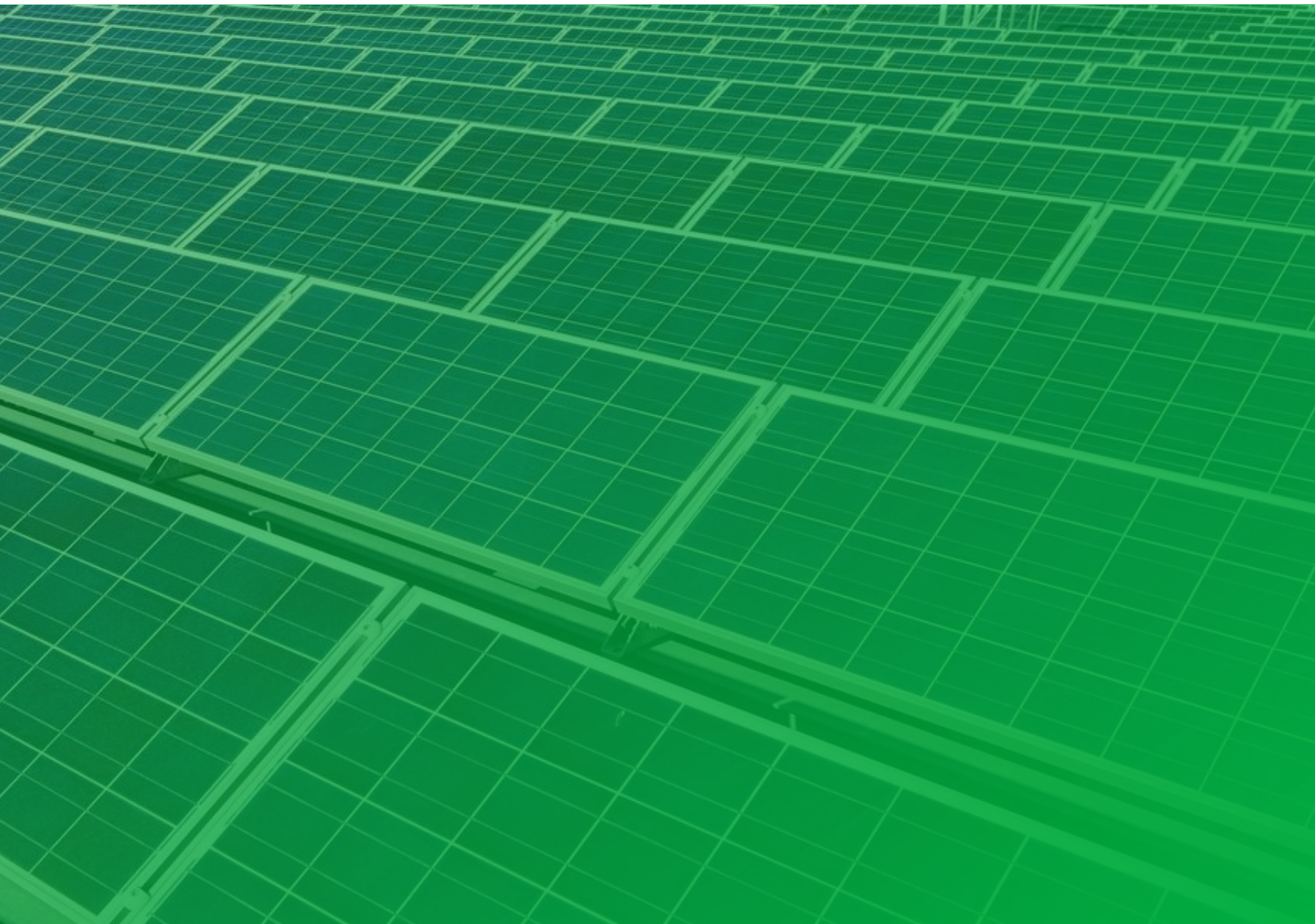
IHS Markit™

TECHNOLOGY

Predictions for the PV industry in 2019

8 trends that will define the market this year



What lies ahead?

2018 was another exciting year for the Solar and Energy Technology team at IHS Markit. Turbulent market conditions created by changing policies and trade disputes kept us, and our customers, busier than ever. Despite the uncertainty and volatile pricing dynamics which came as a result, demand for solar PV continued to grow and the long awaited milestone of 100 GW of annual installations was reached. This is a figure that seemed unreachable back in 2007, when we were publishing our first reports on the industry, and annual installations had just tipped the 2 GW mark.

Over the last year, we've have worked alongside companies that have been active in this PV industry for many years, as well as with global corporations and investors that are playing an increasingly important role in renewables. Attracted by the growing opportunity and attractive returns, as well as pressure to increase the sustainability these companies are investing into the renewables industry and this will only continue to grow in coming years, with solar is increasingly competitive with conventional sources of power generation.

In addition, solar and other renewables are playing a key part in the decentralization and digitalization of the power system, or the so-called "Energy Transition", which is now on the agenda of nearly all companies, governments and institutions. Distributed generation now plays a very significant part in the overall power mix and addressing the challenges that come with this will be at the core of our research this year.

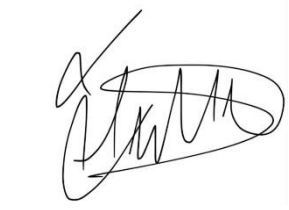
We hope you find these predictions for what to expect in 2019 useful in planning for the year ahead. Please feel free to get in touch to discuss any of the issues raised in this white paper or to find out more on how we can help you.

Our top trends for the PV industry in 2019 include the following:

1. Global PV installations will return to double-digit growth.
2. European PV demand will return to 2012 levels – corporate PPAs play a growing role.
3. Revamping and repowering of PV plants will grow in importance as the installed base in Europe ages.
4. China's policy decisions will continue to define global dynamics.
5. More than 500 megawatt hours (MWh) of batteries will be deployed in utility-scale solar plants in North America.
6. Diversification of PV inverter suppliers to continue as they continue to battle against stagnating revenues
7. The race for the 400 Watt (W) PV module will heat up as high efficiency products gain share of the market
8. There will be 11 million new connections to the Internet of Energy from solar systems in 2019

For more information on this white paper, refer to our Energy Technology services, or contact one of our analysts.

We look forward to continuing to support you in 2019!



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#1

Global PV installations will return to double-digit growth—record volumes to be installed in the fourth quarter of 2019

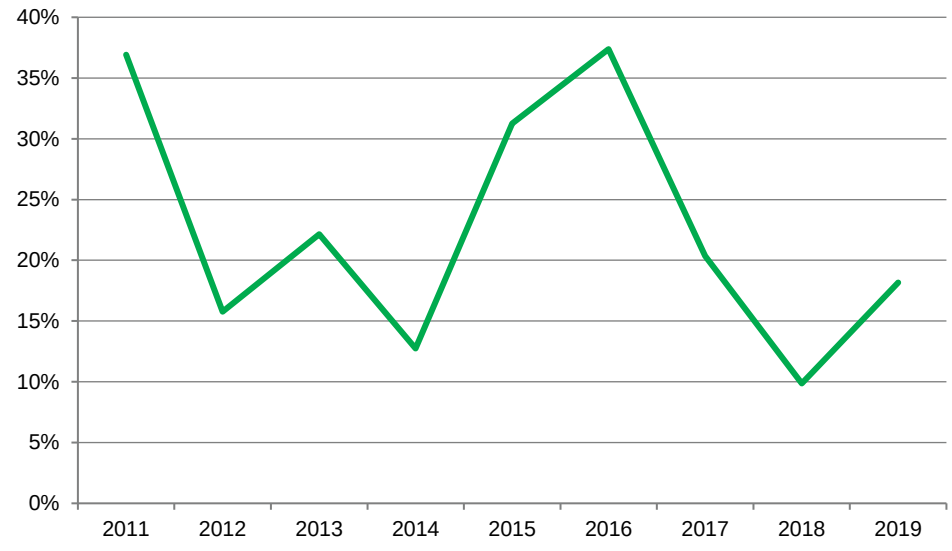
This year will be the first year since 2011 that annual photovoltaic (PV) installations will grow in all six global regions. Europe, the Middle East, North America, South and Central America, Africa and Asia-Pacific will all contribute to 18 percent year-on-year growth.

The first year global PV installations grew at only single-digit levels was 2018. This slower growth was largely caused by declining demand in two of the three top markets: China and the United States. Expected and unexpected policy changes, and uncertainty around trade disputes, led to softer demand.

A return to much stronger global growth in 2019 will occur, thanks to increases in a wide range of markets. In fact, nearly ninety countries will increase annual PV installations this year, with nine of them forecast to grow by more than 500 megawatts, compared to 2018. This widespread growth has been aided by declining prices for PV technology, with average PV module prices falling 32 percent, and average PV inverter prices falling by 18 percent, in the past two years. Even as many regional markets conribute to growth, the evolution of the PV market in China will yet another year determine the final installation levels for 2019, as further highlighted in trend #4.

The fact that Spain will be the fastest growing market in 2019, in terms of the absolute increase in annual installations, is clear evidence that lower prices are igniting additional demand. A large pipeline of projects will be built this year, the majority of which will compete with wholesale electricity prices, supported by the security of guaranteed minimum prices via Government tenders. As a result, Spain will return to being a "gigawatt-market" for the first time since 2008, when a highly generous, short-lived feed-in tariff (FiT) scheme enabled the country to dominate the global market.

Year-on-year growth in annual global PV installations (% growth)



Source: IHS Markit

Under current projections, a record 34 GW of global PV installations will be completed in the fourth quarter of 2019 alone, exceeding the current quarterly installation record of 28 gigawatts (GW) set in the final quarter of 2018. This record growth will be driven by a large number of countries ramping up throughout the year. Even with new manufacturing capacity coming online throughout the year, predicted demand levels are right at the upper limit of what the PV module supply chain can deliver, meaning tight supply is likely throughout the second half of the year.

#2

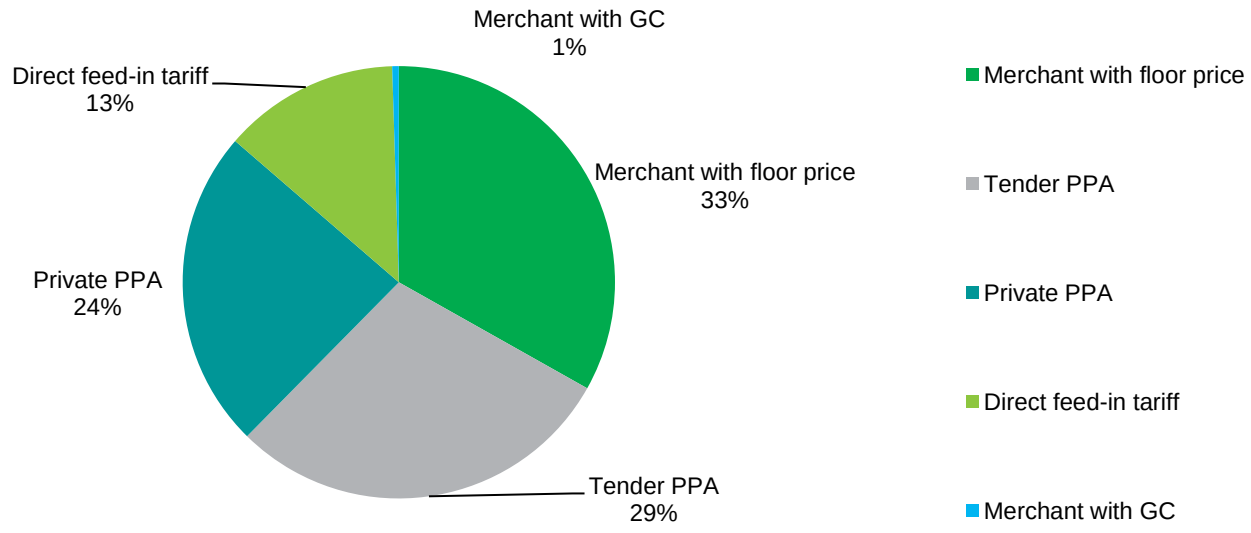
European PV demand will return to 2012 levels – corporate PPAs play a growing role

Europe will continue to reclaim ground as a PV market in 2019. In fact, 18 GW will be installed across the region, which has not been achieved since 2012. The increasingly attractive economics of PV are helping to reignite markets, aided by growing opportunities to sign private purchase power agreements (PPAs).

Between 2007 and 2010, Europe accounted for 81 percent of all global PV installations. However, after government support was paired back in key markets – and as PV markets accelerated elsewhere in the world -- demand dwindled in the region. European market share fell to 10 percent in 2016. The market will continue to recover in 2019, with a third consecutive year of growth. A surge in utility-scale projects will cause most of the growth, representing a predicted 48 percent of total installations, up from 33 percent in 2018. This increase is greatly aided by tender projects in Germany, France, the Netherlands, Spain, which will drive 62 percent of new utility-scale additions in Europe this year.

Projects selling electricity directly to large electricity consumers -- or to electricity traders by signing private PPAs -- are also increasing demand in Europe. Although they were just a marginal phenomenon in the past, these types of business models will represent almost one-quarter of new utility-scale additions in 2019. These private PPA projects are mainly located in Spain, Portugal and Italy, where solar resources are strong enough to make the cost of PV-generated electricity competitive with wholesale power prices. There is not yet any standard form of private PPA, but each contract differs in length and conditions, depending on the seller and the buyer. Duration can be from 5 to 20 years, and the pricing can be variable or fixed.

Revenue source for utility-scale PV installed in Europe in 2019



Notes: Utility-scale PV projects only (>5 MW)
Source: IHS Markit

#3

Revamping and repowering of PV plants will grow in importance as the installed base in Europe ages

At the start of 2019, more than 40 GW of PV systems in Europe larger than 100 kilowatts (kW) were more than six years old. Technology costs have fallen dramatically since these installations were completed, so the question of how older PV plants can be upgraded to improve their yield and return on investment is becoming more commonplace.

On paper, older PV installations have the highest incentives and internal rates of return. However, they can also have problems with aging technology, component defects and plant underperformance -- sometimes due to the rush to meet tight feed-in tariff deadlines, when they were initially installed. For this reason, the concept of revamping and repowering is one of the newest terms in the solar industry, and it is becoming increasingly relevant to PV plant asset managers looking to boost yields, as well as to manufacturers looking to establish new sales channels.

What are revamping and repowering?

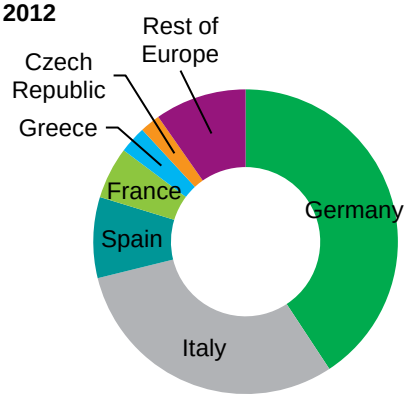
- Revamping is the replacement of malfunctioning components of distressed PV plants that no longer perform according to original specifications and are no longer covered by product warranties, potentially because of supplier bankruptcies and exits. "Revamping" can also mean the partial replacement, removal or reinstallation of modules or inverters. Other balance-of-system (BOS) components might be totally or partially replaced, or adjustments made to PV system supporting structures. Replacement components perform better, but do not alter the fixed power of the system.
- Repowering aims to increase the power rating of the system, within the surface boundaries of the existing plant. Solar PV plant repowering is mainly used to extend the lives of plants past their initial 20- to 25-year design lifespans.

Corrective action is, in fact, more common than revamping or repowering, focusing not only on replacing defunct modules within the warranty, but also on repairing inverters or other parts of the system. Corrective action also applies to systems damaged by earthquakes or weather events. Another solution being considered is the addition of retrofit technologies that boost energy performance, such as retrofit coatings designed for uncoated solar modules manufactured before 2013 or the addition of power optimizers.

No matter the level of adjustments to the plant, the overall aim of revamping is to boost the performance of the existing asset for the asset manager, either restoring the performance ratio to the original financial model or increasing the internal rate of return beyond the original calculations. This kind of improvement within the original operations budget is made possible by the sharp decline in investment costs over the past ten years. For PV component manufacturers, revamping opens a new sales channel in mature markets with older utility-size plants, beyond the established channel of selling to new PV power plants.

European PV installations (>100 kW) at end of 2012 (% of MW)

38 GW of >100 kW PV Systems were completed in Europe prior to the end of 2012



Note: Cumulative installations. Includes only systems > 100 kW in size
Source: IHS Markit

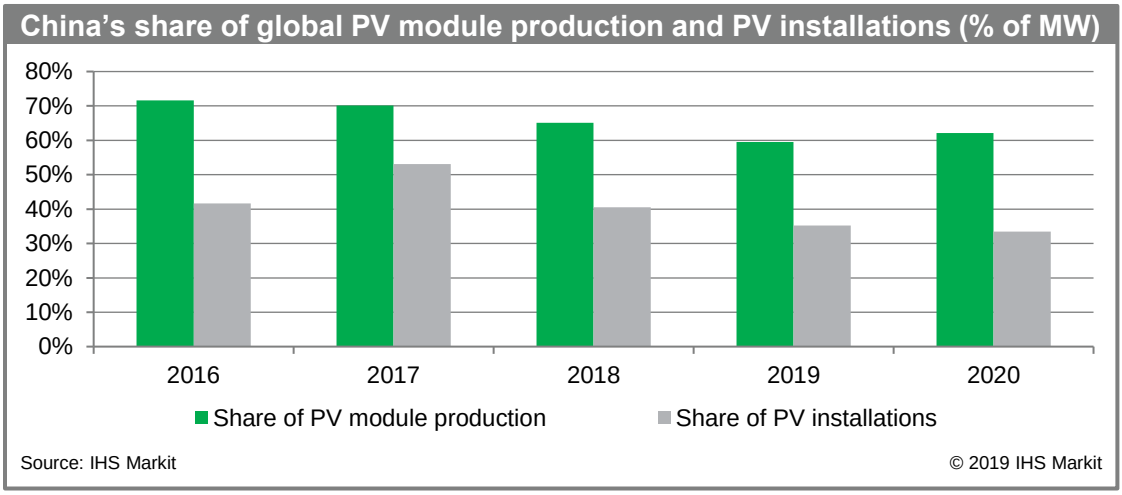
In theory, boosting the output of existing plants with high FiTs, by replacing components at today's prices and performance, sounds straightforward. However, several obstacles can hinder a cost-effective intervention and limit the benefits. Every PV plant is different, and each one requires companies to analyse specific considerations, before making any revamping decisions. In addition to the technical-performance characteristics of each plant, the actual policy framework has to be considered, prior to any intervention, since each major PV market in Europe has its own regulations for system interventions -- in particular the FiT that applies after the intervention.

#4

China's policy decisions will continue to define global dynamics, as it drives its domestic market toward grid parity projects

With China accounting for an estimated 65 percent of PV module production, and 41 percent of global installations in 2018, the country clearly dictates the supply-and-demand balance of the industry. This trend will be more pronounced than ever in 2019, as the industry awaits confirmation of anticipated changes.

PV demand in China has grown radically over the last eight years, with 175 GW of installations completed after a national FiT was introduced to stimulate the domestic market. This policy has been instrumental in helping China to exceed its short-term renewables goals and further strengthen its manufacturing base. A consistent lack of clarity on the future direction of the policy has always led to great uncertainty, despite the global industry being so heavily dependent on it. The most pronounced example of this lack of clarity was the sudden withdrawal of the national feed-in tariff in May 2018, which sent the entire industry into a period of oversupply and falling prices. After that, demand in China fell for the first time on record last year. Since then, confidence in the market has returned, on the back of increased renewable targets, which signal China's commitment to reinstating the necessary policies in some form.



The dramatic change in policy in 2018 was caused by the financial burden the incentive scheme placed on the Chinese Government, and at the end of 2017, there was a staggering deficit of RMB 113 billion (~$16.7 billion) of unpaid feed-in tariff payments, according to China's NEA (National Energy Administration). This also explains why the latest policies are increasingly focused on pushing the market toward grid-parity projects that are economically viable without needing subsidies. On January 7, 2019, China's National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) released a scheme for unsubsidized PV and wind power projects. Under the new scheme, pilot projects will not receive any national subsidies on a per-kilowatt-hour (kWh) basis, but they will receive financial support for land procurement and financing.

The new policy for unsubsidized solar provides an increasing amount of control at the provincial level, allowing local governments much more autonomy regarding the number of projects they will allow. It also explicitly prevents projects being built under the scheme in red-alert regions, which currently experience high levels of renewable curtailment.

IHS Markit projects unsubsidized PV will generate very little demand in China before 2020. Past this point, unsubsidized PV is set to make a more meaningful impact on total installations. IHS Markit maintains a relatively stable forecast for China, in terms of annual installations, with 40 GW to 50 GW to be installed each year in the coming four years. This forecast assumes China's policy makers will continue to offer a framework reflecting its climate agenda and protecting its manufacturing base, which is a key assumption underpinning the forecast for the continuous growth of global solar installations over the next five years. Any significant deviation by China from this pathway would, of course, have significant consequences for the global outlook.

#5

More than 500 megawatt hours (MWh) of batteries will be deployed in utility-scale solar plants in North America

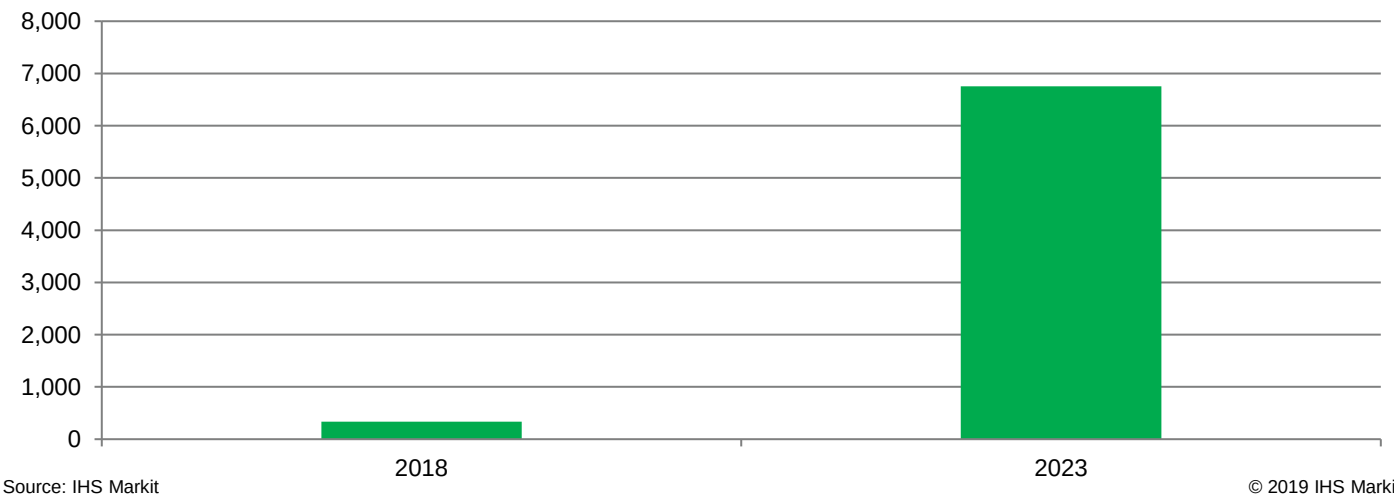
The combination of intermittent renewables and batteries has long been considered the key to providing scalable, dispatchable, clean power. In 2019, the first meaningful volumes of these systems will be installed, with the action focused on North America.

There are many inherent challenges, when it comes to balancing the supply and demand of electricity, as solar and wind energy is added the global energy mix. Energy storage technologies -- and batteries, in particular -- are generally seen as one of the solutions. Adding storage to a power plant gives the plant the flexibility to store the energy it generates when the grid does not require it, or inject extra power when demand peaks. From a practical point of view, storage is an ideal solution. In fact, in some non-interconnected island grids, high levels of renewables are creating challenges, such as in Puerto Rico and Hokkaido, Japan. In those areas, the government has effectively mandated that PV plants must add battery energy storage, in order to comply with ramp-rate regulations. However, justifying the solution from an economic point of view is more complicated, although the cost trajectory of batteries means that this will change in the coming years.

The reason utility-scale solar and batteries are now showing real signs of growth in the United States is mainly due to the Federal Investment Tax Credit (ITC), which has been the primary enabler of the U.S. solar industry, since its introduction. Following clarifications in 2018 that the ITC can also be applied to the cost of a battery paired with a PV system -- provided it is charged with solar energy at least 75 percent of the time -- the pipeline of utility-scale PV systems with plans to add batteries in the United States grew to more than 6 GW. A large number of these projects are viewed as speculative, but IHS Markit still projects that more than 2 GW of energy storage paired with solar will be installed over the next five years.

South Korea is another region where this approach is quickly gathering pace. In that country, PV systems with batteries attached receive a multiplier on the number of Renewable Energy Certificates (the local incentive scheme for solar) that they earn. These types of deployments in the United States and South Korea will serve to verify the solution. They will also be a key factor in driving down system costs, which will influence an emerging trend of them being installed globally within the coming years.

Cumulative battery installations paired with utility-scale PV in North America (MWh)



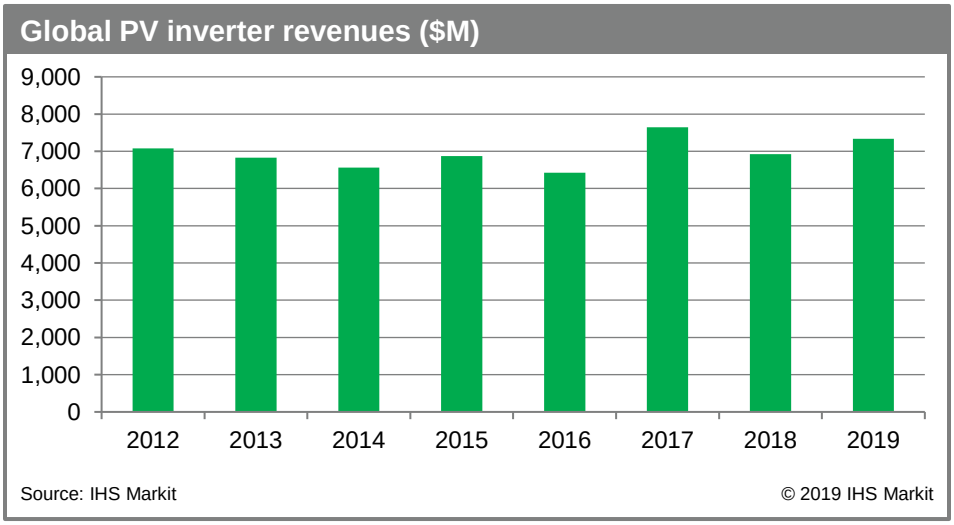
Source: IHS Markit

#6

Diversification of PV inverter suppliers to continue as they continue to battle against stagnating revenues

PV Inverter suppliers will continue to expand into a diverse range of adjacent industries, as price pressure and intense competition persists.

PV inverter suppliers have faced aggressive competition in recent years, and average global PV inverter prices have fallen by a staggering 61 percent in the last five years. This price decline has placed huge pressure on manufacturers' margins, greatly limiting their ability to increase revenues. As a result, suppliers are heavily focused on diversifying their businesses, in order to find new growth opportunities – a growing trend in 2019. To date, such expansions have included stepping into other areas of the solar value chain, such as module-level power electronics (MLPE), or providing EPC (Engineering, Procurement and Construction) and O&M (operations and maintenance) services, but also expanding into energy storage inverters, digital energy platforms, EV charging stations and other new adjacent markets.



Energy storage inverters are a particularly natural expansion to the activities of PV inverter suppliers, given the similar technology and sales channels to their existing business, so nearly all have already followed this avenue. While some suppliers have chosen to focus on one specific energy storage segment, Sungrow, SMA and others have released a full portfolio offering. In Israel, SolarEdge -- the fourth largest provider of solar inverters in revenue terms in 2017 -- took an even deeper step into the energy-storage supply chain, by acquiring South Korean battery manufacturer, Kokam.

To further combat the commoditization of inverter products, inverter suppliers must quickly adapt to and utilize artificial intelligence (AI), machine learning, IoT and other new technologies. For example, SolarEdge has developed its own virtual power plant software offerings and SMA has formed Coneva, a subsidiary focused on digital energy solutions. Almost all PV inverter suppliers have some form of cloud-based data-monitoring platform, and these suppliers may be able to leverage their broad software and data-monitoring platforms to provide greater value to both customers and grid operators.

Suppliers expanding their capabilities and products in the EV charging sector is expected to continue throughout 2019. It is an area where huge growth is forecast in the coming decade, as the electrification of the transport sector continues to ramp up. ABB, Efacec, Fimer, Power Electronics, SolarEdge and other inverter suppliers are tackling this space, in order to take advantage of the huge growth opportunities and capitalize on the many synergies with smart-home and smart-building applications.

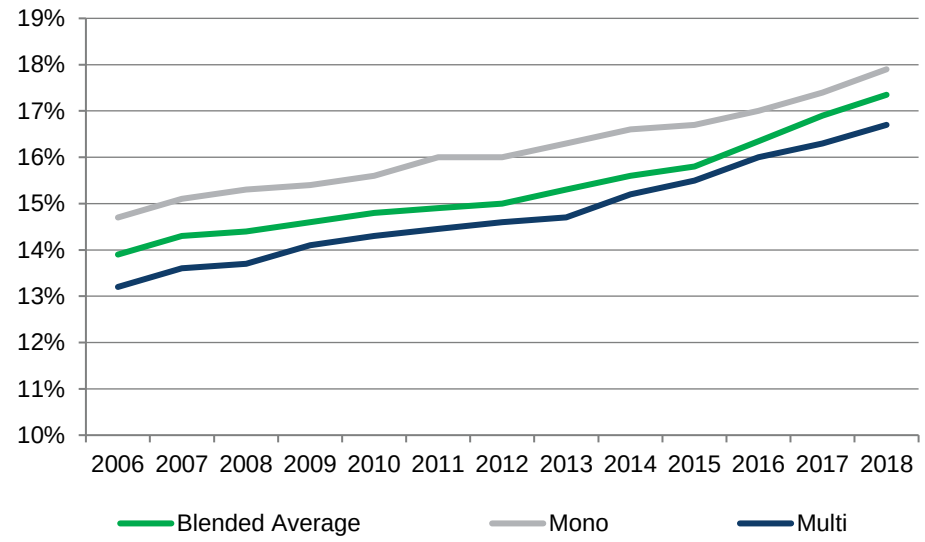
#7

The race for the 400 Watt (W) PV module will heat up as high efficiency products gain share of the market

Solar PV has become a highly competitive energy source, as the average price of a solar panel has fallen by over 80 percent in the last decade. However, these cost improvements have been aided by ongoing improvements in cell and module efficiencies, which have increased by approximately 25 percent during the same period.

Improvements in module performance are not only important to lower the cost of panels on a per watt basis, but they also contribute to lower balance-of-system (BOS) costs. More powerful modules lead to fewer required modules for a given system size, so fewer BOS components are required, which ultimately helps drive down the critical metric of levelized cost of electricity (LCOE) for the entire system.

Average crystalline PV module efficiency (%)



Source: IHS Markit

The trend of using monocrystalline cell technology is an increasingly important factor, when it comes to increasing average efficiency. In particular, PERC cells are becoming a mainstream technology, accounting for half of global cell production in 2019, compared to just 14 percent in 2016.

The possibility of 400 Watt peak (Wp) modules using p-type PERC cells reaching mass production in 2019 is now under discussion. Until now, these power ratings were only achievable using n-type cell technologies, with have a higher production cost and make up a minor share of the industry, but new technology developments with p-type cells may make it possible to break the 400 Wp threshold this year. Longi, Jinko Solar, Canadian Solar and other tier-one manufacturers have recently announced planned products that will reach this level, through different combinations of technology, including half-cells and slightly larger cell and module sizes, in some cases.

The production of bifacial modules for utility-scale projects is yet another development helping the industry reach 400 Wp this year. However, significant growth for bifacial products is not anticipated until 2020, when more pilot projects have been installed and a better track record has been established to provide certainty for financial institutions.

#8

There will be 11 million new connections to the Internet of Energy from solar systems in 2019

Digitalization of the grid continues to be a megatrend for the power sector, and in the solar industry. IHS Markit forecasts an average of 30 thousand new connected PV inverters will be shipped each day in 2019, which is approximately 11 million in the full year.

In 2019, there will be a growing focus on ways to generate value with this data. Connecting devices and collecting data isn't useful on its own, but the implementation of complete IoT solutions with clear outcomes could be transformational.

IHS Markit defines an IoT solution to have 4 key pillars:

- Connect - how is the data brought from the device?
- Collect - what measurements are taken and by which device?
- Compute - how/where is the data analysed?
- Create - what insight do you produce/action from that data do you take?

Given that nearly all solar inverters are communicating in some form, the solar inverter will play the critical role in connecting PV systems to the internet of energy. The United States even mandates this type of communication through grid regulations. An IoT solution is only as strong as its weakest pillar, and collecting data means nothing, unless insight is created and action is taken. In the case of solar energy, PV system maintenance is a particular application that will be predictive. This action would involve monitoring connected inverters, to show system performance over time, which can help O&M providers and asset owners to diagnose problems quickly (or even before they occur), in order to minimize downtime.

The four key pillars of IoT

Source: IHS Markit

Industrial giants demonstrate all-encompassing industrial IoT platforms as the future solution for all software applications, such as Ability from ABB, EcoStruxure from Schneider Electric, and Mindsphere from Siemens. As each individual sub-system becomes increasingly connected, the next logical step is to combine data into overall utility-management packages. For example, combining customer metering data, solar inverter output and weather information could allow utilities or grid operators to compute and overlay energy requirements and better manage the grid.

While convergence of these different applications into a single platform may be on the long-term horizon, the picture for 2019 is much more fragmented. Discrete applications will be solved by various software solutions across the utility departments – from metering residential customer energy consumption to monitoring and operating grid-scale solar farms.

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