



Thought Leadership / 2025

Power Struggles: Renewable Power Generation in a Changing Global Economy

A THREE-PART SERIES

Part 2: Solar Photovoltaic (PV) Power Plants

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This is part two of a three-part series regarding the changing global economy and Renewable Energy Power Generation with a focus on Solar Photovoltaic (PV) Power Plants. Part one of the series is available at this link:

<https://bit.ly/HalliwellPowerStrugglesWind>.

SOLAR PHOTOVOLTAIC (PV) POWER PLANTS

Of the 21% of United States (US) power generation from renewable energy sources, solar photovoltaic (PV) dominated new installations every year since 2021¹. Utility-scale solar photovoltaic (PV) power plants accounted for 52%¹ of all newly installed power generation in 2023 (32 Gigawatts (GW)) and 64% in 2024 (50GW). Utility-scale project installations are at or below \$1,000 per kilowatt-DC (kWdc) which makes these projects the least capital-intensive installations of any power generation source. In Halliwell's experience, utility-scale solar PV power plants can be installed at a rate of about 75-100 Megawatts (MW) per year. Put a different way, a 75MW solar PV power plant should be able to be constructed in one year where a 250MW solar PV power plant may take two and a half years. The massive national pipeline of 1,085 GW¹ of solar PV power generation capacity has clogged interconnection queues and extended project commercial operation dates (COD).

The massive growth in solar PV power generation has been supplied by imported components. The majority of solar modules and cells are produced in Southeast Asia and China has not been a major supplier to the US since 2017. Tariffs imposed by the US International Trade Commission (USITC) and by the current administration are bound to impact the solar PV power generation market.

What solar PV power plants lack in energy density, they make up for in rapid deployment. The rapid deployment of solar power matches well with the unprecedented energy demand from planned data center construction. Solar power cannot provide the complete power requirement for a 24/7 data center, but pairing solar power generation with battery energy storage systems (BESS) can potentially provide power around the clock. The electricity demand for data centers alone is expected to be as much as 67 Gigawatts (GW) by 2030³. Another advantage of creating a renewable energy microgrid (e.g. solar PV with BESS) is the avoidance of utility interconnection queues. The continued decrease in materials costs, few limitations on geographic siting, lower specialization requirements for craft labor, and comparative rapid deployment have combined to push power plant developers towards solar.

The rapid growth of solar PV power plants has required significant support from imported materials (see image 2-1).



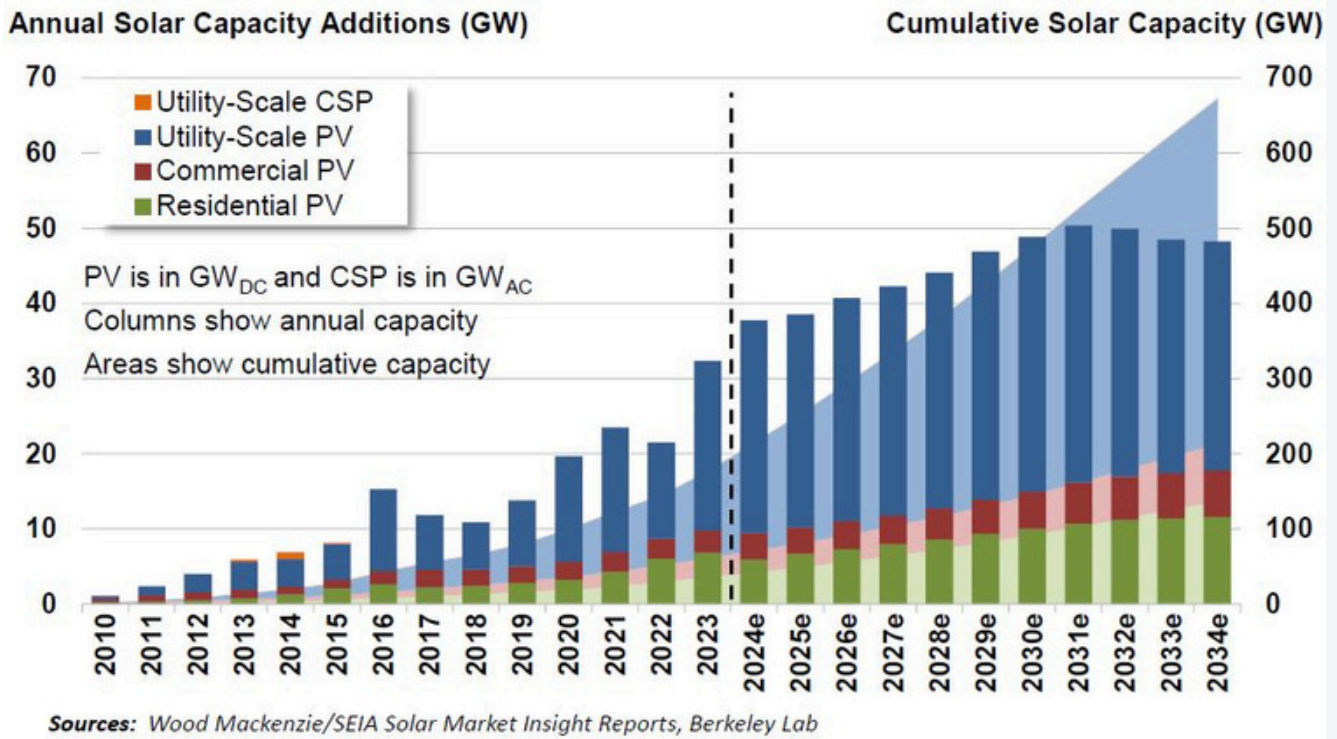


Image 2-1: Growth of Solar PV power generation, courtesy of Berkeley Labs report¹

Quarterly US solar panel imports (MW)



Data compiled May 22, 2024.

Only includes countries that report monthly data to the US Census Bureau.

Source: S&P Global Market Intelligence Global Trade Analytics Suite.

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Image 2-2: US Solar module imports by quarter, courtesy of S&P Global⁴

As of 2024, about 92%⁵ of solar module imports to the USA were from SE Asia: Cambodia, Thailand, Vietnam and Malaysia. India, Indonesia, and Laos were also measurable contributors. Contrary to conventional wisdom, China has not been a direct major supplier of solar modules since 2017. Duties and tariffs imposed on solar imports from China were initiated by the Obama administration in 2012:

- 2012: 36% tariff/duty imposed on Chinese Solar products. Chinese suppliers shift to Taiwanese facilities to avoid tariffs and duties.
- 2014: 33% increase of tariffs on Chinese producers and new tariffs on Taiwanese producers where Chinese producers shifted production.

- 2018: 30% tariff on all overseas made solar modules. Chinese-made products receive additional 25% tariff. This completes the shift of US imported solar module production away from China to other SE Asian countries.
- 2022: Tariffs are extended and additional tariffs are placed on China. Some new duties on Thailand, Vietnam, Malaysia and Cambodia are implemented as solar module import supply has shifted to these countries.

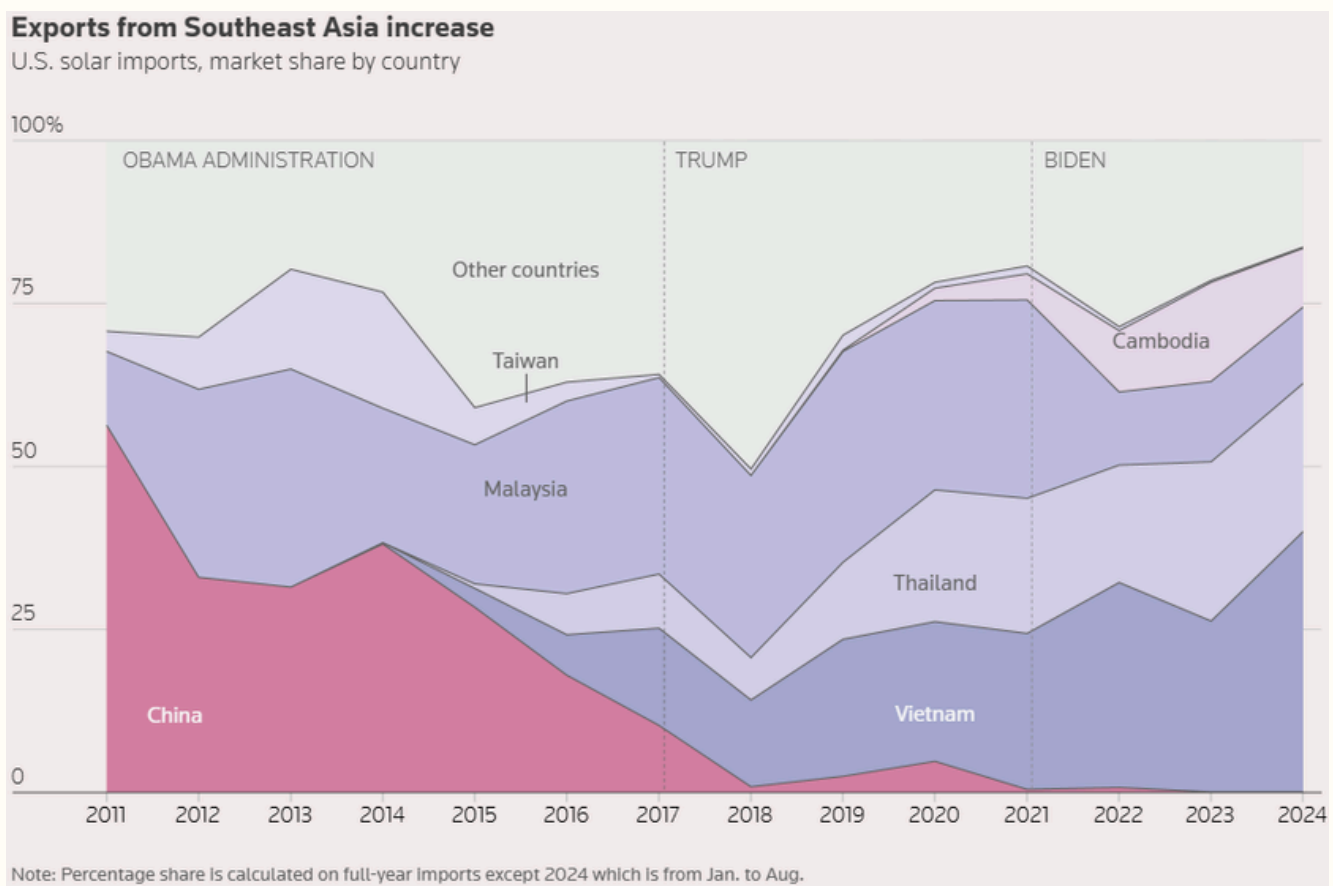


Image 2-3: US Solar Imports, courtesy of Reuters.com⁵

On May 20, 2025, the United States International Trade Commission (USITC) voted to implement duties on Vietnam, Thailand, Malaysia and Cambodia made solar modules and cells⁴. The USITC determined that US producers were materially harmed by the import of inexpensive

solar modules and cells. USITC has issued levies specific to certain companies and their country of origin, as shown in tables 1 through 4. **These tariff amounts would be in addition to 35% duties that are currently applied to all solar modules or cells according to the Harmonized Tariff Schedule (HTS).**

CAMBODIA

Companies	Final AD Rate	Final CVD Rate	Total Tariff Amount
Solarspace New Energy	117.18%	534.67%	651.85%
Hounen Solar, Jinktek Photovoltaic, ISC Cambodia, Solar Long PV Tech	117.18%	3,403.96%	3,521.14%
All others	117.18%	534.67%	651.85%

Table 2-1: USITC tariff recommendations for solar module and cell manufacturers, Cambodia⁵

MALAYSIA

Companies	Final AD Rate	Final CVD Rate	Total Tariff Amount
Hanwha Q CELLS	0%	14.64%	14.64%
JinkoSolar	1.92%	38.38%	40.30%
Baojia New Energy	81.24%	168.80%	250.04%
CRC, Lynter, Mega PP	81.24%	32.49%	113.73%
Pax Union, SunMax Energy	1.92%	168.80%	170.72%
All others	1.92%	32.49%	34.41%

Table 2-2: USITC tariff recommendations for solar module and cell manufacturers, Malaysia⁵

/ THAILAND

Companies	Final AD Rate	Final CVD Rate	Total Tariff Amount
Trina Solar	111.45%	263.74%	375.19%
Sunshine Electrical, Taihua New Energy	172.68%	799.55%	972.23%
All others	111.45%	263.74%	375.19%

Table 2-3: USITC tariff recommendations for solar module and cell manufacturers, Thailand⁵

/ VIETNAM

Companies	Final AD Rate	Final CVD Rate	Total Tariff Amount
JA Solar	52.54%	68.15%	120.69%
JinkoSolar	120.38%	124.57%	244.95%
Blue Moon Vina	77.12%	124.57%	201.69%
Boviet Solar	77.12%	230.66%	307.78%
Elite Solar, Letsolar, Mecen Solar Vina, Nexuns, Trina Solar, Vietnergy, Vietnam Sunergy (VSUN)	77.12%	124.57%	201.69%
GEP New Energy, HT Solar, New Energy Vina, Vietnam Green Energy	271.28%	542.64%	813.92%
All others	271.28%	124.57%	395.85%

Table 2-4: USITC tariff recommendations for solar module and cell manufacturers, Vietnam⁵



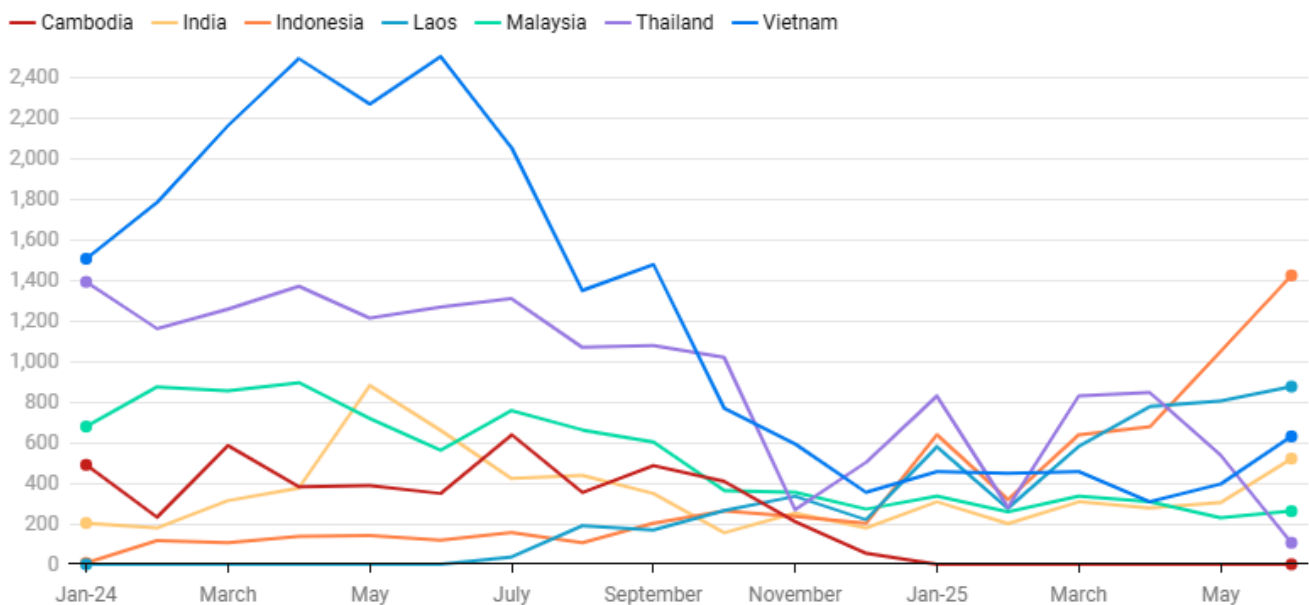
This news was not exactly a secret and many of these companies have throttled (or completely stopped, in the case of Cambodia) their exports to the USA in anticipation of these large tariff percentages (see image 2-4).

Solar modules and cells are the most commonly imported item of a utility-scale or commercial rooftop solar PV power plant installation. NREL reports that modules make up \$0.327/Wdc of the \$1.20/Wdc total cost for a utility scale solar PV power plant installation; about 27.3% of the total

project cost (2023 reported costs). The soft costs for commercial rooftop solar PV power plants are higher than utility power plant costs, raising the total project cost to \$1.80/Wdc. However, the module cost is equivalent to that of the utility-scale projects at \$0.327/Wdc; resulting in a percentage of 18.2% of the total project cost. These costs have held steady for the past five years, so these estimates are likely to continue to be accurate in the near future.

Monthly U.S. c-Si solar panel imports

Quantities in megawatts (MW)



Data from January 2024 through June 2025. Countries listed include the four Southeast Asian countries under the AD/CVD orders (Cambodia, Malaysia, Thailand, Vietnam) and the three countries in the latest AD/CVD petition (India, Indonesia, Laos).

Chart: Solar Power World • Source: U.S. ITC • Get the data • Created with Datawrapper

Image 2-4: Solar module and cell imports from SE Asian countries, courtesy of Solar Power World⁷

Rank	Headquarters	Manufacturer
1	China	Jinko Solar
2	China	LONGi Green Energy
3	China	JA Solar
4	China	Trina Solar
5	China/ Canada	Canadian Solar
6	India	Adani Solar
7	China China	Tongwei Astronergy
8	China	DMEGC Solar
9	Singapore Japan China	EliTe Solar VSUN Solar Risen Enserly
10	Singapore	Maxeon Solar Technologies

Image 2-5: Largest global producers of solar modules, 2024, courtesy of Wood-Mackenzie⁸

Vietnam, Thailand and Malaysia have shown to be the countries of origin that would continue to supply modules during the tariff period; Cambodia does not appear to be a viable option. The largest module suppliers on the tariff list are Trina, Jinko and JA Solar according to Wood-Mackenzie (image 2-5). These would be the suppliers that would most likely be needed to replace damaged modules as the result of fire, storm, or other damaging event.

The exponential increase in demand for monocrystalline silicon solar modules has not sparked a large increase in US manufacturing capacity, as demonstrated in image 2-6. First Solar, the largest US based manufacturer of solar cells and modules, has previously opened manufacturing facilities in Southeast Asia which is one data point indicating that manufacturing solar modules outside the US is more advantageous than domestic manufacturing. It is not clear which First Solar manufacturing facilities supply solar modules to the US market.

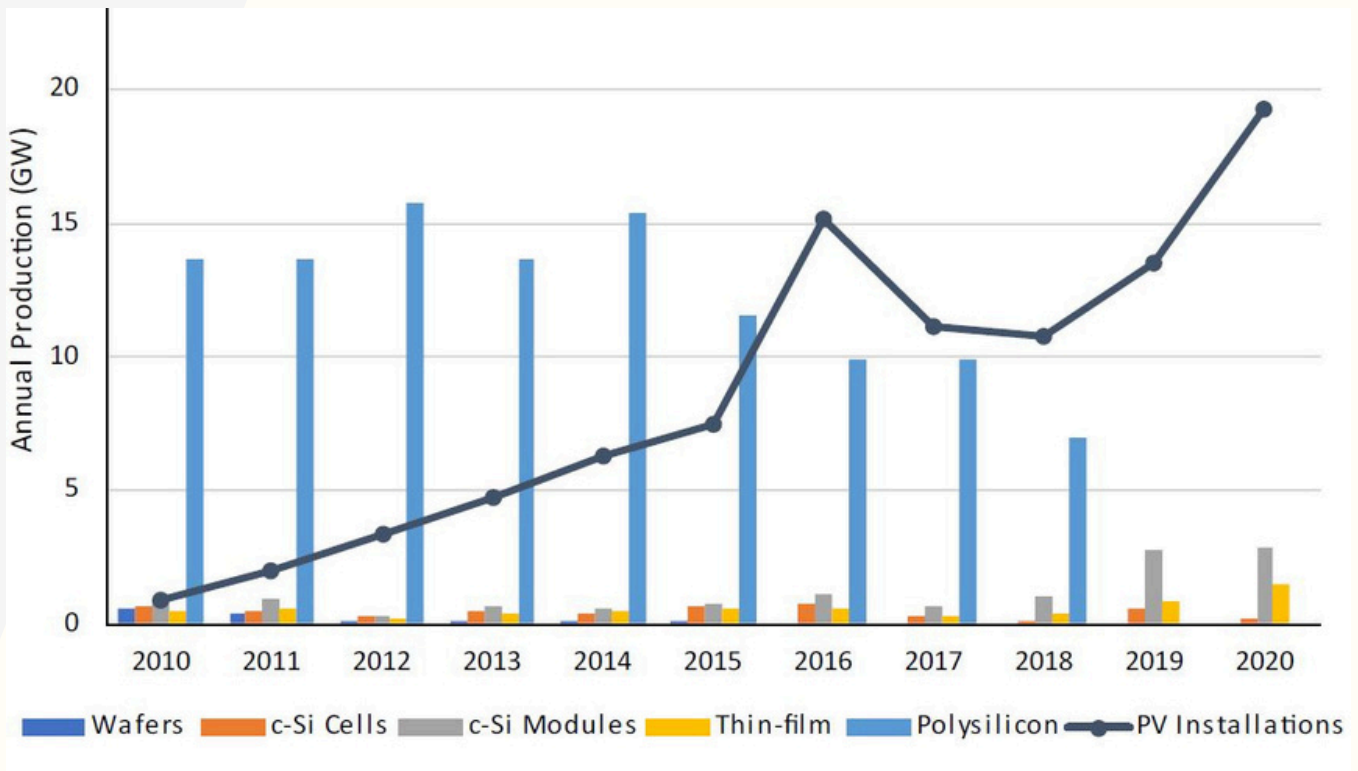


Image 2-6: US manufacturing capacity of Solar PV components vs. installed capacity⁹



/ PERSPECTIVES

Developers: Power plant developers like solar for several reasons: the components are relatively cheap per unit of power production, the components are presently readily available, and the installation locations are widely accessible. The Energy Information Administration (EIA) estimates that 32.5 Gigawatts (GW) of new solar PV power plants are under construction and scheduled to be commercially operational by the end of 2025. These projects are already under construction and the materials have already been bought and paid for. Many of these modules have already cleared US customs if they are to come online at their scheduled COD. However, an estimated 25% of these modules scheduled to be installed this year may NOT have cleared US customs yet and may be subject to additional negotiated and USITC scheduled tariffs. These unanticipated tariff costs could easily overtake the planned project margins of 5-15% and collapse the profitability of these projects.

The Solar Energy Industries Association (SEIA) estimates that "more than 159 GWdc of large-scale solar projects [are] either under construction or under development."¹⁰ Removing the anticipated 32.5GW of projects under construction in 2025, this leaves **126.5GW in advanced or initial development through 2028**. Given the high demand and growing manufacturing capacity for solar modules and

cells, it is safe to assume that imported solar modules for these projects have not hit US shores. Project managers may delay projects until supply circumstances change or cancel projects altogether. The variables related to these decisions are addressed on a case-by-case basis and it is a fool's errand to predict exactly how the industry will adapt. It is easier to anticipate the additional disruptions caused by project delays and cancellations with additional stress to an already overburdened interconnectivity queue. However, solar PV power plants are the fastest growing power generation technology for the past five years and this trend is likely to continue.

Operators: The day-to-day costs of operating a solar PV power plant are relatively predictable due to the minimal amount of moving parts. This results in many solar PV power plants having minimal on-site service personnel. When losses occur, labor resources must be redirected from other asset operations or contracted to assist with evaluations and repairs. The personnel responsible for managing the repair and restoration of major damage are typically disconnected from the day-to-day operations of the solar PV power plant. The information needed to determine the root cause of the failure will be gathered from multiple people performing different tasks. The labor resources dedicated to building solar PV power plant projects do not overlap with the labor resources assigned to operations and repairs. This drives to labor cost

related to repairs higher than what is estimated for project work.

High costs of imported solar modules will push operators to find alternate sources of this equipment: secondary markets, domestic suppliers, or increased spare capacity. Some operators may choose to decommission sections of their solar PV power plant in lieu of repairing due to materials costs (assuming this does not violate their power purchase agreements (PPA)).

The rapid expansion of solar PV power plants in recent years has not yet driven operators to large-scale blending of different manufacturers' solar modules due to adequate supply of materials. Obsolescence and increasing costs of imported materials will push operators to redesign their solar PV power plants to accommodate replacement modules that are different makes, models, and capacities from the original design scope.

Interestingly, the loss of new solar PV power plants could drive wholesale electricity prices higher which would increase the profitability of solar power plants that were already operational. Berkley Labs "Wholesale Electricity Market Price Drivers"¹¹ analysis indicates that solar PV power plants are one of the few downward pressure drivers on electricity prices.

Insurance: Insurance carriers will need to adjust their pricing and capacity models to consider higher prospective property damage and business interruption exposures. The high demand for electrical power generation will ensure solar PV power generation is considered due to its low relative cost and relative rapid deployment. In the

event of widespread damage to a solar PV power plant as the result of a convective storm, for example, large amounts of solar modules would be required to be purchased to rebuild the power plant. Due to the high volume of solar modules in the market for construction projects, solar modules purchased for repairs tend to be equivalently priced to new modules for construction projects. However, the labor and tooling costs can be higher due to most labor being tied up in construction projects.

The presence (or threat) of tariffs can cause any surplus solar modules to be purchased as soon as possible. The short-term increase in demand will drive solar module prices up and extend lead times. This can lead to repair/replacement costs that are higher than insurance carriers planned for when underwriting projects. As noted above, repair prices could increase by as much as 75%, depending on the country of origin. As lead times for replacement modules increase, carriers should expect longer periods of business interruption and the claimed costs (e.g. power production loss) associated with this period. Alas, necessity is the mother of invention, or in this case, additional options. Potential cost mitigation plans might be:

- Sourcing domestically produced solar PV modules. Expanding the definition of "like, kind and quality" may benefit all parties when compared to increased importation costs.
- Sourcing solar modules from spare inventory or construction project stock. This is more plausible for large asset owners, but large asset owners may be willing to sell to other owners with more limited inventory options.





- Work with module suppliers to share tariff costs. Following the short-term demand spike, the project delays and cancellations may cause solar module manufacturer inventories to swell. Manufacturers may be willing to share the tariff costs to shed inventory.
- If many new or planned solar PV power plants are delayed or cancelled, labor costs may be driven down by the availability of workers without construction projects.

These materials issues will require developers, owners, operators, and insurance carriers to communicate to find creative and mutually beneficial solutions. Carriers should quickly work with asset owners to determine the cause of loss so that these repair and rebuilding conversations can progress quickly.

CONCLUSION

The solar PV industry supply chain in the USA is bolstered by imported solar modules. Recent news provides more clarification on the tariff levels on solar modules and cells imported in the US: duties of 110-3500% are already in place. These increases will drive the imported cost of solar modules by at least 75%. After an event causing major damage, the parties involved in repairs can expect:

- Higher costs of materials, specifically solar modules.
- Higher costs of labor due to reassignment of construction labor to other projects like data centers or traditional thermal power generation.
- Longer repair periods related to sourcing materials, labor, and potentially redesigning solar PV power plants to merge different technologies as part of a repair.

Owners of existing solar power plants and their insurance carrier partners will have a more difficult time avoiding these material cost increases to get solar power plants back online after a loss event. Developers will likely revisit plans for new projects to determine the solvency of these ventures and wait for a more stable and predictable environment to determine the true cost of new solar PV power plants.

In spite of these pressures, the increasing cost and soaring demand for electricity ensure that solar PV power generation will continue to grow in the immediate future. If this analysis concerning solar PV power generation has impacted you, please reach out to us directly to continue a dialogue on this topic or related risk and insurance topics in the renewable energy space.

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