MAC Solar Index

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SOLAR SECTOR UPDATE

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MAC Global Solar Energy Index (SUNIDX)

SOLAR INDEX PERFORMANCE

The MAC Global Solar Energy Stock Index, the tracking index for the Invesco Solar ETF (NYSE ARCA: TAN) and the Invesco Solar Energy UCITS ETF (London: ISUN LN), has settled back in recent months after posting a 13-year high in January 2021. The Index is currently down by -25% on a year-to-date basis, giving back some of the extraordinary +235% annual gain seen in 2020.

The MAC Solar Index in 2020 rallied sharply as the industry shook off the impact of the pandemic and looked ahead to more favorable solar policy support as Joe Biden won the November 2020 U.S. presidential election and Democrats took control of both the House and Senate.

The Index has since fallen back in 2021 as the solar industry hit some temporary obstacles caused by the pandemic, a polysilicon shortage, various supply chain disruptions and costs, and concern about the Biden administration's ban on some solar products from China's Xinjiang province. There has also been a slowdown in project planning due to higher solar costs. The markets are also getting impatient for Democrats to pass solar policy-support legislation contained in the Build Back Better bill, or pass those solar-support measures through other bills.

Despite the recent obstacles, bullish longer-term factors for solar stocks continue to include (1) expectations for a global dash to reduce carbon emissions now that the U.S. has reclaimed its leadership role in the global Paris climate effort, (2) the strong global solar demand picture that has resulted from the fact that solar has now reached unsubsidized grid parity in more than two-thirds of the world, (3) the pairing of solar with large-scale battery systems to provide a 24/7 electricity solution, (4) broadening solar growth in India, Turkey, Latin America, Middle East, and Southeast Asia, and (5) strong demand for renewable energy as countries seek to meet their carbon-reduction targets under the Paris COP21 global climate agreement.

Solar stocks settle back on temporary obstacles but long-term industry trends remain bullish

Solar stocks are sharply higher from their pandemic lows seen in spring-2020 due to (1) the overall recovery in global stocks seen since the pandemic-induced dip in spring 2020, (2) the realization that solar is emerging as a key solution to climate change as it becomes the cheapest source of new electricity generation and is paired with battery storage for 24/7 electricity, (3) the Biden administration's clean energy push through executive actions and proposed legislation, (4) a big European renewable energy push to stimulate the pandemic-ravaged economy and meet its Paris climate goals, and (5) the recent announcement by China of massive solar and wind projects in its desert areas.

The recent obstacles for the solar industry are likely to prove temporary, allowing the bullish long-term secular trend for solar to continue. BNEF is forecasting that global solar installs in 2021 will be very strong at +28% despite this year's problems. Moreover, BNEF is forecasting that 2022 will be another very strong year, with +25% solar growth. The solar industry already shook off the pandemic shutdowns in 2020 with very strong growth of 21%.

The long-term growth story for the solar industry remains intact, with BNEF forecasting more than $4 trillion of solar spending through 2050.

SOLAR PV GROWTH OUTLOOK

Global solar growth is expected to show another strong year in 2021 despite temporary disruptions from the Covid pandemic and higher solar costs. Bloomberg New Energy Finance (BNEF) is forecasting that solar installs in 2021 will grow by +28% to 183 GW from 143 GW in 2020.

In 2020, world solar growth soared by +21% to 143 GW, accelerating from the +9% growth rates seen in both 2018 and 2019, according to BNEF. Solar growth in 2018 and 2019 was hindered by a temporary pull-back in Chinese solar installs and two years of global retrenchment after two very strong global solar growth years in 2016 (+34%) and 2017 (+32%). Over the past five years (2015-20), global solar has grown by a very strong compounded annual growth rate of +21%.

Solar growth soared in 2020 despite the pandemic, which slowed planning, construction, and supply-chain deliveries. Solar is being installed at a torrid clip across the globe due to its low cost and attractiveness as a long-term solution for a sustainable energy future. Solar's low cost means that it is now on a strong long-term growth path without the need for government subsidies.

Solar will account for 28% of all electricity capacity additions, and there will be a massive $4.2 trillion of spending on solar through 2050, according to BNEF's 2020 New Energy Outlook. BNEF forecasts that solar PV will account for 38% of world electricity capacity by 2050, up sharply from the 2019 level of 11%.

Solar will easily be the largest source of electricity generation in 2050 at 38%, far outpacing wind at 20% and gas at 15%, according to BNEF. BNEF expects coal to fall to 7% of electricity generation by 2050 from 28% in 2019, and for nuclear to drop to 2% in 2050 from 5% in 2019.

"I see solar becoming the king of the world's electricity markets, Fatih Birol, executive director of the International Energy Agency (IEA), said upon the release of the IEA's flagship World Energy Outlook report. In that report, the IEA forecasts that solar will easily become the largest source of electricity generation by 2040. The report goes on to say:

> "Solar PV becomes the new king of electricity supply and looks set for massive expansion. From 2020 to 2030, solar PV grows by an average of 13% per year, meeting almost one-third of electricity demand growth over that period. Global solar PV deployment exceeds pre-crisis levels by 2021 and sets new records each year after 2022 thanks to widely available resources, declining costs and policy support in over 130 countries."

Demand for solar should surge in the coming years as solar costs fall and as solar becomes even more competitive against fossil fuels and nuclear. Solar's levelized cost has already plunged by an overall -85% since 2010 and by an average -8% per year over the last five years, according to Lazard (see p. 10).

China's transition to subsidy-free solar is progressing well

There is strong optimism about the Chinese solar market as it shakes off the Covid pandemic and shifts toward a subsidy-free market in the coming years.

The markets are also optimistic about the Chinese government's intent to rely heavily on solar to meet increasingly aggressive climate targets. In September 2020, China's President Xi surprised the world by announcing at the UN General Assembly that China intends to be carbon-neutral by 2060, which was the first time China had set such a target.

In December 2020, President Xi then announced a more specific target of 1,200 GW of solar, wind, and biomass capacity by 2030, which is nearly triple the current capacity of 450 GW. The Chinese government also proposed a new clean power mandate that would require grid operators, power retailers, and large consumers to source 25.9% of their output from solar, wind, or biomass by 2030. BNEF estimates that meeting that mandate would require 1,580 GW of cumulative capacity by 2030, or a third higher than President Xi's earlier goal of 1,200 GW.

The Chinese government in March 2021 then announced a draft of the 14th Five-year Plan for 2021-2025. That plan reiterated the targets for carbon emissions to peak before 2030 and achieve carbon-neutrality by 2060. In October 2021, China adopted those goals in its National Determination Contribution (NDC) under the Paris Climate Agreement.

To meet its NDC goals, China has adopted a target of generating 25% of its electricity from non-fossil fuel sources by 2030. China also reiterated its target of achieving 1,200 GW of renewable energy capacity by 2030 and 619 GW of solar by 2030.

In order to meet that dramatic renewables goal, China has begun work on a massive solar and wind project in its desert regions. The first phase of 100 GW of wind and solar began earlier this year and has been running smoothly, leading to the government to plan a second phase. There are reports that the project total will be a massive 400 GW, with a target of being half-completed by 2025.

Turning to solar growth rates, Chinese solar installs in 2020 soared by +57% to 52.1 GW from 33.1 GW in 2019. The 2020 install level of 52 GW was just slightly below the record high of 53.0 GW posted in 2017.

Solar installs were undercut in early 2020 by the Covid pandemic but finished the year on a very strong note as developers sought to beat the expiration of some subsidies at the end of 2020.

BNEF is forecasting that Chinese solar installs in 2021 will have another strong year with growth of +19% to 61.8 GW. Strength in

SOLAR PV GROWTH OUTLOOK (CONTINUED)

2021 is expected to be driven in part by the completion of projects that were started in 2020 to qualify for subsidies.

Chinese solar installs are expected to remain strong even though the Chinese government is transitioning to a solar market without national subsidies. Developers are showing strong interest in subsidy-free solar projects since they can still earn attractive internal rates of return. The Chinese government has also added benefits to subsidy-free projects, such as a guaranteed price for solar electricity output and priority on the grid. Solar projects can still qualify for subsidies at the local level.

The move away from national subsidies should be a long-term positive factor for the Chinese solar industry since the industry should be able to grow in a more predictable manner with more stable profit margins, as opposed to the boom-bust days of the past that were caused by erratic government subsidy policies.

Without subsidy distortions, the solar industry should be able to more closely match end-user demand, thus eliminating the small and less competitive players that can only compete when there are generous subsidies. The current trend should accelerate whereby the solar industry is dominated by large players with the best technology and the lowest production costs.

In recent years, the Chinese solar market has been buffeted by erratic subsidy policies that previously caused upheaval in the industry. For example, Chinese solar installs in 2017 soared by 76% to a record high of 53.0 GW as developers took advantage of very generous government subsidies.

However, in response to that 2017 install surge, the Chinese government, on May 31, 2018, announced a sharp cut in most of its solar subsidies, with utility-scale solar capped at 40 GW and roof-top distributed generation (DG) capped at 10 GW in 2018. China's subsidy phase-out plan was referred to in the industry as the "China-531" order after the date of the announcement.

The government was forced into its China-531 action partly by the big backlog of unpaid subsidies that reached $23 billion by the end of 2018. The China-531 curtailment of subsidies caused a sharp drop in Chinese solar installs by -17% to 44.3 GW in 2018 and -25% to 33.1 GW in 2019.

Regarding Chinese labor issues, the U.S. government in June 2021 imposed a "withhold release order" that blocked the import of polysilicon products produced by five companies based in China's Xinjiang province due to allegations the companies were involved with forced labor programs of the Uyghur Muslim minority. The Biden administration also placed those companies on the Treasury's Entity List, which blocks U.S. exports to those companies.

One of the targeted companies denied the use of forced labor. In order to rebut the claims, the company hired a global auditor to study its workforce practices and opened its Xinjiang factory to tours by global equity analysts and investors.

The markets were relieved that the U.S. order was narrowly focused and did not involve a blanket prohibition on the import of polysilicon from the Xinjiang region. Factories in the Xinjiang region produced about 45% of the world's solar-grade polysilicon in 2020, according to Bernreuter Research. Polysilicon plants consume a large amount of electricity, which makes Xinjiang an attractive location for those plants due to the region's cheap electricity prices.

There is concern that the ban could hamper the ability of U.S. developers to import solar products and raise the price of imported solar panels, thus curbing the U.S. solar growth rate. However, a Citigroup analyst quoted by Bloomberg said he expects the impact from the ban will be "mild" since the U.S. only buys a small portion of China's solar module output. The U.S. in recent years has had tariffs on Chinese solar products, which means that U.S. imports of Chinese solar products are relatively small.

Also, the U.S. accounted for only 14% of global solar installs in 2020, which means that the impact of the U.S. ban is likely to have only a minor impact on the overall global solar growth rate even if it impedes the U.S. solar install rate.

Global solar companies have been aware of the Xinjiang risk for months and have already been taking steps to divert supplies away from Xinjiang and do a better job of ensuring transparency and documenting their supply chains.

The global solar industry as a whole is also taking steps to address allegations of forced labor. About 175 solar companies from around the world signed a pledge sponsored by the Solar Energy Industries Association (SEIA) to ensure that their supply chains are free of any forced-labor products (see "Solar Companies Unite to Prevent Forced Labor in the Solar Supply Chain"). The SEIA also released a Supply Chain Traceability Protocol that helps companies prove that their supply chain is free of any products that are potentially connected with forced labor (see "New Traceability Protocol Allows Solar Companies to Ensure Ethical Supply Chain").

U.S. solar is seeing strong growth despite obstacles

U.S. solar growth is seeing strong growth despite recent obstacles. U.S. solar installs in 2020 soared by +64% to 18.9 GW, adding to 2019's strong +15% growth rate. BNEF is forecasting another strong year for U.S. solar in 2021 despite recent obstacles with growth of +56% to 29.5 GW.

Solar accounted for an impressive 43% of U.S. electricity installs in 2020, which was a record high and up from 40% in 2019, according to Wood Mackenzie. Solar remained first among all the electricity generation technologies for the second straight year,

SOLAR PV GROWTH OUTLOOK (CONTINUED)

beating the 38% share for wind and 18% share for natural gas. The share of natural gas electricity additions fell sharply to 18% in 2020 from 32% in 2019 and 57% in 2018 as solar and wind took the lion's share of new installs and shoved aside natural gas.

Solar showed very strong growth in 2020 despite the pandemic, which turned out to have a minor impact on the overall install rates. The residential sector was negatively impacted by the pandemic in Q2-2020 but then came roaring back in the second half of the year and still showed strong yearly growth of +11% to 3.1 GW.

Solar installs in the non-residential sector (commercial, government, nonprofit, and community solar) showed a -4% decline in 2020 to 2 GW, according to Wood Mackenzie. Non-residential installs were undercut by the pandemic, which slowed development timelines and delayed project interconnections.

By contrast, U.S. utility solar installs in 2020 soared by +60% to a new record of just under 14 GW, according to Wood Mackenzie. Moreover, Wood Mackenzie expects strong growth to continue into 2021 due to a massive utility-solar pipeline of 69 GW. The firm expects utility solar to show continued strong growth due to "the expansion of state-level renewable energy targets, utilities' self-enforced carbon reduction plans, a renewed focus on clean energy deployment at the federal level, and large corporate off-takers looking to meet net-zero carbon emissions goals."

Solar installs in 2020 also showed strength as developers sought to take advantage of the previously-set 26% solar investment tax credit (ITC) in 2020 before it was to step down to 22% in 2021 and 10% in 2022 for utility PV projects, non-residential, and third-party-owned residential solar projects (but to zero for direct-owned residential projects).

However, the solar industry received a pleasant surprise in December 2020 when Congress extended the solar ITC for another two years as part of the combined passage of the $900 billion pandemic aid bill and the $1.4 trillion omnibus spending bill. The 2-year extension of the ITC caused Wood Mackenzie to increase its U.S. solar install figure by a total of +17% for its 2021-25 forecast.

The ITC is currently set at 26% for 2021 and 2022. The ITC will then fall to 22% in 2023, and then in 2024 to 10% indefinitely for large-scale solar projects and to zero for small-scale solar projects.

Regarding the ITC, the markets are mainly waiting to see if Democrats can pass the $1.75 trillion Build Back Better bill, which contains a long-term extension of the ITC. Alternatively, Democrats could pass an ITC extension by appending it to other legislation.

The Build Back Better bill, currently under consideration in the Senate, contains an extension of the ITC and a hike in the ITC rate to 30% from the current 26%. Also, the ITC proposal would have a "direct pay" provision, which would allow tax credits to be converted into direct payments from the federal government, rather than as an offset by investors against tax liabilities, which a shortage of tax equity can hinder. The Build Back Better proposal also has a production tax credit for U.S. solar manufacturers.

Congress in November 2021 completed passage of the $550 billion bipartisan infrastructure bill that contained funds for clean energy research, power grid upgrades, and support for building a nationwide network of power charging stations for electric vehicles, some of which may be solar-powered. The bill included about $80 billion of funding for the energy transition, with $28 billion of that earmarked for grid enhancement.

Since taking office in January 2021, the Biden administration has taken a number of executive actions on the climate front. President Biden, on his first day in office, announced that the U.S. would rejoin the international Paris Climate Accord. That confirmed that the U.S. would resume its global leadership position in trying to meet the Paris Climate Accord's goal of keeping global warming to less than 2 degrees Celsius above the pre-industrial level, and preferably below 1.5 degrees Celsius. President Biden also pledged to reach a 100% carbon-free electricity sector by 2035 and to reach net-zero greenhouse gas emissions by 2050.

The Biden administration in April 2021 announced a new "Nationally Determined Contribution" under the Paris Climate Agreement of a reduction in U.S. greenhouse gas emissions by 50-52% by 2030 from 2005 levels. That was nearly double the previous commitment made by President Obama of a 26-28% cut in greenhouse gas emissions by 2025 from 2005 levels. The NDC also adopts the target of the U.S. economy having net-zero carbon emissions by 2050.

In December 2021, President Biden signed an executive order to cut the federal government's emissions by 65% by 2035 and make the government carbon neutral by 2050, the same year that carbon neutrality is targeted for the U.S. economy as a whole. As part of that order, the U.S. government is instructed to have 100% carbon pollution-free electricity by 2030, which is only eight years away.

Explaining the order, the White House said, "The federal government will work with utilities, developers, technology firms, financiers, and others to purchase electricity produced from resources that generate no carbon emissions, including solar and wind, for all its operations by 2030."

The markets are waiting to see how the Biden administration handles the tariffs on the solar industry that were previously imposed by the Trump administration. There is concern that Mr. Biden will take a continued aggressive approach to China on solar tariffs. Indeed, the Biden administration in March argued in court that the Trump Administration's reimposition of tariffs on bifacial

SOLAR PV GROWTH OUTLOOK (CONTINUED)

solar panels was legal and should remain in effect.

The U.S. solar market in recent years has been negatively impacted by solar tariffs imposed by the former Trump administration. Mr. Trump, in January 2018, announced a Section 201 tariff of 30% on imported solar cells and modules, which hurt solar install growth because of the higher price of solar panels for U.S. solar projects. The markets are waiting to see if the Biden administration might raise or extend that tariff.

The initial Section 201 import tariff of 30% for 2018 already stepped down to 25% as of February 2019, 20% as of February 2020, and 15% as of February 2021. The tariff is set to drop to zero in February 2022, when it expires. The first 2.5 GW of solar imports are exempt from the tariff. Thin-film solar modules, such as those produced by First Solar, are exempt from the tariff even if those modules are imported from overseas factories. The only significant solar-producing countries that are exempt from the tariff are Turkey, Brazil, and South Africa. However, imports from those exempted nations are capped each year at 300 MW each and at 900 MW as a group.

The former Trump administration in June 2019 surprised the solar industry by exempting bifacial (two-sided) solar panels from the Section 201 tariff, which resulted in a surge in imports of those panels during summer 2019. The Trump administration then reversed its decision, but it took time to reimpose the tariff because of procedural requirements. More recently, a U.S. trade court in November 2021 reinstated that tariff exemption and ordered a return of tariffs paid by companies for bifacial panels.

On the tariff front, the U.S. solar sector is also dealing with some disruptions in the solar inverter market. Solar inverters are electrical devices that convert the direct current (DC) from solar panels into the alternating current (AC) used on the grid.

The Trump administration in May 2019 raised the tariff on inverters imported from China to 25% from the 10% level that was first imposed in September 2018 as part of the U.S. move to impose tariffs on $200 billion of Chinese products.

However, the inverter tariff is not having much direct impact on the U.S. solar sector because inverters can easily be sourced outside of China. Yet, the inverter tariff makes it difficult for the big Chinese inverter companies such as Huawei Technologies and Sungrow Power Supply to build their market share in the U.S.

On another tariff issue, the former Trump administration, on September 1, 2019, imposed a 15% tariff on about $110 billion of Chinese goods that included Chinese lithium-ion batteries. Before the tariff, the U.S. imported about 40% of its lithium-ion batteries from China, although most of those batteries were for end-markets other than grid storage.

China supplies less than 5% of the batteries used in large-scale U.S. energy storage products, according to BNEF, which means that the U.S. tariff on Chinese batteries did not have much impact on the U.S. solar-plus-storage market.

U.S. solar growth has been very volatile in recent years, mainly because of changes by the U.S. government in tax credits and tariffs. For example, solar growth in 2016 spiked higher by +92% to beat the scheduled expiration of the investment tax credit (ITC) at the end of 2016, although Congress in December 2015 then extended the ITC by 5 years. U.S. solar installs fell by -23% in 2017 and by -2% in 2018 on a let-down after the 2016 spike and on the solar tariffs imposed by the Trump Administration in January 2018.

In another episode, solar growth in 2020 soared by +64% on strong demand and the desire to beat the scheduled step-down of the ITC at the end of 2020. However, Congress in December 2020, extended the ITC for another two years.

European solar expected to show strong growth in 2021

European solar growth remained relatively strong in 2020 despite the pandemic. European solar installs in 2020 rose by +8.0% to about 16.6 GW from 15.3 GW in 2019, according to BNEF. That added to the extremely strong growth years of +48% in 2018 and +98% in 2019.

In 2020, the largest PV install amounts were in Germany with 4.9 GW (+22% yr/yr), Netherlands 3.0 GW (+19% yr/yr), Spain 2.8 GW (-45% yr/yr), France 875 MW (-9% yr/yr), and Italy 645 GW (-13% yr/yr), according to BNEF.

European solar growth in 2020 continued to see support from the spread of subsidy-free solar throughout Europe and the EU's elimination in late 2018 of the minimum-price scheme. Also, Europe is mandating increasing amounts of solar power to meet its aggressive targets for cutting emissions.

Much of Europe's solar install growth in 2020 was driven by auctions for utility-scale solar in Germany, France, and Poland. Solar growth in Spain is being driven by subsidy-free power purchase agreements with both utilities and corporations.

European solar installs are expected to show strong growth in the coming years, with BNEF forecasting a +25% rise to 20.8 GW in 2021 and a +9% rise to 22.5 GW in 2022.

A very large pipeline of subsidy-free solar projects in Europe will contribute to installs in 2021 and 2022. BNEF reports that there is a huge 37.2 GW pipeline of unsubsidized solar projects in Europe that are scheduled to be built, with 6.6 GW of that due in 2021. BNEF reports that there are particularly large pipelines in Spain and Portugal.

SOLAR PV GROWTH OUTLOOK (CONTINUED)

European solar growth should receive a solid boost in coming years after the EU in July 2020 approved a big pandemic stimulus plan of 750 billion euros since almost one-third of those funds are targeted for fighting climate change. That added to the EU's 7-year budget that has 1 trillion euros of funding to help EU countries meet their EU's Paris Agreement goals for reducing carbon emissions.

European solar growth improved significantly after the EU in September 2018 ended its anti-dumping duties against solar modules imported from China and ended the associated minimum import price (MIP) scheme. The EU's MIP scheme had been in place since 2013 when the EU tried unsuccessfully to protect local European solar manufacturers from Chinese competition. The MIP scheme succeeded only in raising the cost of solar modules for European solar installers and caused several years of very slow solar growth in Europe.

The end of the MIP scheme, combined with the sharp drop in solar module prices that resulted from the China-531 order in 2018, allowed solar to reach grid-parity in a growing portion of Europe. Many solar projects in Europe are now being installed on an unsubsidized basis.

European solar growth is expected to show solid growth in the coming years due to the need to meet renewable energy targets. The European Parliament in 2018 raised the EU renewable energy target for 2030 to 32% from 27% and also made the target binding on EU members. The European Commission in July 2021 proposed raising that renewable energy target to 40%, with that proposal going to the European Parliament and its members for approval. The EU is relying on its renewables target to meet its pledge under the UN Paris climate agreement to cut its greenhouse gas emissions by at least 55% by 2030 from 1990 levels, and to become carbon neutral by 2050.

India's solar expected to recover after weak 2020

India's government is pushing solar very hard as a means to modernize India's infrastructure, boost its global business competitiveness, expand electricity access in rural areas, and meet its climate goals.

The Indian government has set 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. However, India is unlikely to meet that goal due in part to the pandemic disruptions in 2020 and 2021. The 100 GW target is more than twice India's cumulative installed solar capacity of 48 GW as of the end of 2020. India has set a climate target of achieving zero carbon emissions by 2070.

India's solar installs in 2020 slowed sharply by -63% to 4.2 GW from 11.6 GW in 2019, according to BNEF. India's solar installs in 2020 were hurt mainly by the Covid pandemic, which caused planning and construction delays and supply-chain disruptions. Also, solar developers pulled back due to the poor financial condition of electric utilities and their delayed payments to developers.

However, India's solar installs are expected to show a major recovery in 2021 and 2022 as delayed projects come on line and as the government continues to push hard for more solar. India's solar installs in 2021 will grow by +186% to 12.1 GW, and will then grow by another 7% in 2022 to 13.0 GW, according to forecasts by BNEF.

India's solar sector has seen serious disruptions over the past several years from the government's use of tariffs to encourage the development of domestic solar panel manufacturing capacity. The government tariff has made it difficult for solar installers to obtain reasonably-priced solar panels to meet their installation plans. However, the tariff has been sidestepped to some extent by sourcing panels from non-tariffed countries and by having solar plant owners pay the tariff for imported panels to get their plants finished on schedule.

The Indian government first implemented the 25% safeguard tariff on July 30, 2018, covering modules imported from developed countries, China, or Malaysia. The 2-year tariff started at 25% for the first year (30-Jul-2018 to 29-Jul-2019) but then stepped down to 20% for the next 6-month period (30-Jul-2019 to 29-Jan-2020) and to 15% for the next 6-month period (30-Jan-2020 to 29-Jul-2020).

The safeguard tariff was imposed to prevent the "threat of serious injury" to domestic solar module producers from import competition. Prior to the tariff, India imported 90% of its modules from China and Malaysia.

The government then extended the tariff for another year at 14.9% for the 6-month period of July 30, 2020 to January 29, 2021, stepping down slightly to 14.5% for the next 6-month period of January 30, 2021 to July 29, 2021. In addition to developed countries and China, the 2020-21 tariff also applied to Thailand and Vietnam. India dropped Malaysia as a country covered by the tariff.

The government's current plan is to have no import tariffs from July 2021 through March 2022. However, the government then plans to impose a large 40% basic customs duty on solar modules, and a 25% duty on solar cells, starting in April 2022. That duty will be a further attempt to promote the development of solar panel and cell manufacturing capacity within India. However, India's solar manufacturing base remains far smaller than solar demand, meaning the duty is likely to hurt solar installers' ability to find enough reasonably-priced solar panels to meet the strong demand.

SOLAR PV GROWTH OUTLOOK (CONTINUED)

Japan's solar sees strong growth in 2020

Solar installs in Japan in 2020 rose sharply by +20% to 8.1 GW from 6.7 GW in 2019, according to BNEF. Solar growth was strong as developers sought to meet project completion deadlines in 2020 and 2021 to qualify for the solar feed-in-tariff (FIT), which is progressively stepping down.

Solar installs in Japan are expected to be negatively impacted by the phase-out of the government's generous FIT program for large-scale solar projects in 2022. BNEF is forecasting that Japan's solar installs will fall by -13% to 7.1 GW in 2021 and by -35% to 4.6 GW in 2022.

However, the Japanese government's support for solar will continue in the coming years. The government's FIT program will continue to support smaller-scale solar projects while the government is developing a new feed-in-premium (FIP) support program for large-scale projects starting in 2022.

The Japanese government in July 2021 almost doubled its solar target to a cumulative capacity of 108 GW by 2030. In order to meet that target, Japan would need to install 37 GW of solar by 2030, or an average of 3.7 GW per year. The government raised its solar target to help meet Japan's carbon target of cutting greenhouse gas emissions by 46% by 2030 from 2013 levels.

Solar in Japan should also see support in coming years from Japanese corporations looking to acquire solar power purchase agreements to meet their corporate renewable energy goals. Corporate demand is expected to drive the development of subsidy-free solar in Japan in the coming years.

Elsewhere in Asia, Taiwan is expected to see strong solar installs in the coming years as the government promotes solar to meet its climate goals. Solar installs in Taiwan grew sharply by +41% to 1.4 GW in 2019 but then fell by -22% to 1.1 GW in 2020, according to BNEF.

Solar is seeing strong demand in Taiwan from corporations looking to meet their renewable energy goals. Also, there is rising demand for solar power in Taiwan to replace the coming closure of coal and nuclear plants. Taiwan's government is targeting a 25% renewable energy supply by 2025 and has announced an aggressive solar cumulative-capacity target of 20 GW by 2025, which would be four times the current cumulative capacity of about 5 GW.

South Korea is another bright spot for solar in Asia. Solar installs in South Korea grew sharply by +70% in 2018 and +62% in 2019, before tailing off to +5% growth in 2020 to 3.8 GW, according to BNEF.

Corporate demand for solar power is expected to grow sharply after South Korea's government in January 2021 revised its electricity laws to allow clean energy developers to sell electricity directly to corporations with power purchase agreements. The South Korean government in February also raised its mandate to 25% from 10% for the amount of annual renewable energy that electric utilities must source by 2030.

SOLAR PV ANNUAL NEW INSTALLATIONS

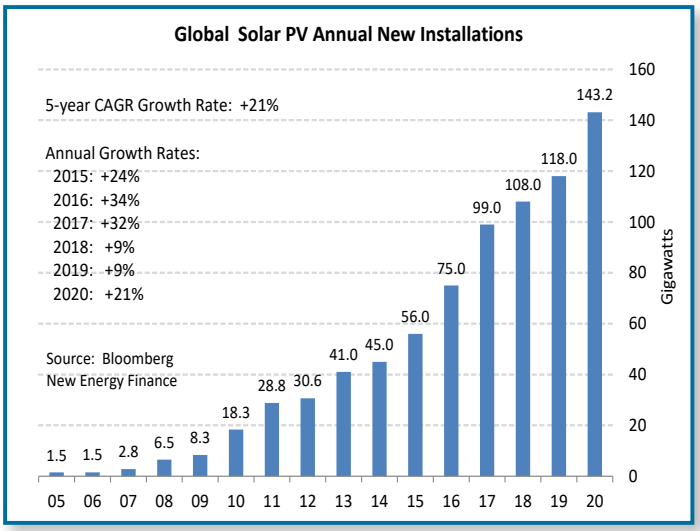
New global solar PV installations in 2020 grew by +21% yr/yr to a record 143 gigawatts (GW), according to Bloomberg New Energy Finance (BNEF). PV growth improved in 2020 from the weaker growth rates of +9% in 2018 and 2019 that were caused by temporary weakness in Chinese installs in 2018-19. Global solar PV installations have grown by a compounded annual rate of +21% over the last 5 years and have risen 8-fold from 2010.

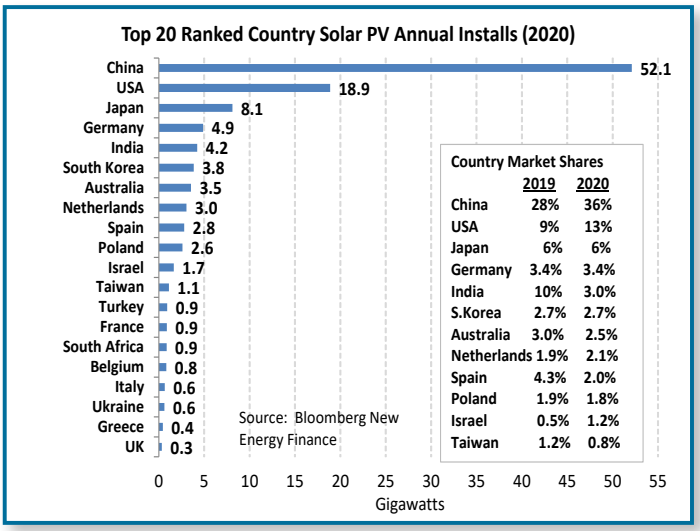
In 2020, China led the world for annual new solar PV installs for the seventh straight year with 52 GW of installs, up 57% from 2019 and just below the record of 53 GW posted in 2017, according to BNEF. The U.S. had a big year in 2020 with +64% growth to 18.9 GW, moving into second place for the most annual installs. Japan moved up to third place from fourth place with 8.1 GW of installs, up +20% yr/yr. Germany was in fourth place with 4.9 GW of installs (+22% yr/yr). India in 2020 fell to fifth place from second place, with 4.2 GW of installs (-63% yr/yr).

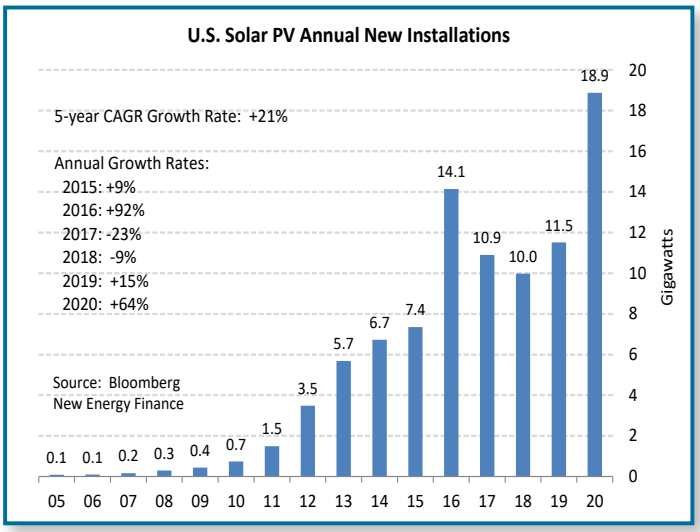
There were 12 countries in 2020 with installs above 1 GW, more than the 7 such countries seen as recently as 2016-17. The global spread of solar illustrates how the industry is becoming more diversified and less dependent on growth rates in a few countries. Fitch forecasts that 36 nations will install more than 1 GW of solar by 2029.

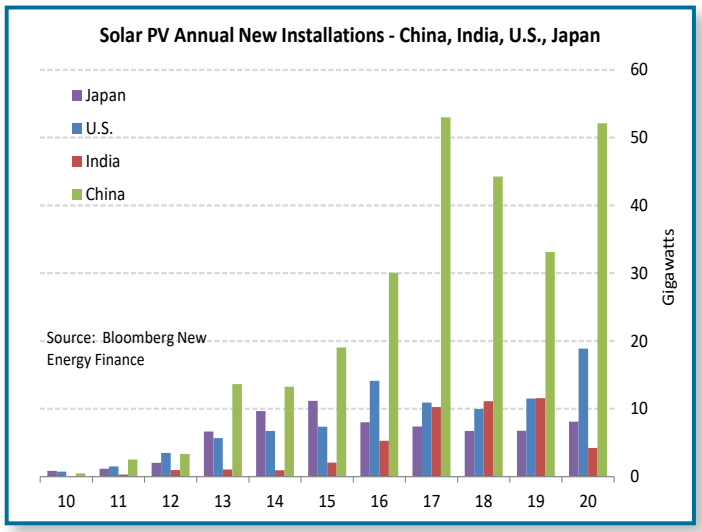
Solar growth in Europe in 2020 grew by +8% yr/yr. The largest PV install amounts were in Germany with 4.9 GW (+22% yr/yr), Netherlands 3.0 GW (+19%), Spain 2.8 GW (-45%), France 875 MW (-9%), and Italy 645 GW (-13%), according to BNEF.

U.S. solar PV installations in the five years through 2020 grew at a compounded annual rate of +21% and rose 25-fold from 2010, according to BNEF. The states with the largest amount of new PV solar installations in 2020 were California with 3.9 GW (+26% yr/yr), Texas 3.4 GW (+143%), Florida 2.8 GW (+107%), Virginia 1.4 GW (+965%), North Carolina 785 MW (-19%), South Carolina 617 MW (+20%), New York 544 MW (+15%), Arizona 503 MW (-45%), and Utah 427 GW (+250%), according to Wood Mackenzie.









SOLAR PV CUMULATIVE INSTALLATIONS

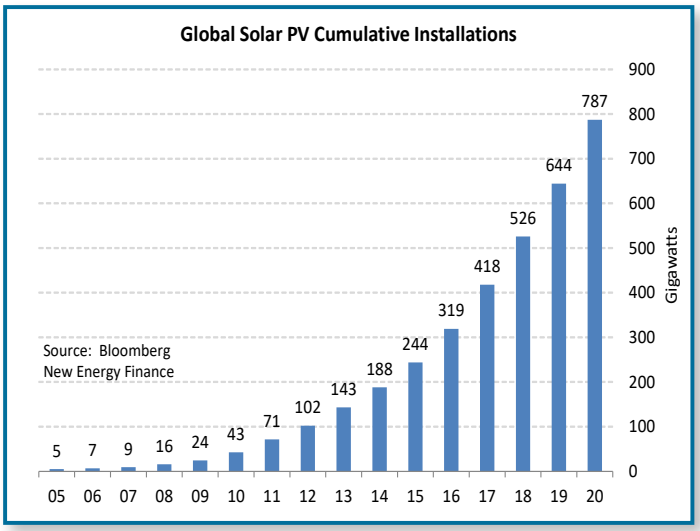
The amount of cumulative PV electricity generation capacity across the world in 2020 grew sharply by +22% yr/yr to 787 GW, according to Bloomberg New Energy Finance (BNEF). In the last five years, global cumulative solar PV electricity generation capacity increased by more than 3-fold from 244 GW in 2015 to 787 GW in 2020, representing a compounded annual growth rate of +26%.

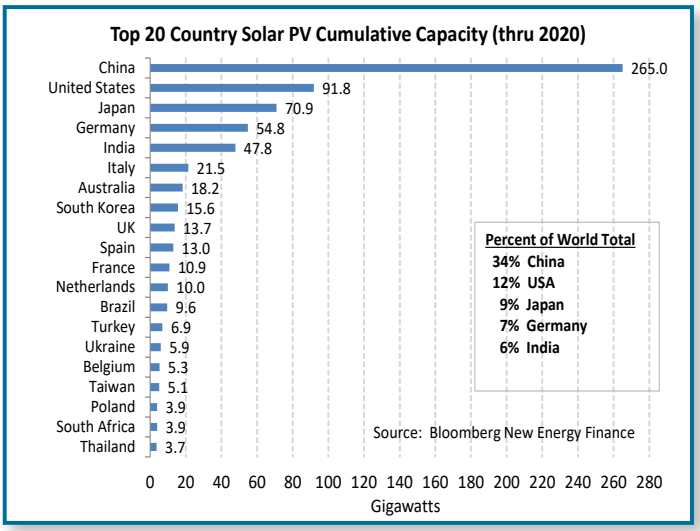
China in 2020 continued to be the world's leader for cumulative solar capacity at 265 GW, according to BNEF. China at the end of 2019 accounted for 34% of the world's solar PV capacity. In the past five years, China's cumulative installed solar capacity soared by 5-fold from 52 GW in 2015 to the 2020 level of 265 GW, representing a 5-year compounded annual growth rate of +38%.

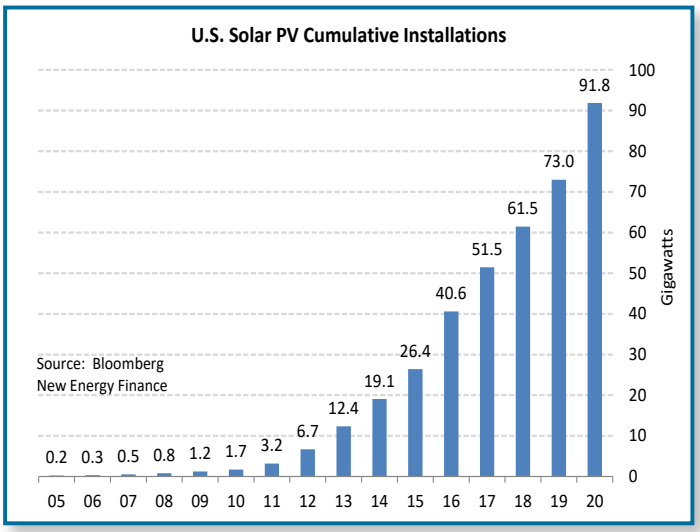
The U.S. in 2020 remained in second place for cumulative solar installs. U.S. solar electricity capacity in 2020 rose by +26% to 92 GW, representing 12% of world capacity. Over the past five years, U.S. cumulative solar electricity capacity rose by more than 3-fold to 92 GW from 26 GW in 2015 and showed a compounded annual growth rate of +28%.

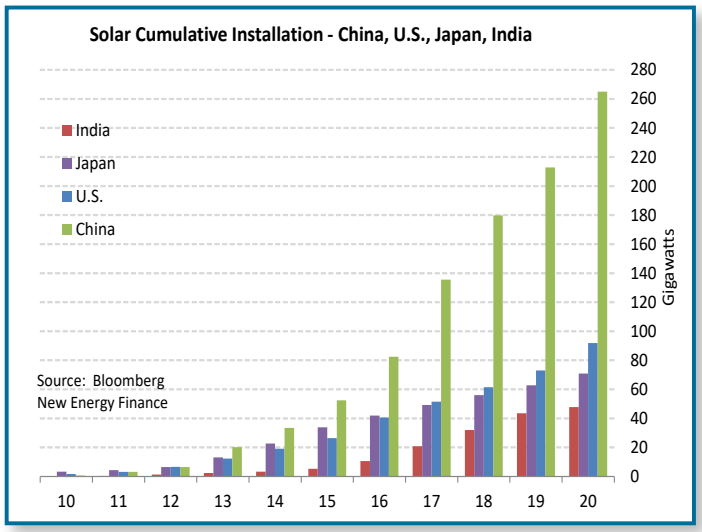
Japan remained in third place for the seventh straight year. Japan's cumulative solar capacity in 2020 rose by +13% to 71 GW, representing 9% of world capacity. Japan's cumulative solar capacity in the past five years has risen by 2.1-fold to 71 GW from 34 GW in 2015, representing a 5-year compounded annual growth rate of +16%.

Germany in 2020 remained in fourth place with 55 GW of cumulative solar PV capacity, up +10% yr/yr. Germany's cumulative solar capacity in the past five years has risen 1.4-fold to 54 GW from 39 GW in 2015. Germany, at the end of 2020, accounted for 7% of the world's total solar PV capacity.









LEVELIZED COST OF SOLAR ELECTRICITY

Solar's electricity cost falls -3% and beats fossil fuels and nuclear by even larger amounts

The levelized cost of electricity (LCOE) for newly-built U.S. utility-scale crystalline solar PV plants as of late-2021 fell by -3% yr/yr to a midpoint of $35.5 per MWh ($30-41 range) on an unsubsidized basis, according to Lazard in the latest annual edition of its comprehensive "Levelized Cost of Energy Analysis-Version 15.0" released in October 2021. That added to the declines of -7% in 2020, -7% in 2019, and -14% in 2018.

The LCOE for utility-scale PV has now plunged by an overall -85% from $248/MWh in 2010, and has fallen by an average of -8% per year over the past five years.

The cost of community solar and residential PV systems also fell. Lazard reports that the unsubsidized mid-point LCOEs in 2021 fell by -4% yr/yr for Community Solar to $75.0/MWh ($59-91 range) and -1% yr/yr for Rooftop Residential to $184/MWh ($147-221). The mid-point LCOE for Rooftop Commercial and Industrial fell by -2% to $123.5/MWh ($67-180 range).

The Lazard report found that the mid-point cost for utility-scale crystalline solar PV of $35.5/MWh is now 67% cheaper than the $108.5/MWh mid-point cost for newly-built coal plants, 79% cheaper than the $167.5/MWh mid-point cost for nuclear plants, 80% cheaper than the $173.5/MWh mid-point cost for gas-peaking plants, and 38% cheaper than the mid-point cost of $59.5/MWh for natural gas plants.

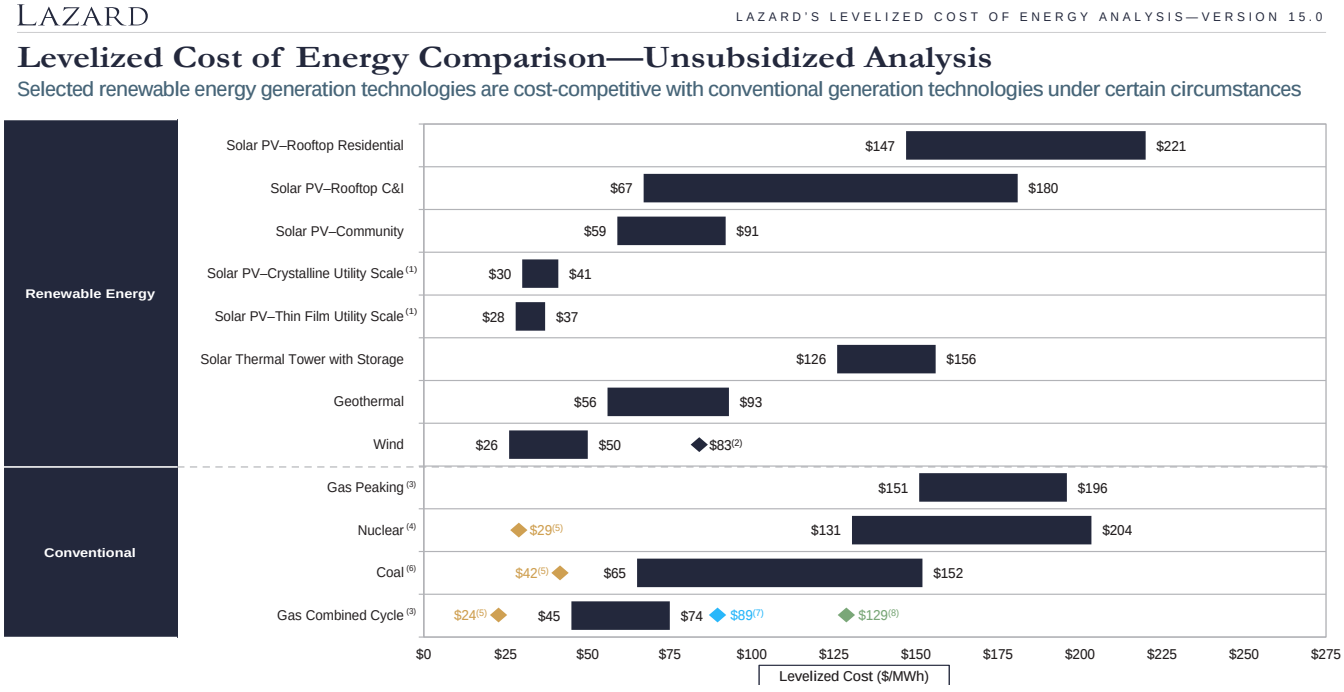
The Lazard data shows that, on average, it is no longer economical for a utility to build any new coal, nuclear, or natural gas plants, relative to solar or wind.

Moreover, solar has become so inexpensive that it is now cheaper to build a brand new PV utility-scale solar plant from scratch for $35.5/MWh than it is to keep an existing coal plant running at a marginal cost of $42/MWh. However, installing a new solar plant does not yet beat the marginal cost of keeping an existing nuclear plant running of $29/MWh or a natural gas plant of $24/MWh.

Solar has big potential as a replacement technology since many coal and nuclear plants are reaching the end of their useful lives, with an average age of 40 years for U.S. coal plants and 38 years for U.S. nuclear plants. As coal and nuclear plants are retired, utilities will decide to switch to building new solar, wind, and gas plants based on economics, with gas having some preference for baseload until storage starts to play a bigger role in supporting solar as a 24/7 baseload electricity resource.

Solar has become cheaper than new fossil fuel plants, not just in the U.S., but also globally. BNEF reports that it is already cheaper for two-thirds of the world's population to get new power from solar or wind than from new fossil fuel plants.[1]

1 BNEF, "The First Phase of the Transition is about Electricity, 1/28/2020.



Source: Lazard's Levelized Cost of Energy Analysis - October 2021, Version 15.0.

PRICING - SOLAR MODULES, CELLS, AND POLYSILICON

Solar module prices have edged higher since mid-2020. The price of silicon solar modules fell to a new record low of 16.3 cents per watt in July 2020 but has since risen to the current level of 21.0 cents, according to PV Insights. Since 2010, silicon module prices have plunged by a total of -87%.

The price of thin-film modules fell to a record low of 20.7 cents per watt in July 2020 but has since recovered to 23.4 cents, according to PV Insights. Since 2010, thin-film module prices have plunged by a total of -82%.

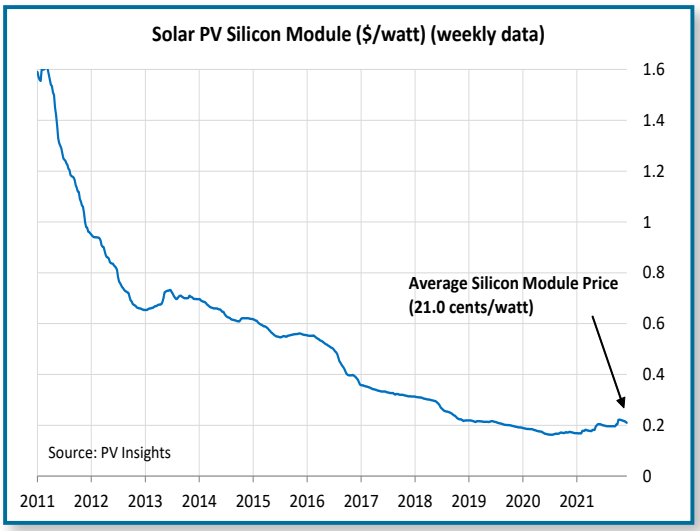
Solar module prices have risen in the past year due to higher polysilicon input prices, higher costs for other materials, and various production, supply chain, and shipping obstacles. Solar module prices should ease as the various pandemic and supply-chain problems recede in 2022.

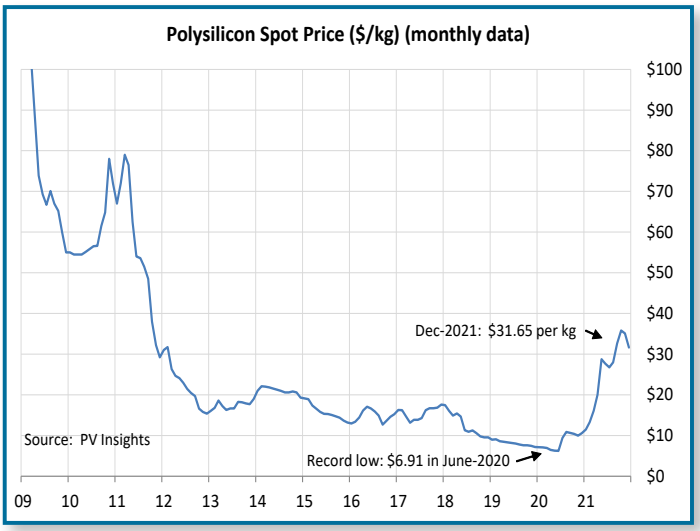
Spot polysilicon prices fell to a record low of $6.90 per kg in May 2020. Polysilicon prices then spiked higher to $35.81 in October 2021 but have since eased to $31.65, according to PV Insights. Despite the recent volatility, polysilicon prices are still down by -56% since 2010.

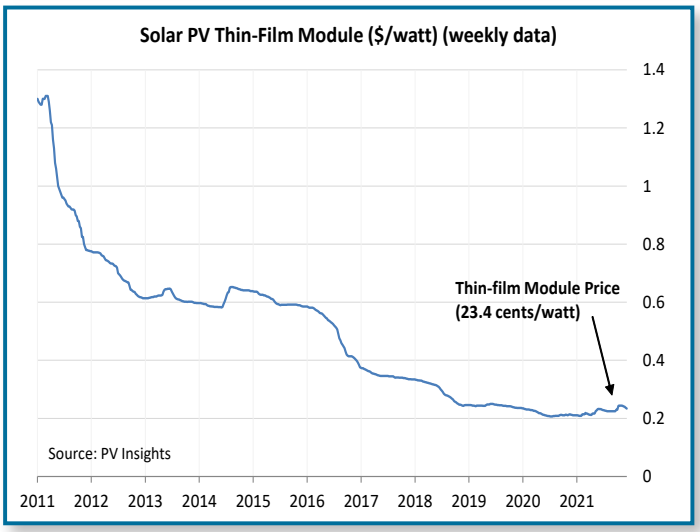
Polysilicon prices fell to a record low during the worst of the pandemic shutdowns in spring 2020, but then rebounded higher after several polysilicon manufacturers were forced to temporarily close down their plants due to disruptions such as fires and flooding.

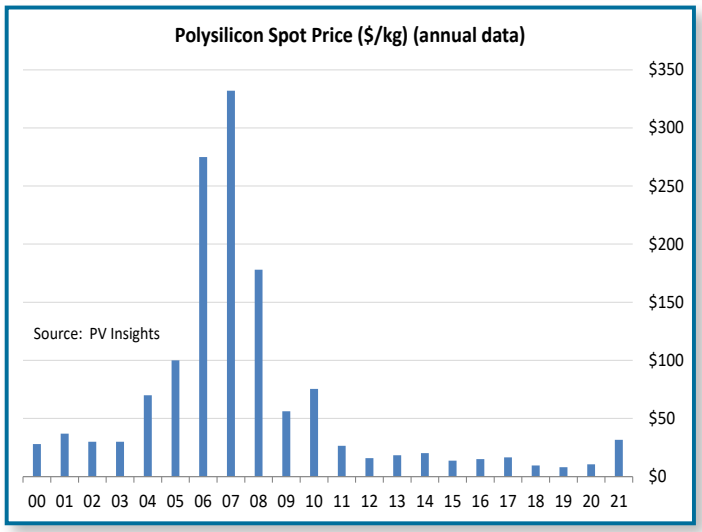
Polysilicon prices have also risen as solar wafer and cell producers try to avoid polysilicon from the Xinjiang province due to U.S. import restrictions. Polysilicon prices should ease as new polysilicon factories come online in 2022.

Historically, solar pricing has seen steady downward pressure due to technology advancements and manufacturing economies of scale, a trend that should resume once pandemic and trade-related problems ease and new capacity comes online.









SOLAR JOBS

U.S. solar jobs in 2020 fell by -6.7% to 231,474 from 248,034 in 2019, according to the "National Solar Jobs Census 2020" published by The Solar Foundation in May 2021. Solar jobs fell in 2020 due to pandemic disruptions and were well below the record high of 260,077 jobs seen in 2016.

Despite the drop in 2020, the U.S. solar industry during the 10-year period of 2010-2020 added a net total of 137,972 jobs to the U.S. economy, rising by a total of +148% over that period.

Solar employment in the ten years through 2020 grew five times faster than the +1.8% annual growth rate of the U.S. economy, according to the Solar Foundation. That illustrates how the solar industry has made a substantial contribution to the U.S. labor market and economy.

About two-thirds of U.S. solar jobs are in the demand-side sectors such as installation, sales/distribution, and project development. Meanwhile, manufacturing accounts for only about 14% of total solar jobs, according to the Solar Foundation.

Solar jobs in the U.S. substantially exceed those in the fossil fuel industries. Specifically, the 231,474 jobs in the solar sector far exceed the 139,500 direct jobs in the oil/gas extraction industry and 42,200 direct jobs in the coal mining industry at the end of 2020, according to figures from the U.S. Bureau of Labor Statistics (see chart on the right).

Globally, solar PV is a huge employer, with 3.98 million solar jobs worldwide at the end of 2020, up by +6% from 3.75 million at the end of 2019, according to the " Renewable Energy and Jobs--Annual Review 2021" from the International Renewable Energy Agency (IRENA).

China is far ahead of the U.S. in solar PV jobs, with a total of 2.3 million jobs due to its much larger installation and manufacturing solar sector, according to the IRENA report. Countries other than China and the U.S. with large solar PV employment include Japan with 220,000 jobs, the EU with 194,000 jobs, and India with 163,500 jobs, according to IRENA.