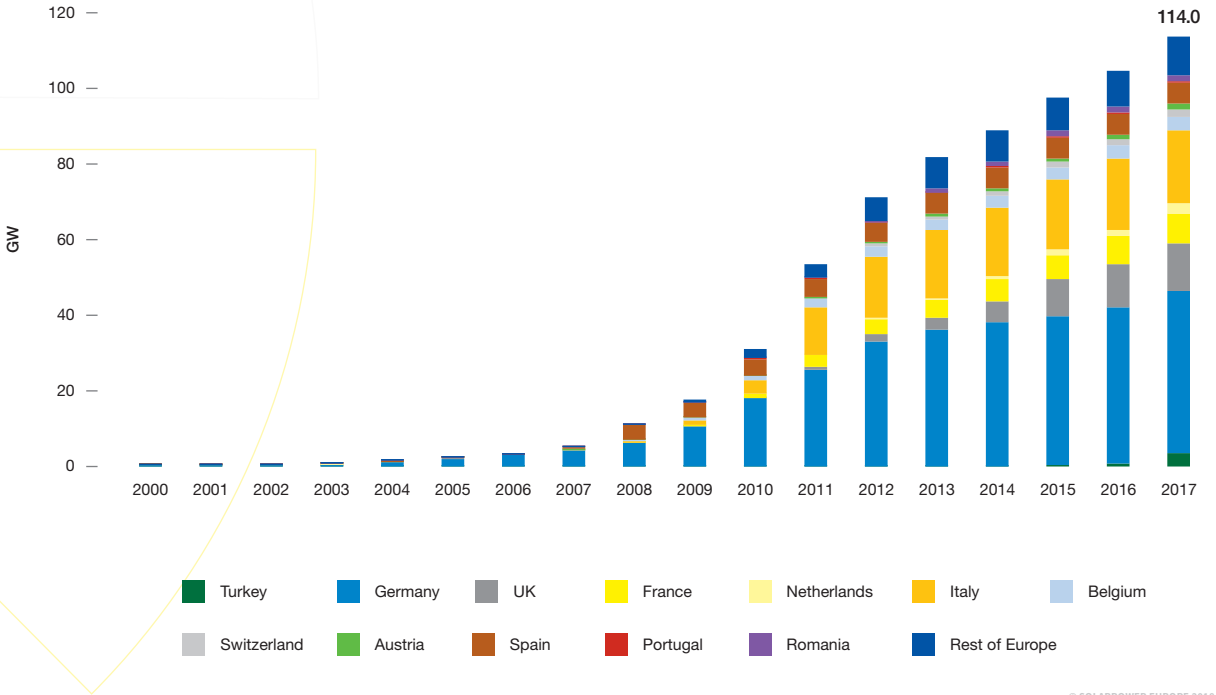
The Netherlands was the only other European market that added more than 500 MW in 2017; in fact, the market increased by 54% to 770 MW. While growth continued to be mostly driven by rooftop systems, the ground-mount segment fuelled by the country's SDE+ program for large-scale solar and RE projects is starting to take off – in 2017, its share was 8%. But the pipeline is quickly getting larger: In the SDE+ 2017 Spring round, solar won 2.4 GW, in the 2017 Autumn round 1.9 GW.

Spain's market nearly tripled in 2017, but the final volume of 135 MW was still very small. Still, the country's solar sector was able to mark the most outstanding victory in Europe last year, when PV companies won 3.9 GW in the July 2017 auction, after they went home basically empty-handed in the first renewables auction of that year.

In summary – and although the aggregated installation numbers don't show – the picture was rather positive for solar in the European Union: 21 of the 28 member states installed more PV in 2017 than the year before. If it were not for the UK, EU-27 solar would have grown by 29% last year.

When looking at total installed capacities in Europe, hardly anything has changed compared to last year. Two countries – Germany (37.7%) and Italy (17.0%) – still operate over half of the total Europe solar power generation fleet (see Fig. 26). The UK remains on rank 3,

FIGURE 26 EUROPEAN TOTAL SOLAR PV GRID-CONNECTED CAPACITY 2000 - 2017



though quite some distance away from the leading duo (11.1%), while France keeps the fourth spot (7.0%). Spain stays on position five (4.9%) although it added less than 750 MW in the last 6 years. No wonder that Turkey's stellar 2017 performance was enough to get the country rank 6 (3.0%) The big solar picture of Europe for 2017 hasn't changed: the European solar power sector continues its transition phase, but is getting ready for the next growth phase.

3 EUROPEAN SOLAR MARKET

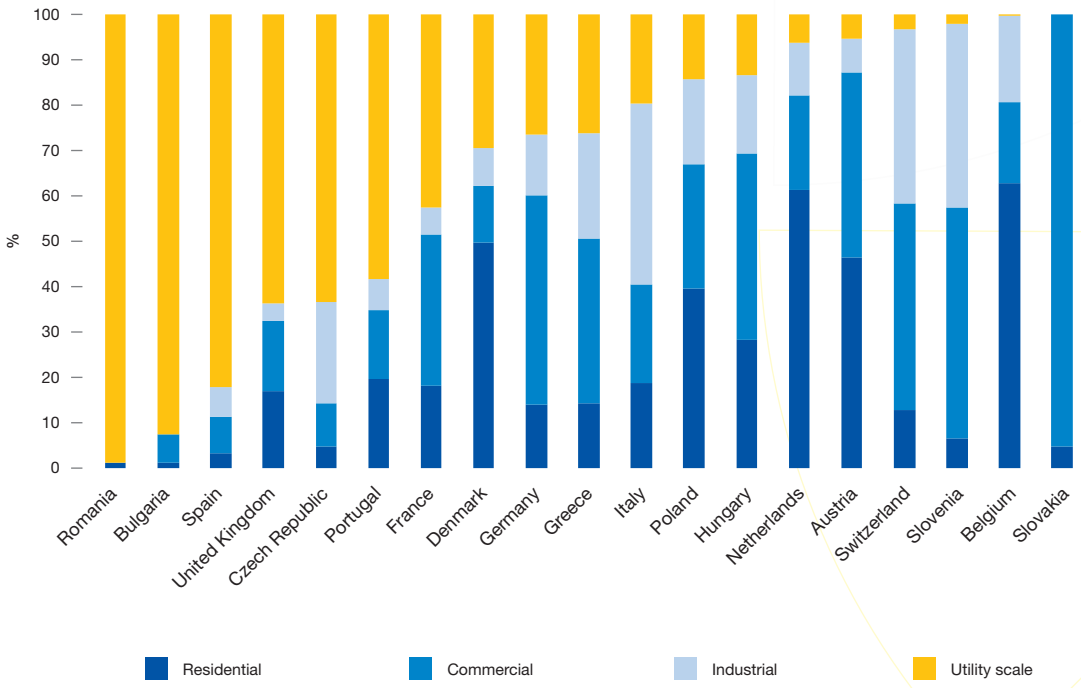
2000 – 2018 UPDATE / SEGMENTATION

Solar market segmentation in Europe continues to show a dispersed picture (see Fig. 27).

All countries that had offered for a short while very lucrative uncapped FIT schemes in the past are still dominated by the utility-scale solar segment in Europe. This is true for Romania, Bulgaria, Czech Republic, which see hardly any solar demand these days, but as well for Spain. The latest example joining is the UK. Other markets, like Germany, where the earlier large-scale FIT program was replaced by an auction system, the distribution is much more even. In a number of markets, like Austria, Switzerland and the Netherlands, ground-mount PV has never played a role – they have been always focussing on rooftop solar. At least for the Netherlands, that is expected to change quite a bit in the near future.

In 2017, around 26% of solar systems were installed on residential rooftops, around 18% on commercial roofs, while the industrial segment accounted for 20% and the utility market for 36%.

FIGURE 27 EUROPEAN SOLAR PV TOTAL CAPACITY UNTIL 2017 FOR SELECTED COUNTRIES



3 EUROPEAN SOLAR MARKET
PROSPECTS 2018- 2022

The writings on the wall are clear: as of 2018, PV will grow very strong both in Europe and EU-28 for the next few years. There are several reasons for this next solar growth phase:

- **EU 2020 targets:** A number of EU governments, which still have some way to go to meet their individual RES targets, have been strengthening their support for solar as they have realized that the technology is very popular and one of the lowest-cost means to increase their renewables share and reduce CO2 emissions. Germany's new government, for example, has announced to issue additional 'special' tenders for both solar and wind (2 x 2 GW each) in 2019/20.
- **Tenders:** Solar tender tools have shown to the public the low cost of solar power and have been embraced by several European countries, substituting traditional uncapped feed-in tariff schemes. Moreover, solar has proven that it can win technology-neutral tenders even against on-shore wind power when the boundary conditions are properly set. While solar was awarded nearly 3/4 of the tender volume in the second Spanish renewables tender in 2017, a pilot solar/wind tender in Germany was won 100% by solar bidders in 2018.
- **Self-consumption:** Solar is much cheaper than retail electricity in most European markets and will quickly continue to reduce in cost, which will be a key driver for people and companies to invest in on-site power generation. Moreover, in developed European PV markets consumers are more and more starting to understand that solar often makes economic sense even without high feed-in tariffs or other subsidy 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 many consumers prefer to have better control over their energy bill.
- **Emerging & Reawakening Markets:** The low cost of solar is attracting European countries that haven't been very active in the field in the past, like Belarus and Russia. European solar pioneers are turning to low-cost solar again, such as Spain.
- **Corporate sourcing:** In a number of European markets, we are now starting to see direct bilateral PPAs with solar increasingly competing with wholesale power markets. This development will be seen primarily in those European countries with the widest spreads between solar and wholesale power prices. While there has been talk about pure PPA based projects for a while in Spain, in 2018 the first are being built. However, the pipeline for these projects has quickly ballooned to over 30 GW.
- **Regulation:** The European Commission and national governments have been addressing the needs for a flexible renewable energy system, working on a new electricity market design framework and implementing new tools and regulations to overcome barriers that have inhibited solar's growth possibilities in recent years.

3 EUROPEAN SOLAR MARKET

PROSPECTS 2018- 2022 / CONTINUED

FIGURE 28 EUROPEAN ANNUAL SOLAR PV MARKET SCENARIOS 2018 - 2022

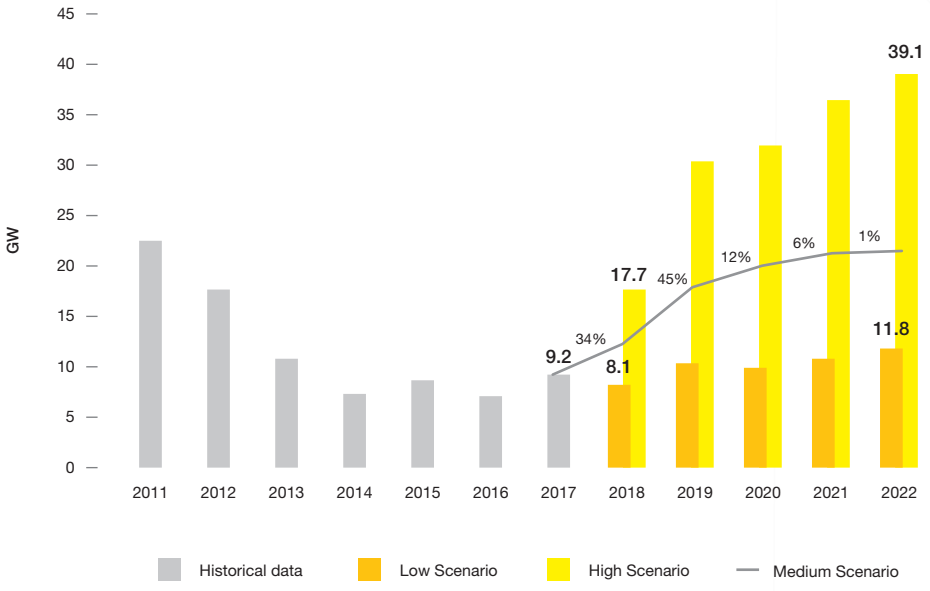


FIGURE 29 EUROPEAN TOTAL SOLAR PV MARKET SCENARIOS 2018 - 2022

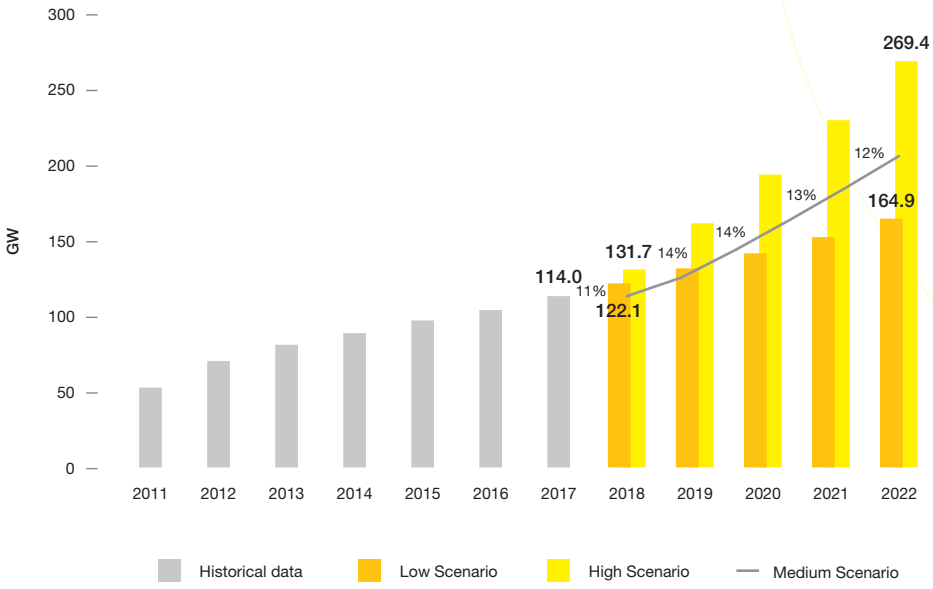


FIGURE 30 EU28 ANNUAL SOLAR PV MARKET SCENARIOS 2018 - 2022

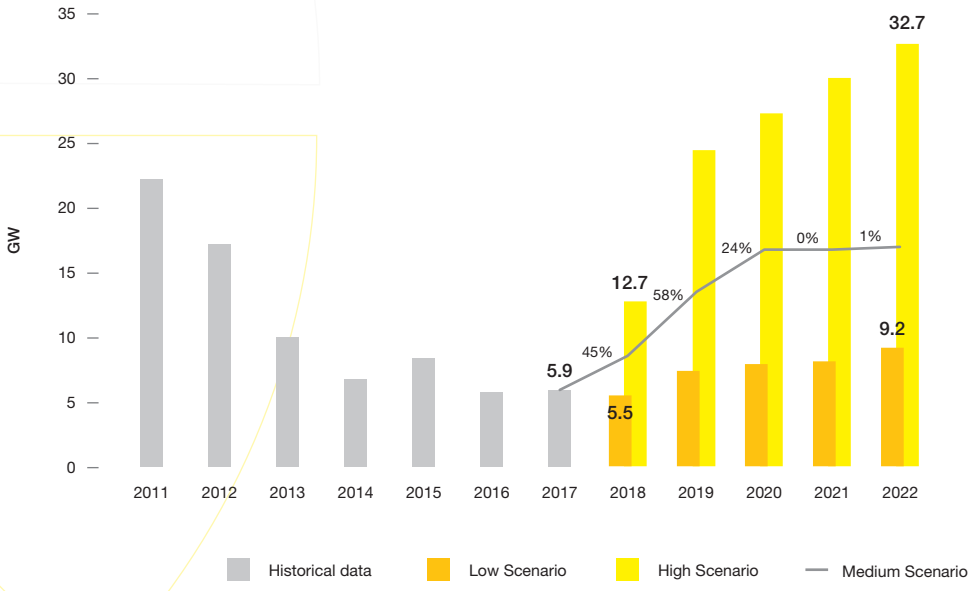
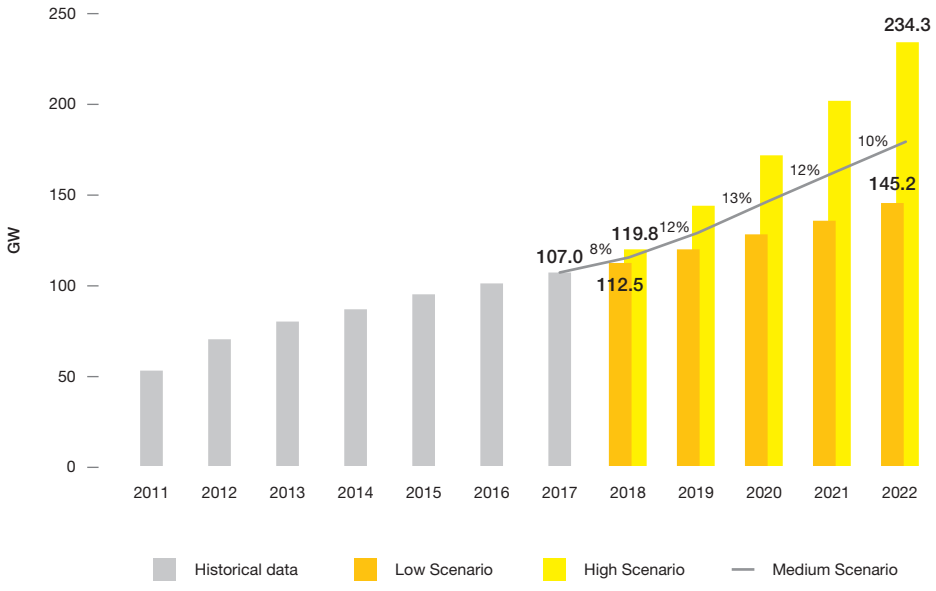


FIGURE 31 EU28 CUMULATIVE SOLAR PV MARKET SCENARIOS 2018 - 2022



3 EUROPEAN SOLAR MARKET

PROSPECTS 2018- 2022 / CONTINUED

As last year, the spread between our High and Low Scenarios is very large for the next 5 years. The way solar will develop in Europe will fully depend on policy makers in Brussels and the European countries.

Our Medium Scenario expects strong growth for the EU-28 until 2020, driven primarily by the 2020 EU renewables targets and the recent tender announcements (see Fig. 30). This year, we see 45% growth to 8.6 GW, for 2019, we even expect demand to surge by 58% to 13.5 GW. After 2020, countries will have 10 years to meet the next clean energy targets. Moreover, there is only limited visibility on how the European clean energy legislation and national implementation for 2020-2030 will finally look like. Based on the current state of discussion, we anticipate hardly any growth in 2021 and 2022. For Europe as a whole, the growth rate is still impressive in 2018/19 but not as steep (34%, 45%) for the next years, and the following flattening not as pronounced as for the EU only. Here, the anticipated further growth in Turkey and strong demand for low-cost solar power make the difference (see Fig. 28).

If Europe fully embraces the enticing business case of low-cost solar, in 2022 the market could reach 39.1 GW, which would be nearly twice as big as in the record year of 2012 with 22.4 GW. EU demand would be somewhat smaller but still reach 32.7 GW. This High Scenario would require elimination of any trade barriers in Europe, any prohibitive taxes on self-consumption/storage, or any other barriers that could slow down flexible and distributed solar power. It also anticipates there will be no macro-economic issues in Europe.

Conversely, if the bulk of European governments fully disregard solar's potential and the benefits for their citizens, or another financial crisis would resurface, even the Low Scenario could become reality, resulting in annual additions of only 11.8 GW in Europe or 9.2 GW in the EU in 2022.

When looking at total PV market growth in Europe, a perfect growth case would result in a cumulative installed capacity of 269.4 GW in 2022, but even the Medium Scenario foresees constant double-digit growth rates to 206.8 GW in 5 years (see Fig. 29). Medium and High Scenarios for the EU show a similarly optimistic outlook, resulting in 179.6 GW and 234.3 GW, respectively (see Fig. 31).

The solar 'weather forecast' for European countries between 2018 and 2022 is now mostly sunny, with only a few cloudy regions and one rainy spot. Again, the UK is the only rainy European country expected to grow only with a 3% compound annual growth rate until 2022.

We anticipate the same Top 3 markets to contribute the largest shares of new solar capacity until 2022 as in our previous GMO – Germany, France and Turkey. We become more bullish on all three and now expect each of them to install over 10 GW.

As Germany is lagging behind meeting its climate targets, the country will push solar and wind as the lowest-cost solutions for this problem over the next few years. One issue might be that the two special tenders announced by the new government will bring total installed solar capacity to the country's 52 GW solar cap, which needs to be fixed.

After France has worked a lot on regulatory issues that have hindered the country's solar sector, the nation is now ready for annual gigawatt-scale solar additions.

After Turkey managed to find ways to access financing for its solar sector following its political turmoil, its recent currency issues pose another risk. Still, the Turkish solar business case remains generally good – the country's population and its need for power continues to grow quickly, there is plenty of space, excellent irradiation and no power plant overcapacities.

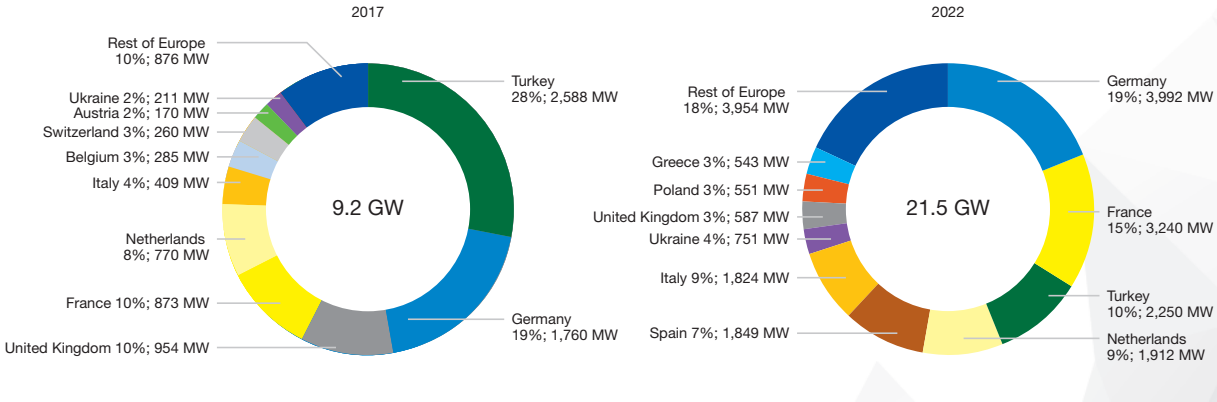
Our Medium Scenario now expects the 15 fastest growing European markets to install each at least 1.3 GW until 2022 (up from at least 1 GW in GMO 2017), with Germany as the largest one adding 20.3 GW (up from 12.5 GW), France over 11.7 GW (up from 8 GW) and Turkey 10.9 GW (up from 6.6 GW). In total, we anticipate Europe to add 92.8 GW (up from 62.9 GW) from 2018 to 2022, based on our most probable Medium Scenario.

FIGURE 32 TOP EUROPEAN SOLAR PV MARKETS' PROSPECTS

	2017 **Total Capacity** (MW)	2022 **Total Capacity Medium Scenario by 2022** (MW)	2018 - 2022 **New Capacity** (MW)	2018 - 2022 **Compound Annual Growth Rate** (%)	**Political support prospects**
Germany	42,973	63,237	20,264	8%	
France	7,999	19,702	11,703	20%	
Turkey	3,420	14,320	10,900	33%	
Spain	5,627	14,460	8,833	21%	
Netherlands	2,681	11,430	8,750	34%	
Italy	19,392	26,924	7,533	7%	
Ukraine	1,152	4,435	3,283	31%	
Poland	261	2,361	2,099	55%	
United Kingdom	12,676	14,742	2,065	3%	
Switzerland	1,955	3,957	2,003	15%	
Russia	158	1,988	1,830	66%	
Austria	1,263	2,922	1,659	18%	
Belgium	3,708	5,325	1,617	8%	
Greece	2,623	4,210	1,587	10%	
Sweden	317	1,601	1,284	38%	
Rest of Europe	7,651	14,172	6,521	13%	

In 2022, Germany is expected to be Europe's largest solar market again, ahead of France and Turkey, which is the same order as in our GMO 2017, according to the Medium Scenario (see Fig. 33).

FIGURE 33 CAPACITY ADDITIONS AND SHARES OF TOP 10 EUROPEAN SOLAR PV MARKETS IN 2017 AND 2022



130 MW, California, USA.

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4 GLOBAL MARKET OUTLOOK FOR SOLAR POWER

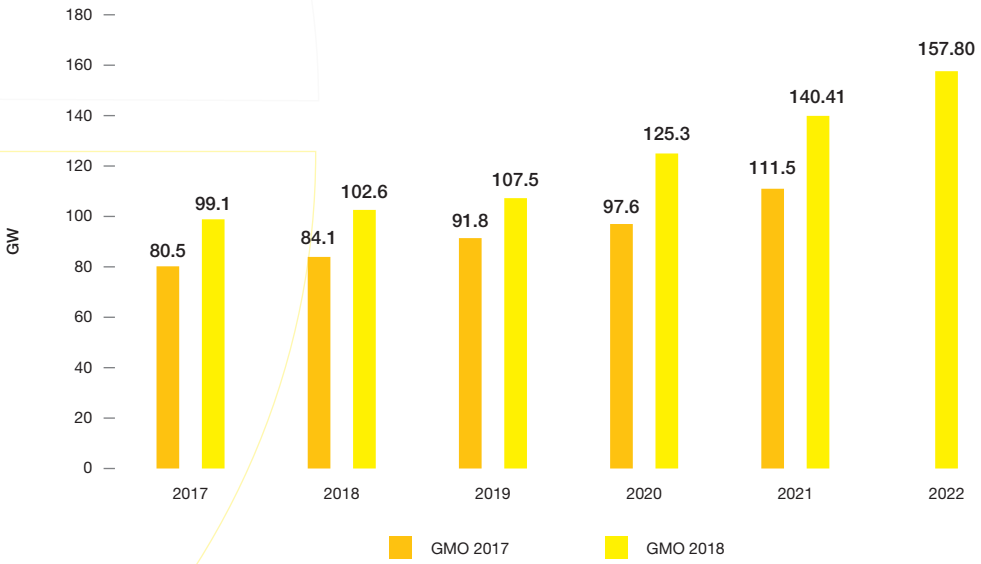
Solar developments have positively surprised everyone again last year – and they will continue to do so in the future. While no one believed the market would grow in 2017 after the stellar 50% growth rate the year before, we have again seen market demand surge by over 30%. For 2018 some experts in the sector are concerned about China's recent announcement to cut solar subsidies, with some analysts predicting a market contraction. SolarPower Europe estimates in our most realistic Market Scenario that the global solar market will grow in 2018 and the years to come. In fact, we are significantly more optimistic than in our GMO 2017 (see Fig. 34).

While the world can be thankful to China that they have financed the growth of the global solar sector in the last few years, it is high time for the global market leader to reform its solar sector and transition from overpriced uncapped feed-in tariffs to more sustainable incentive schemes. There is no doubt China will stay committed to solar – it is one of the few countries that has a clear vison about the technology's potential and considers solar a key tool to fight air pollution and climate change. Solar is a major pillar of China's future energy system as it quickly pushes for electrification of its transport sector. While we expect the Chinese solar market to decrease this and the next year, it will grow strongly again as of 2020, once the Chinese administration has restructured its solar market. On a positive note – we will now see more diversification of solar demand. While in 2016, only seven countries installed over 1 GW, in 2017, the number increased to nine, and this should be 14 in 2018.

While there is so much to be positive about in relation to solar, SolarPower Europe continues to see four major topics that need to be addressed to enable an even faster and more sustainable growth for solar:

It is key for regions and countries to establish **reliable governance** frameworks to navigate their economies towards clean energy with ambitious and binding renewables targets. This provides investor security and transparency on ambition. Subsidies for inflexible power technologies must be eliminated and phase out plans set up to manage communities transitioning from the most polluting forms of energy.

FIGURE 34 COMPARISON MEDIUM SCENARIO GMO 2017 VS 2018



It is of utmost importance to have an **electricity market design** that enables profitable investments and the operation of flexible renewable energy sources, taking into account rules for storage, demand response and aggregation to provide new services. A cross sectoral decarbonisation and electrification approach, increasingly based on renewable energy, is required for the power, heating and transport sectors.

We need **modern energy frameworks** that allow new business models for solar and storage to be created and which put active consumers at the heart of the energy transition. Allowing self-consumption without the burden of prohibitive taxes or other barriers is vital and something the EU has just provided for the decade post 2020. 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 – and technology specific tenders are key here.

Finally, we need to **overcome trade barriers** for solar. Import tariffs as we see them in Europe, the US and other countries are detrimental to the deployment of solar today and simply add unnecessary cost without benefitting society.

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