

## SOLAR SECTOR UPDATE

The MAC Global Solar Energy Index (SUNIDX) is licensed as the tracking index for the Guggenheim 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 Guggenheim Solar ETF (NYSE ARCA: TAN), has rallied sharply since May and is up +45% year-to-date.

Recent bullish factors for solar stocks include (1) a surge in Chinese solar installs in 2017 and broadening solar strength coming from India, Latin America, the Middle East, and Southeast Asia (see page 5 for the world solar growth outlook), (2) stronger demand for solar power due to the increasingly competitive price of solar versus alternatives as countries seek to meet their carbon-reduction targets under the Paris COP21 global climate agreement, and (3) continued low valuation levels that indicate that solar stocks are conservatively priced even after the recent rally.

Bearish factors for solar stocks include (1) uncertainty about whether the Republicans' U.S. tax reform plan will hurt the availability of tax equity financing for the U.S. solar industry, (2) uncertainty about whether the Trump administration in January will impose U.S. import tariffs on solar cells and panels as a remedy

for Suniva's Section 201 trade complaint, (3) continued downward pressure on solar pricing caused by ample global production capacity, (4) uncertainty about the strength of global climate policy after the Trump administration earlier this year withdrew from the Paris climate agreement, and (5) ongoing solar trade disputes that have resulted in tariffs and various market dislocations.

Solar stocks are still trading at low valuation levels compared with the broad market even after the recent rally in solar stocks. The median forward P/E of companies in the MAC Solar Index is currently 13.9, which is well below the forward P/E of 19.8 for the S&P 500 index. In addition, the median price-to-book ratio of 1.30 for the companies in the MAC Solar Index is well below the 3.27 ratio for the S&P 500. The median price-to-sales ratio of 1.55 for the MAC Solar Index is well below the 2.22 ratio for the S&P 500.

### Solar stocks see a sharp recovery rally

Solar stocks have rallied sharply since May on signs of improved solar industry fundamentals and reduced concerns about Trump administration policies. The oversupply of panels that plagued the market in late 2016 has eased and company profit fundamentals are improving. In addition, the market was very encouraged to see a surge of about +45% in Chinese solar demand installs in 2017.

Solar stocks have also been boosted by the stabilization of solar cell and panel prices, which has helped company profit results. Part of the reason for the recovery in U.S. solar panel prices, however, is stockpiling and strong demand ahead of a decision in January on Suniva's trade complaint, which could result in tariffs or import curbs (see discussion on page 2).

Regarding U.S. politics, the solar market has already absorbed the negative moves that President Trump took earlier this year, including his intention to exit the Paris climate agreement and to rescind the EPA's Clean Power Plan. There was relief, however, that the Trump administration did not go so far as to pull the U.S. out of the entire UN climate treaty framework nor to rescind the EPA's legal obligation to regulate CO<sub>2</sub> emissions.

## Chinese PV growth surges

Forecasts for 2017 global solar installs have risen substantially because of a surge in Chinese installs. The China PV Industry Association (CPIA) reported that Chinese PV installs in the first half of 2017 were stronger than expected at 24.4 GW, up +19% year-on-year. The unexpected strength is mainly coming from distributed solar as opposed to utility solar.

CPIA said that Chinese solar installs for 2017 will likely reach 50 GW, which would be up by a blistering +45% from the 2016 install amount of 34.5 GW. In response to the first-half strength, Bloomberg New Energy Finance (BNEF) raised its 2017 Chinese solar forecast to 54 GW from its July forecast of 30 GW. IHS Markit is forecasting 45 GW of Chinese solar installs in 2017.

In July, China met the government's 13th Five-Year-Plan (2016-2020) target for cumulative solar installations of 105 GW. As a result, the government raised its target to 150 GW. However, total Chinese installs are likely to be significantly higher than the target since the target does not include rooftop solar, which is booming.

## Utility solar costs are now comparable to natural gas and have fallen below coal and nuclear

The levelized-cost-of-energy (LCOE) for utility-scale solar PV has dropped by -86% over the last eight years, by -36% over the last four years, and by -9% in 2017, according to Lazard's latest LCOE report ([link](#)). Lazard's report is the most comprehensive LCOE analysis available for alternative and conventional energy sources.

The latest Lazard report found that unsubsidized utility solar PV costs now have fallen by so much that solar is now competitive with new natural gas plants and is cheaper than new coal or nuclear plants.

Specifically, Lazard pegs the unsubsidized utility solar LCOE cost of 4.6-5.3 cents per kWh as comparable to the 4.2-7.8 cent cost of natural gas (combined cycle) and lower than cost of 6.0-14.3 cents for coal and 11.2-18.3 cents for nuclear.

## U.S. is now the lone holdout from the Paris climate agreement

The U.S. is now the only country in the world that has refused to abide by the Paris COP 21 global climate accord. The only other holdouts, Syria and Nicaragua, recently acceded to the agreement. Nicaragua signed the Paris climate agreement in October and Syria in November announced its intention to sign the agreement.

The rest of the world is continuing with the Paris climate agreement without the United States. China and Europe have flatly rejected the Trump administration's request for a renegotiation of the agreement. It makes little sense to renegotiate the agreement since the emission reduction targets are voluntary, which means

that any country including the U.S. can simply change their goals if they wish.

Even though President Trump on June 1 announced that the U.S. plans to leave the Paris climate agreement, the U.S. exit will not actually occur until the end of President Trump's term. The Paris agreement is binding on the U.S. for the next three years and then requires a 1-year notice to withdraw. The earliest date for a U.S. exit is November 4, 2020, one day after the next presidential election. At any time during that period, the U.S. could drop the exit process and recommit to the Paris agreement. The U.S. could also recommit to the agreement at any time in the future if desired by a new president.

The Obama administration originally signed the Paris climate agreement with a voluntary goal of reducing U.S. carbon emissions by 17% by 2020, by 26%-28% by 2025, and an intent to reduce emissions by 80% by 2050. Most climate experts believe the Paris agreement was not tough enough in the first place to meet its goal of limiting global warming to two degrees Celsius (3.6 degrees Fahrenheit) from pre-industrial levels.

## Trump administration's Section 201 trade remedy decision is due by January

The U.S. solar industry is on edge as it waits for the Trump administration's decision on the remedy, if any, to the decision by the U.S. International Trade Commission (ITC) that U.S. solar cell and panel manufacturers have been harmed by foreign competition.

The Section 201 solar trade case began in spring 2017 after two foreign-owned solar manufacturing companies based in the U.S., Suniva and Solarworld, pursued a Section 201 trade case with the ITC. The companies alleged that they had been driven into bankruptcy by foreign competition. Section 201 is a little-used U.S. trade complaint that was last used by the steel industry in 2001.

ITC commissioners on Sep 22 ruled by a vote of 4-0 that American solar manufacturers were in fact harmed by foreign competition. The ITC on Oct 31 then released its remedy recommendations, which were less severe than the markets had feared. The ITC recommended tariffs of 30-35% on imported cells and panels and a possible import quantity limit. The tariff recommendation was substantially weaker than Suniva's request for an import duty of 40 cents per watt and a minimum price of 78 cents per watt. Suniva's requested remedy would have more than doubled the cost of imported panels from the current price of about 32 cents per watt.

The Trump administration currently faces a deadline of January 26, 2018 to announce its decision on remedies, although that deadline could slip. The Trump administration is not bound by the ITC's recommendations and is free to choose whatever remedy it wishes, or even decline to apply any remedy at all. The Trump administration has given no indication of what remedy it might choose.

If the Trump administration does impose tariffs under Section 201, there is a chance that those tariffs will eventually be struck down by the World Trade Organization (WTO). President Trump's U.S. Trade Representative Robert Lighthizer recently asked the ITC to identify any "unforeseen developments" that might come from tariffs, such as the impact on the solar install industry or a challenge to the tariffs at the WTO.

Section 201 solar import tariffs would be negative overall for the U.S. solar industry, which is heavily dependent on imported solar panels to support the rapid installation of solar in the U.S. Indeed, U.S. factories manufactured fewer than 10% of the solar panels that were installed in the U.S. in 2016, according to Bloomberg New Energy Finance. In fact, U.S. installers in 2016 heavily relied on imported panels for more than 90% of their U.S. solar installs.

Any increase in the after-tariff price of imported panels would make U.S. solar projects less economical in the U.S. and would therefore hurt the U.S. solar install growth rate. GTM Research estimates that U.S. solar installs would be cut by -9% from what they would otherwise be if the Trump administration levies a tariff of 10 cents per watt, which would be close to the ITC's recommendation of a 30-35% tariff.

The problem for the Trump administration is that any tariff on imported solar panels will likely result in a net reduction of U.S. solar jobs. Of the 260,000 solar jobs in the U.S., 85% are in installation and only 15% are in manufacturing, according to the Solar Energy Industry Association (SEIA). Import tariffs might give a small boost to U.S. solar manufacturing jobs, but that small boost would be swamped by the number of jobs that could be lost in the solar install industry. For that reason, the Solar Energy Industry Association (SEIA) strongly opposes any tariff or trade restrictions on imported cells and panels.

The Section 201 trade case has been a positive factor for First Solar (FSLR) because the ITC decision exempted thin-film manufacturers from any trade remedies or tariffs. The ITC decision also exempted manufacturers from Canada and Singapore. By contrast, the ITC decision was negative for Chinese and other global solar manufacturers because they could see a tariff slapped on the solar panels that they export to the U.S. The decision was also negative for U.S. companies that specialize in installing solar panels, such as SunRun (RUN) and Vivent (VSLR), since they would face higher prices for imported solar panels.

The Section 201 trade case has already hurt the U.S. solar install industry by pushing solar panel prices as high as 52 cents per watt since installers are hoarding what panels they can find. In addition, many solar projects have been delayed, waiting for the remedy decision and to see how solar pricing shakes out in 2018.

While the Section 201 trade case has been a negative factor for the U.S. solar industry, the industry will nevertheless survive what would be the latest example of governmental trade interference in the solar industry. A 30-35% tariff on imported panels would push up the price of imported solar panels to the 43-44 cent per

watt area from the current 32 cent level, but many solar projects can still be economical at that level. In addition, installers would try to adapt to the tariff by buying domestically-produced panels or otherwise exempted panels. Moreover, some Chinese solar manufacturers are already talking about setting up solar panel factories in the U.S. to avoid the tariffs.

Regarding the impact of the Section 201 trade case on the global solar industry, it is worth remembering that the U.S. market in 2016 accounted for only 18% of global solar installs, according to BNEF. That means that a drop in U.S. installs from tariffs would have a limited effect on the overall global solar market. For example, if the U.S. solar installs suffered a -10% hit from Section 201 remedies, that would translate to a decline of only about -2% in worldwide installs (i.e., a -10% U.S. decline multiplied by the 18% U.S. market share).

## Trump administration moves to rescind Clean Power Plan

The EPA on October 10 took formal steps to repeal the Obama administration's Clean Power Plan (CPP), which was designed to cut CO2 emissions from U.S. power plants. That action, however, was in line with the Trump administration's well-known intentions and had little stock market impact.

When President Trump was elected in November 2016, the markets were already aware that the CPP would not go into effect during the Trump administration's watch. The CPP, in any case, was already bottled up with a legal challenge at the U.S. Supreme Court when Mr. Trump took office. There was a chance that the Supreme Court would have struck down the plan anyway as an overreach of regulatory authority even if Hillary Clinton had been elected as president.

Nevertheless, the loss of the CPP is a blow for U.S. efforts to reduce its carbon emissions. Without the CPP, the U.S. is unlikely to meet the Obama administration's former goal under the Paris climate agreement of reducing U.S. carbon emissions by 17% by 2020, by 26-28% by 2025, and by 80% by 2050.

The EPA's repeal of the CPP will be a long and torturous process since the repeal must go through the EPA's regular rule-making procedures from scratch. The repeal is then likely to be challenged by environmental supporters in court. That whole process is likely to extend well past the end of the Trump administration's first term. In the meantime, the CPP will not be implemented and will have no effect.

The good news for the solar industry is that the EPA is still under a legal requirement to regulate CO2. The EPA's obligation to regulate CO2 emissions has already been litigated all the way up to the U.S. Supreme Court and would be extremely difficult to reverse. The Trump administration has already decided not to challenge President Obama's 2009 CO2 endangerment finding, which established the legal structure by which the EPA is legally obligated to regulate CO2 emissions.

The EPA said it plans to issue a replacement rule for the CPP in order to meet its legal obligation to regulate CO2 emissions. The EPA has requested ideas from stakeholders about the content of a replacement rule. However, few believe that a significant CO2 emission reduction rule is likely to emerge during the Trump administration.

## Republicans' tax reform plan may have negative implications for tax equity financing

The Republicans have not yet finalized their tax reform plan, which means the implications of the plan for solar are not yet clear.

In a very positive development for solar, Republicans appear to be headed towards leaving intact the existing solar investment tax credit (ITC) provisions through 2021, which is an important support measure for the U.S. solar industry. The solar ITC is currently set at 30% through 2019 and is set to step down to 26% in 2020 and 22% in 2021.

The ITC in 2022 will expire entirely for direct-owned residential projects, but will permanently remain at 10% for utility PV projects, non-residential, and third-party-owned residential solar installations. The Republican tax bill, however, may end that permanent tax credit at some date in the future such as 2027. The elimination of the permanent tax credit would be mildly negative for the U.S. solar industry, but would only take effect far out into the future.

The solar industry's main area of concern about the Republicans' tax bill is the impact on tax equity, which is an important source for financing for solar projects. Tax equity accounted for about 21% of the \$58.5 billion of U.S. renewable energy investment in 2016, according to BNEF.

Through tax equity, an investor can take passive partial ownership of a solar project to capture the tax benefits, which might not otherwise be available to the developer. Tax equity helps reduce the overall financing costs of a solar project.

The Republican tax bill aims to reduce the corporate tax rate to 20% from 35%, which by itself means that companies may allocate less capital to tax equity since they will be paying lower taxes. Moreover, there is major concern that tax equity could take a heavy hit depending on whether Republicans go through with ideas to impose a tough alternative minimum tax (AMT) on U.S. corporations and/or put what amounts to an AMT on U.S. affiliates of foreign corporations with a Base Erosion Anti-Abuse Tax (BEAT).

The effect of alternative minimum taxes is to reduce or eliminate the benefit of tax equity financing. The reduction of tax equity financing would mean that some solar projects would have higher overall financing costs, which would translate to less advantageous project economics.

## SOLAR PV GROWTH OUTLOOK

Over the last five years, global PV annual solar installs surged to 75.0 GW in 2016 from only 28.5 GW in 2011, producing a very strong +21% compounded annual growth rate, according to Bloomberg New Energy Finance (BNEF).

The global solar industry in 2016 showed a very strong growth rate of +34% year-on-year to 75.0 GW from 56 GW in 2015 mainly because of a surge of installations in the U.S. and China caused by developers trying to beat respective subsidy deadlines. U.S. growth is expected to slow in 2017 after the 2016 spike, but Chinese solar growth has continued to surge in 2017, supporting the global solar growth rate.

For 2017, BNEF is currently forecasting world solar installs at 92-97 GW, which implies an annual growth rate of about +26%. BNEF expects more than half of that growth (50-54 GW) to come from China. The trade association SolarPower Europe is forecasting higher global installs in 2017 of 100 GW.

Regarding a longer-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 only 1.2% in 2015.

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 solar spending through 2040 (averaging about \$135 billion per year), according to BNEF. BNEF forecasts that solar PV will account for 15% of world electricity capacity by 2040, up from only about 1.2% in 2015.

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. 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 2017 solar installs surge

China's solar installs in 2016 soared by +58% to 30.0 GW from 19.0 GW in 2015, according to BNEF. Solar surged in 2016 as developers scrambled to meet a June 2016 step-down in the feed-in-tariff. Most of the installs occurred the first half of 2016, leading to a glut of panels in the second half of 2016 that caused solar panel prices to drop sharply.

Chinese solar installs have surged again in 2017 and are likely to hit 54 GW this year, up 80% year-on-year, according to BNEF. The strength of Chinese installs has been prompted by strong

utility solar projects and also by strong distributed solar projects. China is making a push for more distributed solar projects, i.e., solar on commercial and industrial buildings, malls, and schools. In the first half of 2017, almost a third of new solar installs were distributed solar projects.

The Chinese government is trying to smooth solar growth to address recent problems such as (1) electricity oversupply in some northwestern districts that have led to some curtailment of solar electricity usage averaging around 6%, and (2) delays by the government in making subsidy payments to developers.

Due to strong solar growth in 2017, the Chinese government in its 5-year plan boosted its target for cumulative utility-scale solar capacity to 150 GW by 2020, reversing a previous decision to cut the target to 105 GW.

### U.S. faces 2017 slowdown after 2016 utility solar surge

U.S. solar installs in 2016 soared by +90% to 13.7 GW, according to BNEF. U.S. solar surged by a +48% compounded annual rate in the five years through 2016.

Solar accounted for 39% of all new U.S. electricity generation capacity in 2016, up from 30% in 2015 and 27% in 2014, according to GTM Research. Solar was the largest source of new electricity generation in 2016, easily beating natural gas at 29% and wind at 26%.

The surge in 2016 solar growth was mainly due to a +148% y/y spike in utility PV, which accounted for about 72% of all U.S. solar installs in 2016. Utility PV saw a big spike in 2016 because many solar projects were hurried into 2016 to take advantage of the Investment Tax Credit (ITC) that was previously scheduled to expire at the end of 2016. Congress in December 2015 extended the ITC by 5 years, but most of the projects that were already planned moved ahead into 2016, thus causing the 2016 bulge.

Meanwhile, U.S. solar installs in the second half of 2017 are expected to be undercut by the uncertainty about the Section 201 trade case, which has pushed PV prices higher on hoarding and has caused a delay in project planning to await the outcome of the case.

Due to the step-down in utility solar from the 2016 spike and Section 201 trade-case uncertainty, GTM Research is forecasting that U.S. solar installs in 2017 will fall by -9% to 12.4 GW. However, that is still a strong install figure since it is +72% higher than the 2015 level of 7.2 GW. GTM is forecasting that U.S. solar installed cumulative capacity will nearly triple over the next 5 years and that annual installs will be more than 16 GW by 2022.

Solar is progressively becoming more diversified across the

## SOLAR PV GROWTH OUTLOOK (CONTINUED)

United States rather than being concentrated in just a few states. A record number of 22 states in 2016 added more than 100 MW of solar PV. California saw the largest number of installs by far at 5.1 GW. Other state solar leaders in 2016 by ranking included Utah, Georgia, Nevada, North Carolina, Texas, Arizona, Massachusetts, Florida, and Colorado.

U.S. solar through 2021 will benefit from the federal investment tax credit (ITC), which stays at 30% in 2017-2019 and then steps down to 26% in 2020 and to 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 only need to 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 was approved by Congress in late 2015 as 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.

### Japan is coming off its Fukushima solar boom

In Japan, solar surged after the Fukushima nuclear disaster in 2011 due to a generous government feed-in-tariff (FIT). Japan solar installs soared by +64% on an annual compounded basis in the five years through 2015. However, Japan is in the process of bringing nuclear capacity back on line and has cut its solar FIT, leading to expectations for substantially smaller Japanese solar installs over the next few years.

Japan solar installs in 2016 fell by -20% to 9.2 GW from the record high of 11.5 GW seen in 2015, according to BNEF. BNEF is forecasting that Japan solar installs in 2017 will drop by -37% to 5.8 GW.

### India solar boom in progress

The Indian government is pushing solar very hard as part of its goal of modernizing India's infrastructure and boosting its global business competitiveness. The government has a set goal of installing a cumulative 100 GW of solar by 2022, including 40 GW of rooftop solar. The 100 GW target would be 10 times India's cumulative installed solar capacity of about 10 GW at the end of 2016.

India's solar installs in 2016 more than doubled to 4.4 GW from the low base of 2.1 GW in 2015. India's solar installs in 2017 will

roughly double again to 8.9 GW, according to BNEF. That means that India in 2017 should be able to easily take over third place from Japan as the third largest country for solar installs.

### European solar growth remains weak on the move away from feed-in-tariffs

European solar growth has slowed substantially in recent years as previous booms ended when subsidies were cut. European governments are now relying more on auctions to buy solar rather than relying solely on feed-in-tariff schemes that are difficult to calibrate.

In 2016, German solar grew slightly by +1% to 1.5 GW, French solar fell by -24% to 675 MW, UK solar fell by -52% to 2.0 GW, and Italian solar grew by +37% to 407 MW.

European solar in 2017 will grow by about +10% to 7.5 GW, according to solar trade association SolarPower Europe.

### Rest-of-world is coming on strong

In 2016, the top three countries of China, U.S., and Japan accounted for 70% of world solar installs. However, solar growth in coming years will diversify as a wide range of other countries ramp up installations.

The geographical diversification of solar will be a very healthy development for the solar industry because it will reduce the industry's exposure to boom-bust events in various countries that have buffeted the solar industry in recent years. The diversification of growth should lead to a more stable and more predictable growth rate that allows the industry to better manage capacity additions and profit margins.

In 2016, solar installs from the "rest of world" (i.e., countries other than China, U.S., Japan, India, and Europe), totaled 11.1 GW and accounted for about 15% of world installs. However, the "rest of world" (ROW) category over the next few years is expected to grow dramatically, becoming larger than even China with a total ROW market share of about 40% by 2019 versus only about 23% for China in 2019, according to BNEF.

Specifically, BNEF is forecasting that ROW solar will grow to 17.3 GW in 2017 (+56%), 33.7 GW in 2018 (+95%), and 36.5 GW by 2019 (+8%). Areas coming on strong include Latin America, the Middle East, and Southeast Asia.

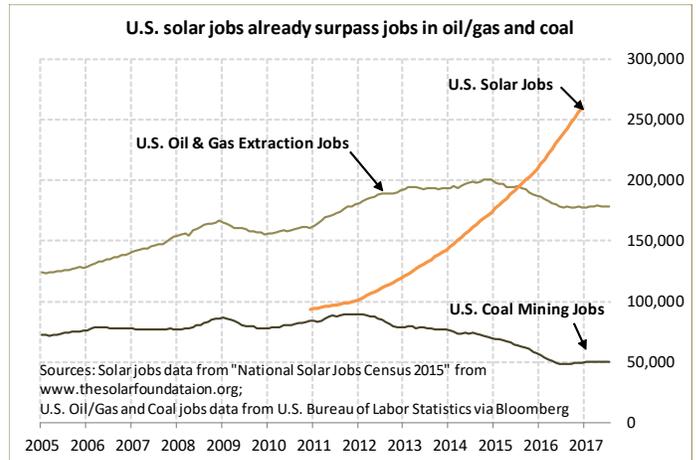
## SOLAR JOBS

U.S. solar jobs have soared by an annual rate of 22% over the last four years to a total of 260,077 jobs at the end of 2016, according to the "National Solar Jobs Census 2016" published by The Solar Foundation ([link](#)).

Solar jobs in the U.S. now exceed those in fossil fuel industries. Specifically, direct solar jobs now exceed the latest figures of 178,000 direct jobs in the oil/gas extraction industry and 50,600 direct jobs in the coal mining industry, according to figures from the U.S. Bureau of Labor Statistics.

Globally, solar is an even bigger employer with 2.8 million solar jobs worldwide in 2015, up 11% from 2014, according to the "Renewable Energy and Jobs - Annual Review 2016" from the International Renewable Energy Agency (IRENA).

China is way ahead of the U.S. in solar jobs with a total of 1.7 million jobs in 2015 due to larger installation and manufacturing solar operations, according to the IRENA report. Japan also has more solar jobs than the U.S. at 377,100, according to IRENA.



## SOLAR PV ANNUAL NEW INSTALLATIONS THROUGH 2016

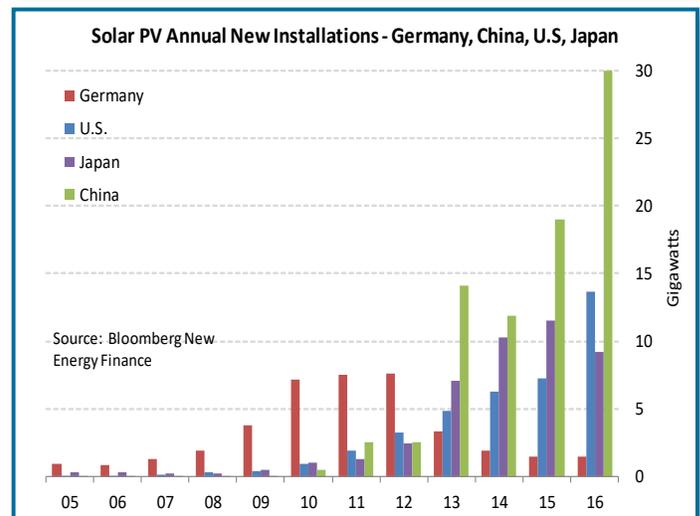
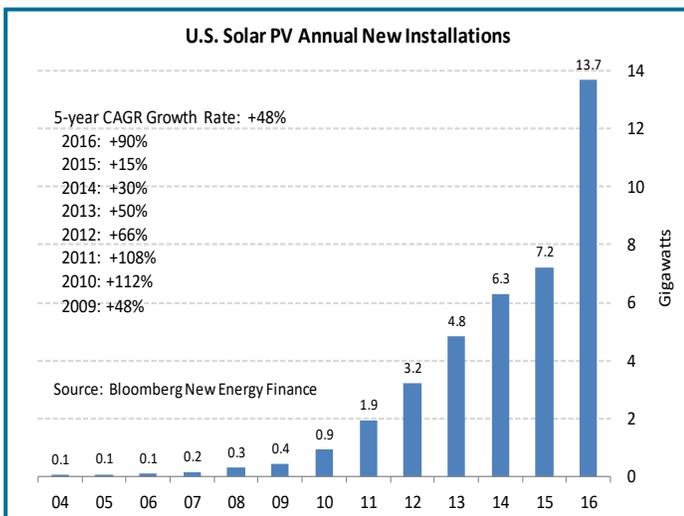
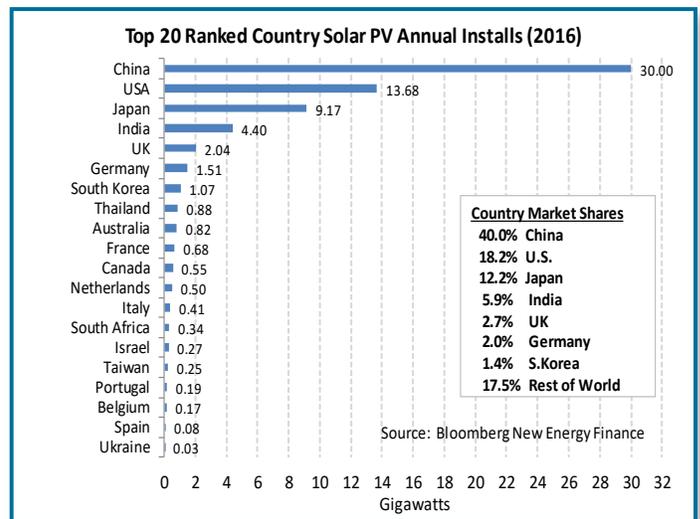
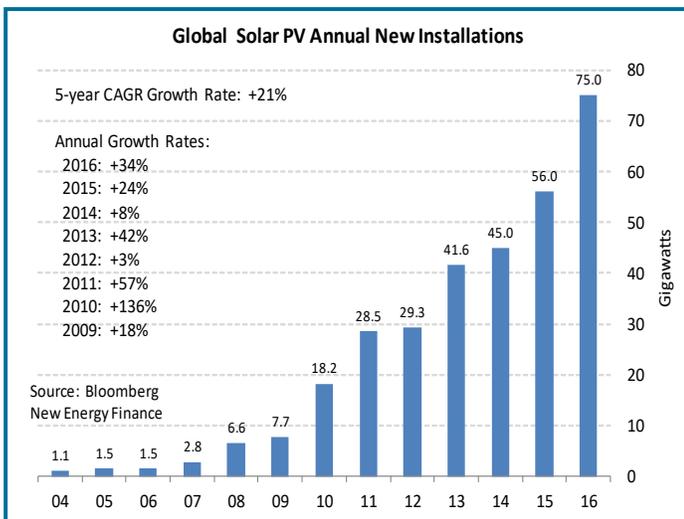
New global solar PV installations in 2016 grew by +34% y/y to a record 75.0 gigawatts (GW), according to Bloomberg New Energy Finance (BNEF). The 2016 growth rate of +34% followed growth rates of +24% in 2015, +8% in 2014 and +42% in 2013. Global solar PV installations have grown at a compounded annual rate of +21% over the last 5 years and have risen eleven-fold from 2008.

In 2016, China was the top country in the world for annual PV installs for the fourth straight year with 30.0 GW of installs, up by +58% from the 19.0 GW of installs seen in 2015. The U.S. passed up Japan to take second place for new installs in 2016 with a 90% surge to 13.7 GW. Japan fell into third place with solar installs falling by -20% to 9.2 GW. India moved ahead of the UK into fourth place with +113% growth to 4.4 GW.

The sharp increase in installs in China, the U.S., and India more than offset the declines in continental Europe where installs continued to be undercut by low subsidy support. German solar

installs in 2016 rose slightly by +1% to 1.5 GW and remained far below the 2013 peak of 7.6 GW. French installs in 2016 fell by -24% to 675 MW, far below the 2011 peak of 1.8 GW. Italian installs in 2016 rose by +37% to 407 MW but remained far below the 2011 peak of 7.9 GW. UK installs fell by -52% to 2.0 GW as the government curbed feed-in-tariffs.

U.S. solar PV installations in the past five years have surged by a compounded annual rate of +48% and are up seven-fold from the 1.9 GW level seen in 2011, according to BNEF. The states with the largest amount of new PV solar installations in 2016 were California (+56% to 5.1 GW), Utah (+438% to 1,241 MW), Georgia (+313% to 1,023 MW), Nevada (+229% to 984 MW), North Carolina (-19% to 923 MW), Texas (+216% to 672 MW), Arizona (+155% to 657 MW), Massachusetts (+23% to 406 MW), Florida (+840% to 404 MW), and Colorado (+162% to 382 MW), according to GTM Research.



## SOLAR PV CUMULATIVE INSTALLATIONS THROUGH 2016

The amount of cumulative PV electricity generation capacity across the world grew sharply by +30% y/y to 323 GW in 2016, according to Bloomberg New Energy Finance (BNEF). In just five years, global cumulative solar PV electricity generation capacity increased by more than four-fold from 73 GW in 2011 to 323 GW in 2016, representing a compounded annual growth rate of +35%.

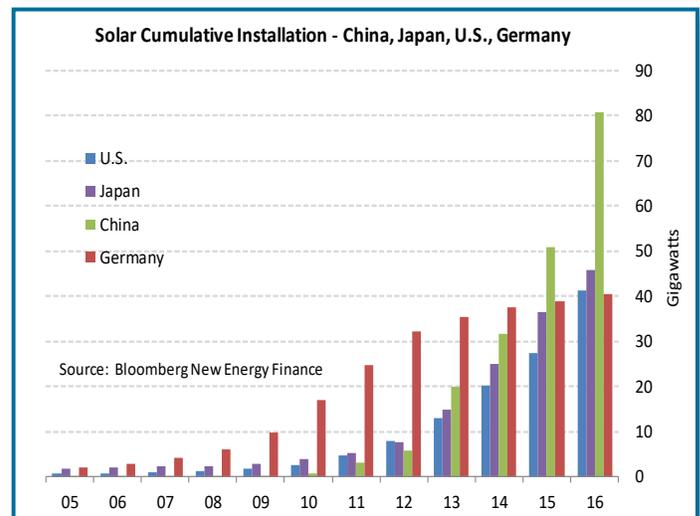
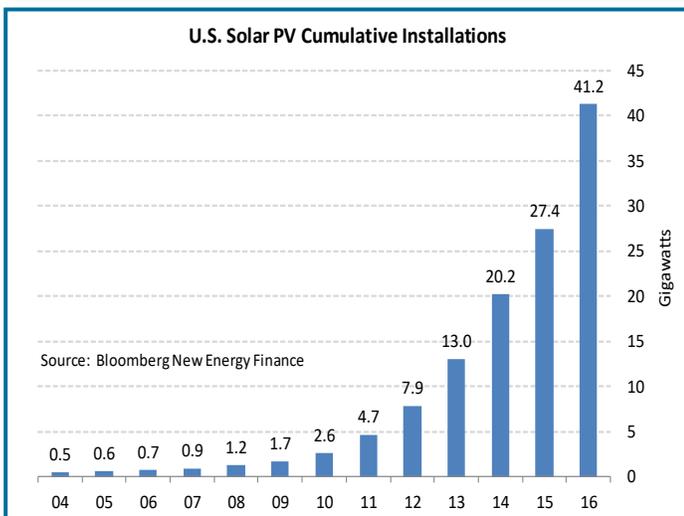
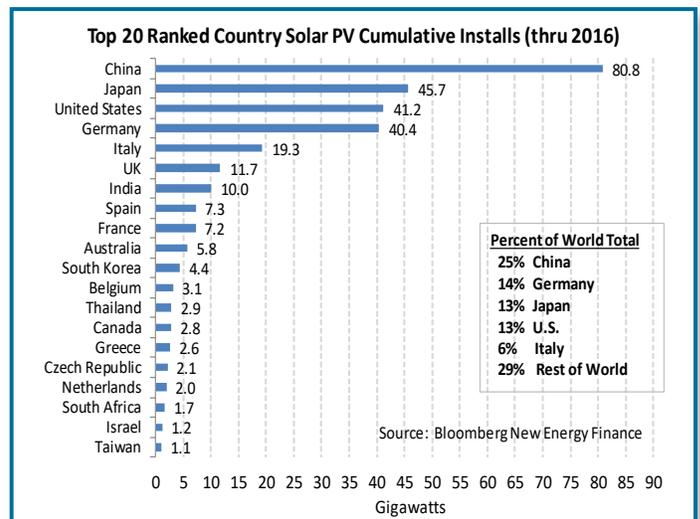
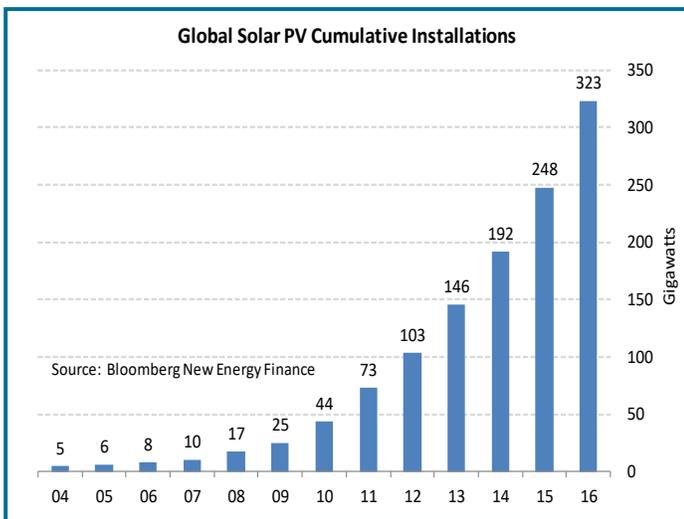
China remained in the world's top spot for cumulative solar capacity at 81 GW, according to BNEF. China at the end of 2016 accounted for 25% of the world's solar PV capacity. In the past five years, China's cumulative installed solar capacity has soared by about 25-fold from 3.2 GW in 2011 to the 2016 level of 81 GW, representing a 5-year compounded annual growth rate of 91%.

Germany in 2016 remained in second place with 40 GW of cumulative solar PV capacity, up by +4% from 2015. Germany's

cumulative solar electricity capacity in the past 5 years has risen 1.6-fold to 40.4 GW from 24.6 GW in 2011. Germany at the end of 2016 accounted for 14% of the world's total solar PV capacity.

Japan remained in third place for the third straight year. Japan's cumulative solar capacity in 2016 rose by +25% to 46 GW, representing 13% of world capacity. Japan's cumulative solar capacity in the past 5 years has risen nearly nine-fold to 46 GW from only 5.2 GW in 2011, representing a 5-year compounded annual growth rate of 54%.

The U.S. remained in fourth place for the fourth straight year. U.S. solar capacity in 2016 rose by +50% to 41 GW, representing 13% of world capacity. U.S. cumulative solar electricity capacity over the past five years rose nearly nine-fold to 41 GW from 4.7 GW in 2011 and showed a compounded annual growth rate of +55%.



## SOLAR PRICING

Prices for solar cells and modules in 2017 have largely stabilized after falling fairly sharply during 2016. Specifically, the price of multicrystalline solar cells fell to a record low of 21 cents per watt in Sep 2016 but has since rebounded higher to 25 cents per watt, according to Bloomberg New Energy Finance (BNEF). Solar cell prices are unchanged on a year-on-year basis but have plunged by a total of -69% in the past six years from the 81-cent level seen in mid-2011.

The average price of silicon solar modules has moved lower since early 2016 and is currently at a record low of 31.4 cents per watt, according to PV Insights. Solar module prices have fallen by -19% on a year-to-year basis and by -75% in the past 6 years from the \$1.25 level seen in mid-2011.

Spot polysilicon prices fell to a new record low of \$12.76 per kg in mid-Oct 2016, but have since rebounded mildly higher to the current level of \$16.00, according to BNEF. Polysilicon prices are

up by +10% year-on-year but have plunged by -69% over the past 6 years from the \$51.37 level seen in mid-2011. 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 others has fallen to a record low of 33.5 cents per watt, according to PV Insights. Thin-film module prices have fallen by -17% on a year-on-year basis and by -65% from the mid-2011 level of 95.5 cents.

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. in 2016 caused by developers trying to beat respective subsidy reduction deadlines. Solar pricing during 2017 has moved mildly lower in line with its natural long-term downward trend that is the result of lower production costs stemming from technology advances and from scale manufacturing.

