

## SOLAR SECTOR UPDATE

The MAC Global Solar Energy Index (SUNIDX) is licensed as the tracking index for the Invesco Solar ETF\* (NYSE ARCA: TAN)

Note: Index performance does not reflect transaction costs, fees or expenses of TAN

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MAC Global Solar Energy Index (SUNIDX)



### SOLAR INDEX PERFORMANCE

The MAC Solar Index, the tracking index for the Invesco Solar ETF (NYSE ARCA: TAN), has fallen sharply from May's 1-3/4 year low to post a new 14-month low. The index is currently down -24.2% on the year, reversing part of the annual +52% gain seen in 2017.

Bearish factors for solar stocks include (1) China's sharply reduced subsidy support for solar that was announced on May 31, 2018, which caused an inventory overhang and sharply lower solar panel pricing, (2) the Trump administration's 4-year 30% tariff on imported cells and tariffs that took effect in February, which dampened U.S. solar install growth, and (3) ongoing solar trade disputes that have resulted in tariffs and various market dislocations.

Bullish factors for solar stocks include (1) the improved solar project economics that have resulted from the sharp drop in solar panel prices, (2) Europe's decision to end its duties and minimum price scheme on Chinese solar panels, which will improve European solar growth, (3) broadening solar growth from India, Turkey, Latin America, the Middle East, and Southeast Asia (see

page 5 for the world solar growth outlook), (5) strong demand for solar power as solar reaches grid parity and as countries seek to meet their carbon-reduction targets under the Paris COP21 global climate agreement, and (6) low valuation levels that indicate that solar stocks are very cheaply priced.

Solar stocks are trading at very low valuation levels compared with the broad market. The median trailing P/E for the companies in the MAC Solar Index is currently 14.6, which is far below the comparable figure of 20.0 for the S&P 500 index. Meanwhile, the median forecasted 2018 P/E of 15.5 for the companies in the MAC Solar Index is well below the comparable figure of 17.0 for the S&P 500 index. The median price-to-book ratio of 1.21 for the companies in the MAC Solar Index is well below the 3.34 ratio for the S&P 500. The median price-to-sales ratio of 1.12 for the MAC Solar Index is well below the 2.16 ratio for the S&P 500.

### Solar stocks are undercut by reduced Chinese subsidies

Solar stocks have fallen sharply since the Chinese government on May 31, 2018, surprised the industry with a sharp cut in its subsidy support for solar. That resulted in a sharp overhang of excess panel supplies and a sharp decline in solar cell and panel pricing, which in turn put downward pressure on the profits of solar manufacturers.

However, the lower pricing is bullish for the solar industry as a whole on a longer-term basis since it means that solar is becoming even more competitive against alternatives and can increasingly stand on its own without government support. The lower pricing is supportive for solar developers and installers who can boost their profit margins and who will see increased demand due to more attractive project economics.

Solar stocks also saw weakness in early October as the broad market fell into a sharp downward correction and as Chinese stocks fell to a 3-3/4 year low. On the bullish side, solar stocks are now priced at very cheap levels that should attract value buyers. Solar stocks should be able to recover in coming months as the industry works down the excess inventories and as demand strengthens.

## UN IPCC says renewables growth must greatly accelerate to curb climate change

The UN Intergovernmental Panel on Climate Change (IPCC) in early October released a report saying that the annual growth of renewables needs to accelerate by seven-fold from current levels if the world wants to come close to halting the worst effects of climate change.

The IPCC report was written by 91 scientists from 40 countries drawing upon more than 6,000 scientific studies. Commenting on the IPCC report, former Norwegian Prime Minister Gro Harlem said, "This report is not a wakeup call. It is a ticking time bomb. Climate activists have been calling for decades for leaders to show responsibility and take urgent action, but we have barely scratched the surface of what needs to be done."

The world has already warmed by 1 degree Celsius (1.8 degrees Fahrenheit) since pre-industrial times and the effects of climate change are already being felt. The Paris Climate agreement seeks to limit global warming to "well below" 2 degrees Celsius (3.6 F). However, the fact that the world is not living up to its Paris commitments suggests that the world is on its way to a temperature rise of at least 4 degrees (7.2 F) by 2100.

A temperature rise of just 2 degrees Celsius (3.6 F) would be bad enough with IPCC forecasting that: (1) coral reefs would mostly disappear, (2) the sea level would rise by nearly three feet and subject 32-80 million people to flooding, (3) about 37% of the world's population would be exposed to severe heat waves, (4) 411 million more people would be exposed to the effects of severe drought, and (5) the need would arise for a "disproportionately rapid evacuation" of people from the tropics. CarbonBrief.org has an informative [factsheet](#) on the impact of climate change at various temperature increases.

In order to avoid the worst effects of climate change, the IPCC concludes that the world must limit warming to 1.5 degrees Celsius (2.7 F). The IPCC says that this would require CO2 emissions to be cut by 45% by 2030 from 2010 levels and to zero by 2050.

The IPCC's middle-range recommendation to meet that 1.5 degree Celsius goal is that (1) renewables should supply 70-85% of power generation by 2050, (2) coal should be cut to 2% of power generation capacity or less, and (3) natural gas should be cut to 8% of total capacity if sufficient carbon capture technologies can be deployed to offset the emissions from burning natural gas.

To get to that goal, the world would need to boost annual investment in clean energy to \$2.4 trillion per year through 2035, representing a seven-fold increase from current levels.

If the global temperature continues to rise unchecked, the IPCC estimates the damage at \$54 trillion from 1.5 degrees Celsius (2.7 F) of warming and \$69 trillion from 2 degrees Celsius (3.6 F) of warming.

## Subsidy-free solar is spreading quickly as solar reaches grid parity

With its subsidy cut in May, China became the latest country to realize that it is no longer necessary to provide big subsidies to the solar industry since solar pricing has reached grid parity in many areas.

Recent competitive auctions, for example, have produced extremely low subsidy-free solar pricing of under 2.5 cents/kWh in Jordan and under 3 cents/kWh in Egypt for projects financed by the European Bank for Reconstruction and Development.

Indeed, subsidy-free solar is spreading quickly throughout the world in Europe, Latin America, Middle East, and southeast Asia. The U.S. and Japan are now the only major countries that are still providing strong subsidy support to solar, although both of those countries are progressively stepping down that support. The U.S. solar investment tax credit (ITC), for example, is already scheduled to largely phase out by 2022.

The move to subsidy-free solar is being seen in Europe where governments have largely dropped their previous solar support via generous feed-in tariff (FIT) programs. Europe is moving quickly towards competitive auctions and private development without subsidies. SolarPlaza reports that 2.5 GW of subsidy-free solar has been announced in the last six months just in Portugal, Spain, Italy and France.

In Spain, there is a pipeline of 29 GW of subsidy-free solar projects in the planning or construction stage, including 3.9 GW tendered by the government, according to Spain's national solar trade group, UNEF.

UNEF chief Jose Donoso said, "The market has realized that they can expect very little from the government and they aren't going to wait around for a new support scheme. With the degree of competitiveness that solar has, we can go straight to the market on a merchant basis or we can look for PPAs, without any need for input from the government."

Spain's Energy Minister Jose Dominguez Abascal said at a recent London conference, "We are not thinking of subsidies at all. At this moment the cheapest way of producing electricity in Spain is the sun. It's much cheaper than any other form of energy. At this moment in Spain there are gigawatts that are under construction without any knowledge of the government."

The growing use of power-purchase agreements (PPAs) is accelerating the ability of solar developers to build and finance subsidy-free solar projects. When a large corporation or utility signs a long-term contract to buy electricity from a solar facility with a PPA, the solar developer can then use that PPA to help guarantee the bank financing. Subsidy-free solar projects are also being built on a merchant power basis where the owner of the solar facility takes on the risk of electricity price fluctuations and sells electricity directly to the wholesale electricity market.

## Chinese solar shake-out results from government's "China-531" subsidy cut

The Chinese government on May 31, 2018 surprised the industry by announcing a dramatic cut in its subsidy support for solar. The Chinese government's policy action has become known as "China-531" since it was announced on May 31.

Before May, the Chinese government had been providing generous subsidy support to the industry, thus causing runaway solar production and demand. In addition, the Chinese government's subsidy backlog reached an unsustainable \$17 billion. The government in May therefore bowed to reality by cutting subsidy support and forcing the industry to downsize to more sustainable long-term levels.

The Chinese government's 531 order was contained in the "2018 Solar PV Power Generation Notice" issued jointly by the China's state planner The National Development and Reform Commission (NDRC), the Ministry of Finance, and the National Energy Administration. The order removed subsidy support for utility-scale solar until further notice. For roof-top distributed generation (DG), the order capped support at 10 GW for 2018 (which was already reached by mid-2018), and also shifted responsibility for the feed-in tariff (FIT) to the local level from the central government level.

The government also cut the tariff for ordinary solar farms by -9% and cut the subsidy for DG projects by -14% or 0.3 yuan/kWh. The government instructed utility-scale solar projects to use competitive bidding to choose developers. The government left its solar Poverty Alleviation and Top Runner programs unchanged. The government also left residential solar policies unchanged.

The Chinese government clearly intends to move over time to subsidy-free auctions for providing solar resources, which is a strategy that is working well in many other countries. While the Chinese solar industry is currently experiencing a serious dislocation from this policy switch, the industry will come out on the other side as a much more sustainable and competitive industry.

The China-531 action caused a sharp drop in forecasts for China's 2018 solar installs to about 30-40 GW from previous forecasts near the 2017 install rate of 53 GW, indicating an expected year-on-year decline of 25%-40%. China already installed 24 GW of solar in the first half of 2018, according to the China Photovoltaic Industry Association, which indicates that Chinese installs will be very low in the second half of 2018.

The cut in forecasts for Chinese solar installs caused a cut in forecasts for global installs as well since China in 2017 accounted for 54% of global market share. Indeed, BNEF, as a result of China-531, cut its 2018 global install forecast by 12 GW to 95 GW from its January forecast of 107 GW, implying a -3% year-on-year drop in 2018 installs.

The sharp slow-down in Chinese installs in the second half of 2018 means that the industry must work off a big overhang of excess inventories, which is driving down solar prices. In addition, there is no doubt that a significant number of smaller solar companies with me-too technology and a lack of scale will be forced to shut down. Over the medium-term, that will force the inefficient players out of the market and allow the Tier 1 solar companies to stabilize their pricing and profitability.

China-531 has caused silicon module prices to plunge by -20% since May to a record low of 23.3 cents/watt, according to PV Insights. Meanwhile, multicrystalline silicon solar cell prices have plunged by -52% since May to the current record low of 11 cents/watt, according to BNEF. Polysilicon prices have plunged by -30% since May to a record low of \$10.87/kg.

The main impact of the Chinese government's cut in solar subsidies is being felt by domestic producers in mainland China. However, China-531 is having a major impact on the world solar markets as well due to the sharp drop in solar pricing and the attempt by Chinese solar companies to off-load excess panels overseas.

The current solar shake-out is somewhat similar to the last major solar shake-out in 2012/2013, which was also driven by excess subsidies and temporary overcapacity. However, the current shake-out should be substantially less severe since the solar industry is now spread out across the whole world and there are now many countries that can absorb solar inventories, particularly at such low and economically attractive prices.

## California mandates 100% carbon-free electricity by 2045

California in September passed a law that requires 100% carbon-free power for the state by 2045. That made California the second state after Hawaii to adopt a 100% carbon-free mandate.

The mandate is expected to allow large-hydro and nuclear to qualify for the carbon-free goal, which is important since large-hydro currently accounts for 15% of California's electricity and nuclear accounts for 9% of California's electricity. The main goal of the legislation is to phase out fossil fuels, which currently account for 47% of California's electricity (natural gas 34%, coal and other 13%).

The need for California to meet its carbon-free goals means that California will significantly step up its efforts to build solar and wind facilities. In addition, California will step up its focus on using batteries to compensate for the intermittent nature of solar and wind resources, thus allowing solar and wind plus storage to provide 24/7 base-load electricity to the grid.

## U.S. solar industry adjusts to import tariffs

The U.S. solar industry since the beginning of this year has been buffeted by import tariff challenges but is adapting and moving forward.

The biggest challenge came from the Section 201 safeguard 30% tariff on imported solar cells and modules that took effect on February 7, 2018. That tariff started at 30% in 2018 and then steps down by 5 percentage points per year to 25% in 2019, 20% in 2020, and 15% in 2021, expiring in 2022. The first 2.5 GW of solar imports are exempt from the tariff. Thin-film solar panels, such as those produced by First Solar, are exempt from the tariff even if those panels are imported from overseas factories.

The tariff applies to imports from all major countries in which solar cells and panels are produced, including U.S. free-trade partners Canada and Mexico. There are a number of countries that are exempt from the tariffs, including India, Turkey, Brazil, and South Africa. However, imports from those exempted nations are capped at 300 MW each and at 900 MW as a group.

The tariff has been a negative factor for the U.S. solar industry, which is dominated by installation companies and has very few American-based solar factories. In fact, the U.S. has so few manufacturers that it needs to import more than 80% of the solar panels that are installed in the U.S. The tariff is putting upward pressure on the cost of solar installs, thus making solar project economics less attractive. However, the good news is that the sharp drop in solar panel pricing seen from the China-531 policy move has partially offset the upward price effects from the U.S. 201 tariff.

The U.S. solar installation industry is adjusting to the tariff by using stockpiled or non-tariffed panels, such as those produced by First Solar (FSLR) and those imported from countries not covered by the tariff. SunPower (SPWR) can now also supply non-tariffed panels since it received an exemption from the tariff for its IBC panels.

In addition, several Chinese companies have announced plans to build manufacturing facilities in the U.S. so that they can sell panels not subject to the tariff. Unfortunately, those new factories will take time to build and will be highly automated, which means they will not produce a large number of new jobs.

In some good news related to the Section 201 safeguard tariff, the IRS in June announced that solar developers will be able to qualify for the Investment Tax Credit (ITC) in the year in which "construction" begins, which is defined as either the beginning of physical work or upon the expenditure of at least 5% of the total project cost. That means that developers of big utility solar plants that take multiple years to complete will be able to qualify for a 2018-2021 ITC credit while delaying the actual purchase of their panels until later years when the 201 safeguard tariff will be lower or phased out.

Aside from the 201 safeguard tariff, the U.S. solar industry was also hurt by the Trump administration's tariffs on imported steel and aluminum implemented on May 31. Those tariffs sparked higher prices for the steel and aluminum that is used in the ground and roof racking systems that are used to support solar panels.

Another challenge emerged when the Trump administration placed a 10% tariff on Chinese inverters as part of its move to place tariffs on \$200 billion of Chinese goods effective September 24. That tariff will rise to 25% on January 1, 2019. The inverter tariff will make it difficult for the big Chinese inverter companies such as Huawei and Sungrow to achieve market penetration into the U.S, with inverters they manufacture in China.

The good news for U.S. solar industry is that there are already plenty of inverter sources for U.S. installers other than China. Major inverter companies such as Enphase (ENPH) and SolarEdge (SEDG) are expected to see little impact from the tariffs on Chinese-built inverters since they can shift what production they have out of China to other countries in order to avoid the tariffs.

## Europe ends its failed anti-dumping program

The EU ended its anti-dumping duties against solar panels imported from China and the associated minimum import price (MIP) scheme effective September 3. That MIP scheme had been in place since 2013 when the EU tried to protect local European solar manufacturers from Chinese competition.

The EU was forced to finally end the MIP scheme as its failure became clear. The scheme did not lead to a flourishing European solar manufacturing base. The MIP instead only caused higher solar panel prices for European solar projects, thus curbing the growth of solar power installs in Europe. The failure of Europe's MIP is a lesson to other countries that protectionist measures are unlikely to meet their intended goals.

Commenting on the end of the EU's MIP scheme, the president of SolarPower Europe, Dr. Christian Westermeier, said, "This is a watershed moment for the European solar industry. By removing the trade duties, the European Commission has today lifted the single biggest barrier to solar growth in Europe. The Commission's move to end the trade measures is unquestionably the right one for Europe. We expect to see a significant increase in solar jobs and deployment -- which will only propel the energy transition in Europe."

The end of the European MIP scheme is a bright spot for the global solar industry since European solar installs should now see a significant increase due to more attractive project economics.



## SOLAR PV GROWTH OUTLOOK

Global annual solar PV installs grew by a strong compounded annual rate of +27% in the five years through 2017. Solar installs in 2017 reached a new record high of 98 GW, up by +31% yr/yr from 75 GW in 2016 and more than tripling from 30 GW in 2012, according to Bloomberg New Energy Finance (BNEF).

The global solar industry showed very strong growth in 2017 mainly because of a +76% surge in Chinese installs and a +94% surge in India installs. European installs showed mild growth while U.S. installs fell on overhang from the growth spike seen in 2016.

For 2018, BNEF is currently forecasting world solar install growth at -3% to 95 GW. GTM Research is forecasting a larger decline of -13% to 85 GW. The solar industry in 2018 is expected to retrench after the extraordinary growth seen in the past two years of +34% in 2016 and +31% in 2017.

The slower growth rate in 2018 is expected to stem from substantially slower growth in China and flat growth in the U.S. Picking up some of the slack will be much stronger growth in Middle East, Latin America, and Southeast Asia.

Regarding a long-run solar growth rate, the International Renewable Energy Agency (IRENA) is forecasting +15% annual solar industry growth through 2030 with PV capacity up six-fold at 1,760 GW by 2030. IRENA expects solar PV to account for about 7% of worldwide electricity generation by 2030 versus the current level of less than 2%.

The long-term demand outlook for solar remains very strong since solar will account for some 35% (3,439 GW) of all electricity capacity additions and a massive \$3.4 trillion of total solar spending through 2040, according to BNEF. BNEF forecasts that solar PV will account for 15% of world electricity capacity by 2040, up from the current level of less than 2%.

Demand for solar should continue to surge in coming years as unsubsidized solar pricing falls farther and increasingly beats other sources of electricity generation. Solar costs have already fallen by some 50% over the past several years due to technological advances and economies of scale. Looking ahead, the International Renewable Energy Agency predicts that the average solar electricity cost will plunge by another -59% by 2025, making solar the cheapest form of power generation in "an increasing number of cases."

### China's 2018 solar installs are set for a sharp slowdown

China's solar installs in 2017 soared by +76% to 53 GW from 30 GW in 2016, according to BNEF. China accounted for 54% of world installs in 2017, which was more than the rest of the world combined.

China's cumulative installed solar capacity reached 130 GW in 2017, representing about 7.3% of the nation's total electricity generation capacity, according to the Asia Europe Clean Energy (Solar) Advisory Co. Ltd (AECEA).

Chinese solar surged in 2017 as developers raced to meet step-downs in the government's feed-in-tariff, which guarantees an electricity price for solar electricity producers.

The bulk of 2017 installs involved utility-scale solar. However, there was also a surge in distributed solar projects (i.e., solar panels on commercial and industrial buildings, malls, and schools), which were not subject to quotas and accounted for about a third of total Chinese installs in 2017.

Chinese solar installs in 2018 likely fall to about 30-40 GW (down 25-40%) from 53 GW in 2017 due to the Chinese government's announcement on May 31 (referred to as "China-531") of a sharp cut in subsidy support for solar. China installed 24 GW of solar in the first half of 2018, indicating expectations for only about 10 GW of installs in the second half of 2018.

The China-531 order left in the place government solar support for the Top Runner and Poverty Alleviation programs. Support for residential solar was also left unchanged.

The China-531 announcement indicated that the Chinese government wants to encourage solar to move towards subsidy-free growth and an increased reliance on competitive auctions, a model that is finding success in many other countries.

### U.S. faces flat year in 2018 after volatile 2016/17

U.S. solar installs in 2017 fell by -22% to 10.7 GW, according to BNEF. Despite that decline, U.S. solar in the five years through 2017 grew by a compounded annual rate of +26%.

Solar accounted for 30% of all new U.S. electricity generation capacity in 2017, representing the second largest source of new electricity generation behind natural gas.

U.S. solar installs in 2017 dropped to a more sustainable level after the +93% growth spike seen in 2016. The growth spike in 2016 was caused mainly by the fact that many utility solar projects were accelerated into 2016 to take advantage of the Investment Tax Credit (ITC), which had previously been scheduled to expire at the end of 2016. It turned out that Congress in December 2015

## SOLAR PV GROWTH OUTLOOK (CONTINUED)

extended the ITC by 5 years. However, many accelerated solar projects were still completed during 2016, thus causing the 2016 growth spike and then causing the relative dearth of projects in 2017.

U.S. solar installs in 2017 were also undercut by uncertainty about the Section 201 trade case, which pushed solar panel prices higher on hoarding of panels and also caused a delay in project planning to await the outcome of the case. The Trump administration announced its tariff decision on January 22, 2018, which involved a tariff on imported cells and modules during 2018-2021. The import tariff was set at 30% in 2018, stepping down to 25% in 2019, 20% in 2020, 15% in 2021, and expiring in 2022. Because of the tariff, GTM Research reduced its estimated overall U.S. solar annual growth rate by -13% annually for 2018/2022.

While U.S. solar growth will be dampened by the Section 201 tariff over the next few years, solar will still receive a big boost from the federal investment tax credit (ITC) through 2021. It is worth noting that the ITC gives a tax break on the total project cost whereas the tariff is only on the smaller cost for solar modules.

The ITC will remain at 30% in 2018-2019 and then step down to 26% in 2020 and 22% in 2021. In 2022, the ITC will expire entirely for direct-owned residential but will remain at 10% indefinitely for utility PV projects, non-residential, and third-party-owned residential solar. Projects need only commence construction by the end of the year in question to qualify for the ITC, as opposed to the previous requirement that the project had to be completed and grid-connected by year-end.

The solar ITC extension approved by Congress in late 2015 was part of a bipartisan energy bargain that involved trading the solar ITC extension in return for dropping the ban on exporting U.S. crude oil. The solar ITC was left intact by the tax-cut bill that Congress passed in November 2017. The cut in the top corporate tax rate to 21% from 35% reduced the benefit from the ITC, but the tax bill was still helpful in eliminating the alternative minimum corporate tax.

For 2018, GTM Research is forecasting U.S. solar installs of 10.9 GW, up slightly by +2% from 10.7 GW in 2017. GTM is forecasting that U.S. solar installs will grow to 14 GW in 2023, representing compounded annual growth of +5.5% over the next five years.

The U.S. installed 4.7 GW of solar in the first half of 2018, according to GTM's "U.S. Solar Market Insight Q3-2018" report. Solar PV accounted for 29% of all new U.S. electricity generating capacity additions in the first half of 2018, below natural gas at 57% but above wind at 13%. Utility solar accounted for 55% of first half installs. Utility solar procurement saw a surge in early 2018 after the announcement of the safeguard 201 tariff provided clarity to the market, leading to a strong utility pipeline going forward into 2018 and beyond.

### Japan solar growth stabilizes following the post-Fukushima solar boom

Solar power surged in Japan after the Fukushima nuclear disaster in 2011 due to encouragement from a generous government feed-in-tariff (FIT). Japan solar installs during the post-Fukushima solar boom soared by +77% in 2012, +227% in 2013, +46% in 2014, and +16% in 2015.

However, the Japanese government then started cutting the feed-in-tariff to reduce subsidy costs, which caused solar growth to fall back to more sustainable levels. Solar installs fell by -28% in 2016 and by -7% in 2017 to 7.5 GW, which was well below the peak of 11.5 GW seen in 2015, according to BNEF.

For 2018, BNEF is expecting Japan solar installs of 7.3 GW, which would represent a small -3% yr/yr decline. BNEF is expecting slower growth in large-sized Japanese solar projects in 2018, offset by stronger growth in smaller-sized (sub-500 kW) distributed and rooftop solar projects.

### India solar boom runs into some obstacles

The Indian government is pushing solar very hard as part of its goal of modernizing India's infrastructure, boosting its global business competitiveness, and providing electricity in rural areas to non-electrified households. The government has a goal of installing a cumulative 100 GW of solar by 2022, consisting of 60 GW of large-scale solar and 40 GW of rooftop solar.

The 100 GW target is about five times India's cumulative installed solar capacity of 21 GW as of the end of 2017. To meet that target, India would need to install an average of 16 GW of solar per year for the next five years.

India's solar installs in 2017 nearly doubled to 10.3 GW from 5.3 GW in 2016, according to BNEF. That put India in third place for global installs in 2017 behind China (53.0 GW) and the U.S. (10.7 GW).

Solar accounted for about 45% of new Indian electricity generation installed in 2017, easily taking first place as the most popular new electricity generation source, according to Mercom Capital. Wind was a distant second at about 20% of new capacity.

Solar growth in India may slow in 2018 to about 7.5 GW after the torrid 2017 pace, according to Mercom Capital. Mercom then expects Indian solar growth to revive to the 10.5-11.0 GW area during 2019-2022.

Slower growth in 2018 would be due to (1) increased solar panel costs due to the 25% safeguard tariff that was implemented on July 30, 2018, (2) slow payment of subsidies for developers installing rooftop solar, and (3) delays in grid connections.

## SOLAR PV GROWTH OUTLOOK (CONTINUED)

The Indian government as of July 30, 2018 implemented a 25% safeguard tariff on panels imported from developed countries or from China or Malaysia. The only developing countries of note that are excluded from the tariff are Thailand, Indonesia, Vietnam and the Philippines. The 2-year tariff will start out at 25% for the first year (30-Jul-18 to 29-Jul-19) and then step down to 20% for the next 6-month period (30-Jul-19 to 29-Jan-20) and to 15% for the final 6-month period (30-Jan-20 to 29-Jul-20).

The safeguard tariff was imposed to prevent the "threat of serious injury" to domestic solar panel producers from import competition. Prior to the tariff, India imported 90% of its panels from China and Malaysia. The government is hoping the tariff will allow a domestic solar manufacturing industry to develop, although that seems unlikely since there are few domestic Indian solar companies that will be able to produce at the scale necessary to support India's ambitious solar installation goals.

In addition, the tariff lasts only two years, which means it won't even be in effect by the time new Indian factories can be built. The more likely outcome is that Indian developers will try to find non-tariffed foreign panels to buy or will simply be forced to pay the tariff on imported panels, thus raising the end-price of solar for Indian electricity consumers.

### European solar growth expected to improve

Solar installs in the European Union grew by +6% to 6.03 GW in 2017 from 5.69 GW in 2016, according to SolarPower Europe. Solar power in Europe is starting to recover after having fallen sharply in recent years due to reduced subsidies. European governments are now using more auctions to buy solar as opposed to their former reliance on feed-in-tariffs.

Germany continued to be the largest solar player in Europe by far with 1.56 GW of installs in 2017, up by +33% from 1.51 GW in 2016. German 2017 installs were only about a fifth of Germany's 2012 record high of 7.6 GW. Germany's 2017 install level of 1.56 GW was also far below the German government's 2017 target of 2.5 GW.

In Q1-2018, German solar installs picked up substantially to 580 MW, which could put solar on track to meet the government's 2018 target of 2.5 GW. The German government has a target of deriving 65% of its power generation from renewables by 2030, which will require an additional 11 GW of wind and solar power, according to BNEF.

The UK had the second largest amount of European solar installs in 2017 at 990 MW, which was down by -52% from 2016 due to reduced subsidy support and was far below the peak of 4.3 GW seen in 2015, according to BNEF. The Netherlands had the third largest installs in 2017 at 720 MW, which was up by +37% yr/yr and a record high.

France had the fourth largest European installs in 2017 at 636 MW, which was up by +14% from 2016 but still well below the peak of 1.76 GW seen in 2011, according to BNEF. Italy was fifth with installs of 409 MW in 2017, up by +11% from 2016. Spain trailed with 135 MW of solar installs in 2017, up +146% from 2016 but still far below the peak of 546 MW seen in 2007.

Turkey is coming on very strong in 2018 after installing 1.79 GW of solar in 2017, beating Germany and representing growth of +213% yr/yr, according to SolarPower Europe. Turkey is not a member of the EU but SolarPower Europe nevertheless includes Turkey in its European category.

European solar growth is expected to show solid growth in coming years due to the need to meet renewable energy targets. A SolarPower Europe official recently said, "We are expecting strong growth in the coming years as several EU member-states are choosing solar to meet their national binding renewable targets." The European Parliament earlier this year raised the EU renewable energy target for 2030 to 32% from 27% and also made the target binding on EU members.

European solar should also see a boost from improved solar project economics after the EU dropped its minimum-price duty scheme for imported tariffs.

### Middle East is coming on strong

A core group of Middle East countries will install an impressive 8 GW of solar in 2018 and will reach 22.4 GW of cumulative capacity by 2023, according to GTM Research. The countries in that group include Saudi Arabia, Bahrain, Jordan, Oman, and UAE.

Those Middle East countries as a group would take third place in the global rankings behind China and the U.S. if they can install 8 GW of solar in 2018.

Saudi Arabia will tender 3.3 GW of solar capacity during 2018, according to Saudi Arabia's Renewable Energy Project Development Office. An install rate of 3.3 GW in 2018 would launch Saudi Arabia into fifth place in the all-country rankings in 2018 behind China, the U.S., India and Japan.

Saudi Arabia is seeking to produce a large amount of its electricity from solar as a means of reducing its reliance on electricity produced by burning oil, thus conserving its oil reserves and boosting the amount of revenue it can earn by selling its oil to overseas buyers.

## SOLAR JOBS

U.S. solar jobs in 2017 fell by -3.8% to 250,271 jobs from the record high of 260,077 jobs in 2016, according to the "National Solar Jobs Census 2017" published by The Solar Foundation ([link](#)).

Despite the 2017 decline, the U.S. solar industry during the 5-year period of 2012-2017 added a net total of 131,000 jobs to the U.S. economy, rising by +16% annually and by a total of +110% over the five year period.

Solar employment over the last five years grew nine times faster than the +1.8% annual growth rate of the U.S. economy, according to the Solar Foundation, illustrating how the solar industry has made a substantial contribution to the U.S. labor market.

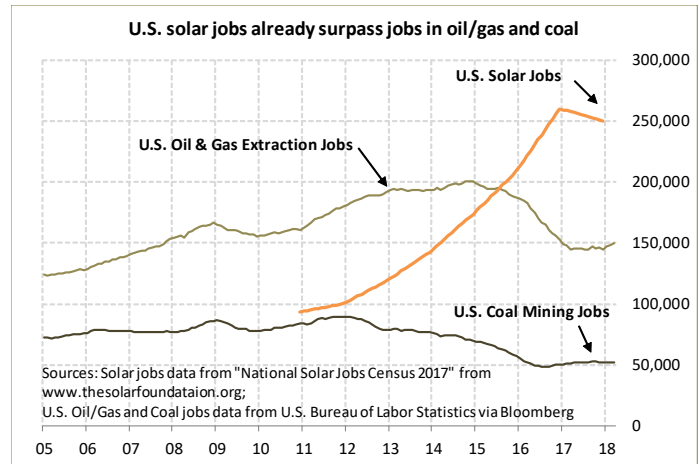
About 78% of U.S. solar jobs are in the demand-side sectors such as installation, sales & distribution and project development. Meanwhile, manufacturing accounts for only 15% of total solar jobs, according to the Solar Foundation.

The decline in solar jobs in 2017 was due to slower solar installs after the growth spike seen in 2016. In addition, solar jobs retrenched in 2017 on uncertainty ahead of the Trump administration's 30% solar tariff on imported cells/modules, which raised the cost of solar projects and reduced project installs.

Despite the 2017 job decline, solar jobs in the U.S. still substantially exceed those in the fossil fuel industries. Specifically, the 250,271 jobs in the solar sector far exceed the 150,200 direct jobs in the oil/gas extraction industry and 52,100 direct jobs in the coal mining industry, according to figures from the U.S. Bureau of Labor Statistics (see chart on the right).

Globally, solar is a huge employer with 3.1 million solar jobs worldwide in 2016, up 12% from 2015, according to the "Renewable Energy and Jobs--Annual Review 2017" from the International Renewable Energy Agency (IRENA) ([link](#)).

China is way ahead of the U.S. in solar jobs with a total of 1.9 million jobs in 2016 due to a much larger installation and manufacturing solar sector, according to the IRENA report. Japan also has more solar jobs than the U.S. at 302,000, according to IRENA.





## SOLAR PV ANNUAL NEW INSTALLATIONS -- 2017

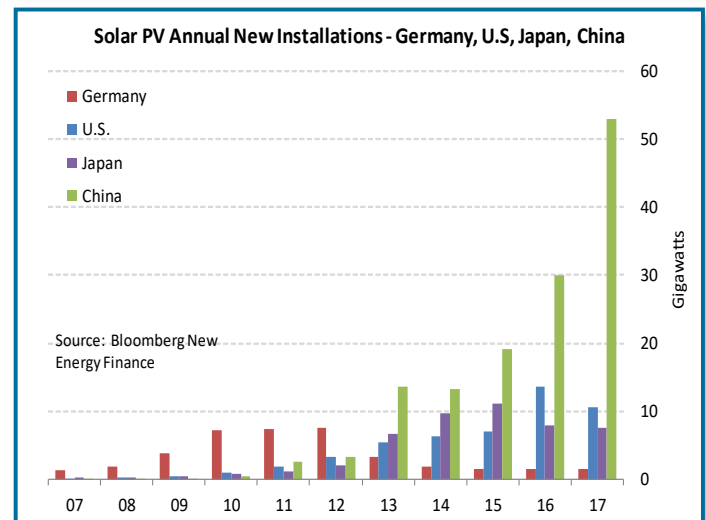
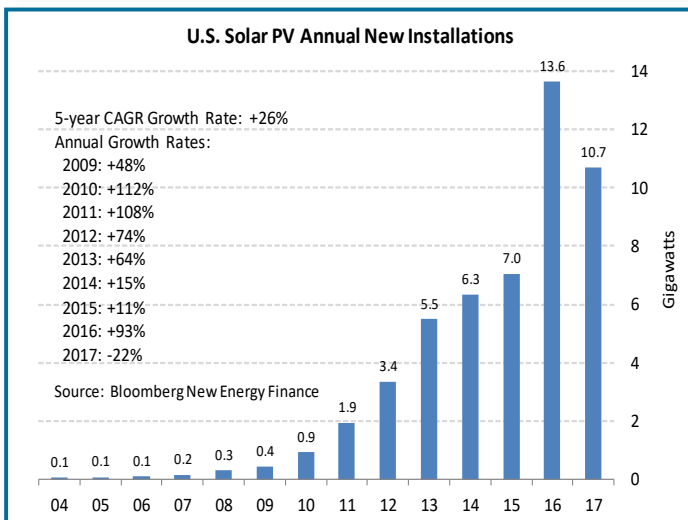
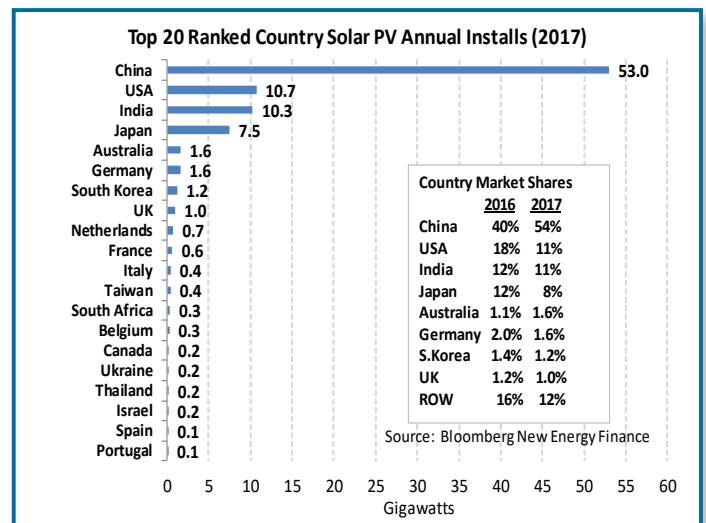
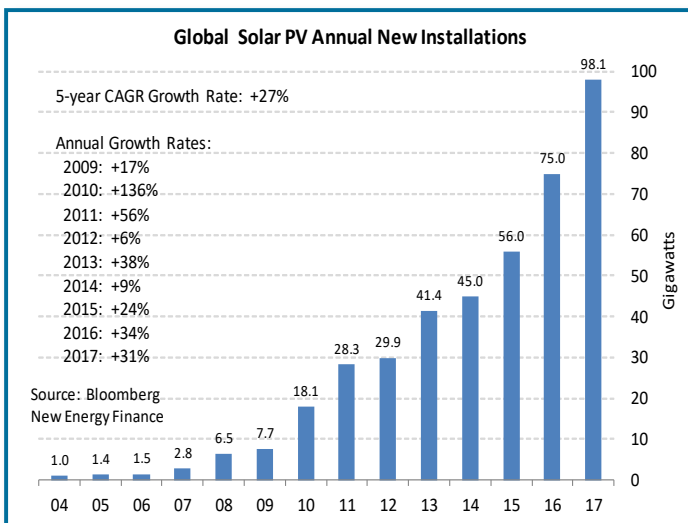
New global solar PV installations in 2017 grew by +31% yr/yr to a record 98.1 gigawatts (GW), according to Bloomberg New Energy Finance (BNEF). The 2017 growth rate of +31% followed growth rates of +34% in 2016 and +24% in 2015. Global solar PV installations have grown at a compounded annual rate of +27% over the last 5 years and have risen by 15-fold from 2008.

In 2017, China led the world for annual solar PV installs for the fifth straight year with 53.0 GW of installs, up by +76% from the 30.0 GW of installs seen in 2016. The U.S. took second place for the second straight year with 10.7 GW of installs, which was down by -22% from 2016. India passed up Japan for third place with 10.3 GW of installs, up by +94% from 2016. Japan fell into fourth place with 7.5 GW of installs, down by -6% from 2016. Other countries trailed the top-four leaders with less than 2 GW of installs each.

Solar installs in Europe showed modest growth in 2017 as Europe deemphasized subsidies in favor of holding auctions to buy solar

power. German solar installs in 2017 rose slightly by +3% to 1.6 GW and remained far below the 2013 peak of 7.6 GW. French installs in 2017 rose by +14% to 636 MW, far below the 2011 peak of 1.8 GW. Italian installs in 2017 rose by +11% to 409 MW but remained far below the 2011 peak of 7.9 GW. UK installs fell by -52% to 990 MW as the government curbed feed-in tariffs.

U.S. solar PV installations in the five years through 2017 grew by a compounded annual rate of +26% and were up by three-fold from 3.4 GW in 2012, according to BNEF. The states with the largest amount of new PV solar installations in 2017 were California (-50% to 2.6 GW), North Carolina (+18% to 1.2 GW), and Florida (+85% to 749 MW), according to GTM Research. After those top three, the states with the largest 2017 installs were Texas, Massachusetts, Minnesota, Arizona, South Carolina, and Nevada. The states with the largest installed cumulative base of solar power are now California, North Carolina, Arizona, Nevada, New Jersey, Massachusetts, Texas, Utah, Georgia, and Florida.



## SOLAR PV CUMULATIVE INSTALLATIONS THROUGH 2017

The amount of cumulative PV electricity generation capacity across the world grew sharply by +30% yr/yr to 421 GW in 2017, according to Bloomberg New Energy Finance (BNEF). In the last five years, global cumulative solar PV electricity generation capacity increased by more than four-fold from 103 GW in 2012 to 421 GW in 2017, representing a compounded annual growth rate of +33%.

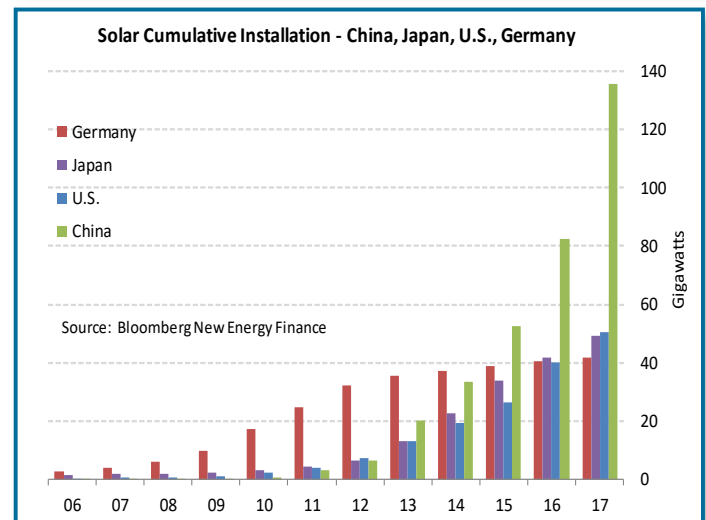
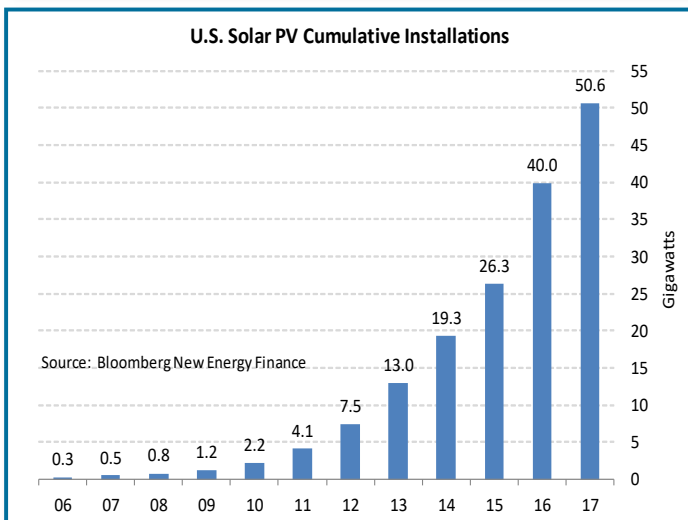
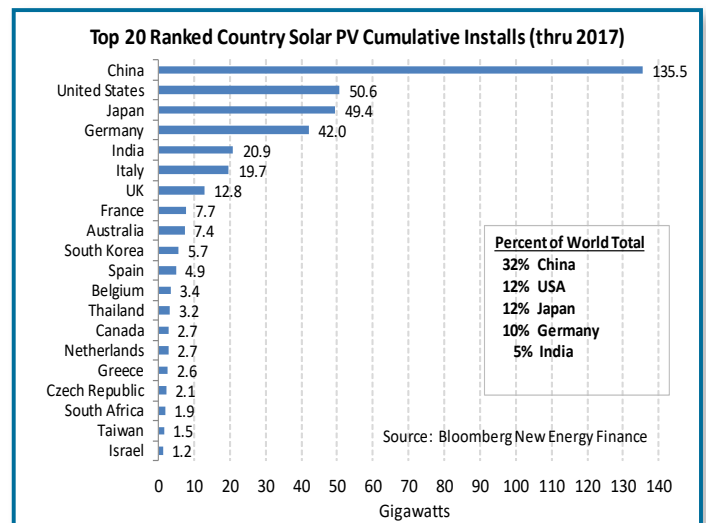
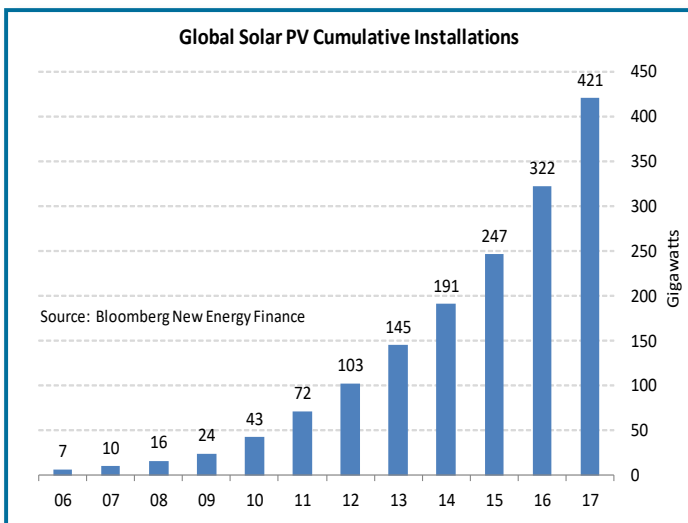
China remained the world's leader for cumulative solar capacity at 135 GW, according to BNEF. China at the end of 2017 accounted for 32% of the world's solar PV capacity. In the past five years, China's cumulative installed solar capacity soared by 21-fold from 6.4 GW in 2012 to the 2017 level of 135 GW, representing a 5-year compounded annual growth rate of 84%.

The U.S. in 2017 jumped into second place from fourth place in 2016 for cumulative solar installs. U.S. solar electricity capacity in

2017 rose by +27% to 51 GW, representing 12% of world capacity. U.S. cumulative solar electricity capacity over the past five years rose by nearly seven-fold to 51 GW from 7.5 GW in 2012 and showed a compounded annual growth rate of +47%.

Japan remained in third place for the fourth straight year. Japan's cumulative solar capacity in 2017 rose by +18% to 49 GW, representing 12% of world capacity. Japan's cumulative solar capacity in the past 5 years has risen nearly eight-fold to 49 GW from only 6.4 GW in 2012, representing a 5-year compounded annual growth rate of 50%.

Germany in 2017 fell into fourth place from second place in 2016 with 42 GW of cumulative solar PV capacity, up by +4% from 2016. Germany's cumulative solar capacity in the past 5 years has risen 1.3-fold to 42.0 GW from 32.2 GW in 2012. Germany at the end of 2017 accounted for 10% of the world's total solar PV capacity.



## SOLAR PRICING

Prices for solar cells and modules since May 2018 have fallen sharply mainly because of the China-531 order by the Chinese government to reduce subsidy support for the solar industry. The price of multicrystalline solar cells since May has fallen by -52% to a record low of 11 cents per watt at the end of September, according to Bloomberg New Energy Finance (BNEF). Solar cell prices have plunged by a total of -85% since mid-2011.

The average price of silicon solar modules dropped by -20% from May 2018 through early October to a record low of 23.3 cents per watt, according to PV Insights. Solar module prices have fallen by -27% on a year-on-year basis and by -81% from mid-2011.

Spot polysilicon prices fell to a new record low of \$10.87 per kg in the week of September 27, 2018, but then rebounded slightly higher to \$10.97 in the Sep 24 week, according to BNEF. Polysilicon prices have fallen by -30% since May 2018 and by -29% on a year-on-year basis. The decline in polysilicon prices is

a key factor in allowing solar cell and solar panel prices to decline since polysilicon is the key raw material for most solar cells.

The price of thin-film modules made by First Solar and other companies has fallen to a record low of 25.5 cents per watt, according to PV Insights. Thin-film module prices have fallen by -25% on a year-on-year basis and by -73% since mid-2011.

Solar prices in the second half of 2016 fell sharply mainly because of panel oversupply after the solar install spikes seen in China and the U.S., which were caused by developers trying to beat respective subsidy reduction deadlines. Solar pricing during 2017 and early 2018 moved mildly lower in line with its natural long-term downward trend that is the result of lower production costs from technology advances and economies of scale in manufacturing. Solar prices then fell sharply after May 31, 2018 when the Chinese government with its China-531 order reduced its subsidy support for solar, thus causing a temporary surplus of panels.

