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The U.S. Solar Supply Chain 2025:

Building a Strong and Resilient American Solar Industry

AN INDUSTRY REPORT BY THE CPA ECONOMICS TEAM

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KEY POINTS

- The U.S. is at risk of losing its entire solar module manufacturing industry, despite 13 years of tariffs, two years of federal tax credits, and billions of dollars of private investment.
- Massive levels of imports, driven by Chinese overproduction of solar modules and components and exports worldwide, has put the U.S. manufacturing industry in crisis. Demand for domestically manufactured modules is weak because cheap imports have taken the majority of the market and reduced prices to unsustainable levels.
- At current solar module prices, few independent U.S.-owned module producers will be able to remain in business long-term. Several companies have already cancelled plans to build new facilities.
- Within the U.S., Chinese-owned solar module facilities are set to dominate onshore U.S. production. Our accounting shows that Chinese-owned facilities account for 39% of total U.S.-based capacity, compared to U.S.-owned which are just 24%.
- With the incoming Trump administration and a new Congress in office, solar energy policy is set to be re-examined. The federal government needs to declare a goal of building a truly diversified and profitable end-to-end solar manufacturing supply chain, with trade and domestic policies that can deliver on that objective.

Part I: The U.S. Solar Manufacturing Industry After the IRA

The two years since passage of the Inflation Reduction Act in August 2022 have seen a huge increase in investment in manufacturing capacity in the solar energy supply chain. According to the SEIA trade association, some $34.6 billion has been invested or announced as planned investments in the several stages of the U.S. solar power manufacturing industry. The majority of the investment has gone into facilities to manufacture solar modules or panels, the final stage of the manufacturing process. Those are the roughly six-foot-tall panels that go on rooftops, in fields, and elsewhere to turn sunlight into electricity.

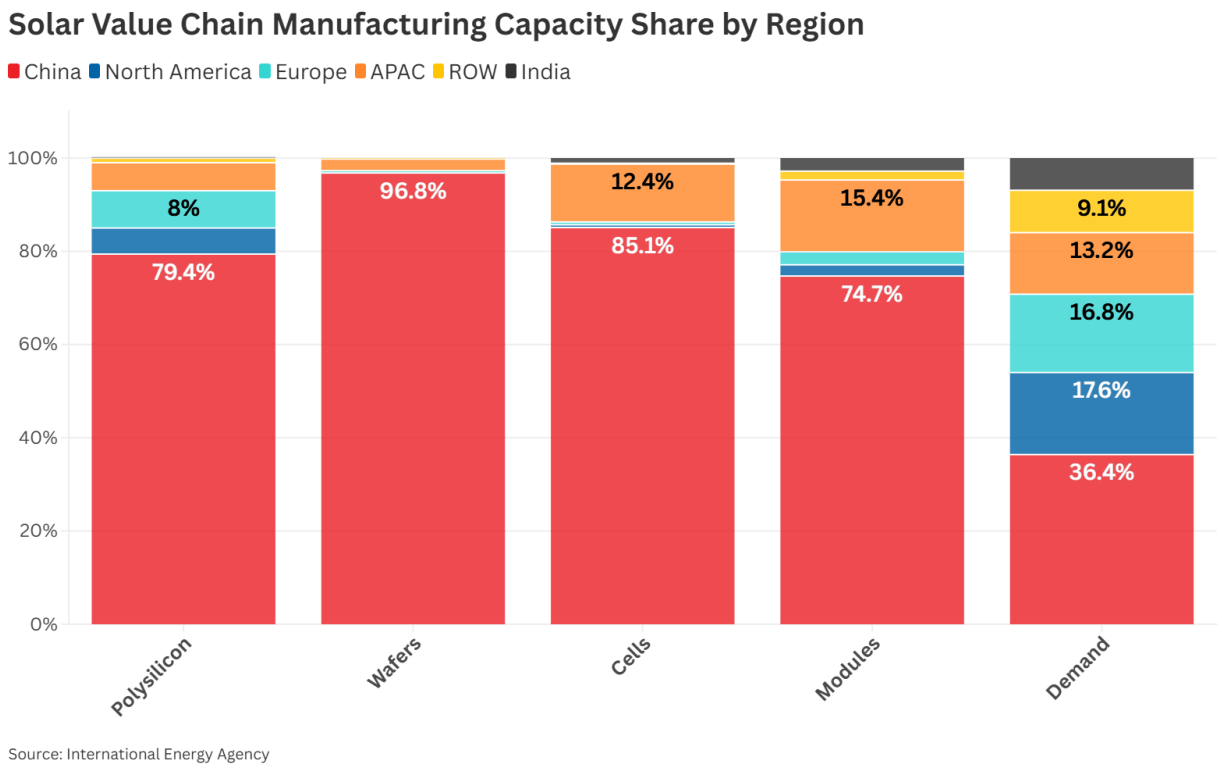
However, the fate of these new facilities, and the entire U.S. solar manufacturing industry, is in doubt. Chinese overproduction across the entire solar manufacturing supply chain has depressed global prices, led to huge financial losses everywhere, including among China's giant solar panel producers, and a flood of imports to the U.S. from facilities in Southeast Asia closely linked to the industry giants in China. In the U.S., many of the investment projects counted in the SEIA total are on hold and some have been canceled. Of the panel manufacturing facilities that are up and running, most are running well below full capacity and some may be idle. There are doubts about how many of the independent manufacturers can survive. For example, Meyer Burger, a Swiss manufacturer, opened a panel manufacturing facility in Arizona in July, with cheerful workers posing under an inspiring banner reading "Born in the USA." But a month later, Meyer Burger announced the cancelation of a solar cell manufacturing facility planned for Colorado, and blamed low prices in the U.S. market. It said it was delaying publication of its financial results and drawing up a restructuring plan. Meyer Burger shares are currently trading at $2.41, down 98% from over $100 a share in early 2024.

The technology behind solar power, the silicon photovoltaic cell, was **invented** by three American scientists at Bell Labs in 1954. Practical use of photovoltaic cells took off in the 1990s with the U.S., Germany, and Japan leading the innovation, product development and deployment. But early in the 2000s, the Chinese Communist government made renewable energy one of its top priority industries. It poured billions of dollars of subsidy into standing up an end-to-end solar manufacturing industry. Following the now-familiar Chinese playbook, dozens of Chinese companies entered the solar manufacturing industry, supported by subsidies from Beijing as well as local and regional governments in China. The subsidies took various forms, including free land for factories, low-cost bank loans from state banks, cheap electric power and, most notoriously, **Uyghur slave labor** in the Xinjiang region working in plants that manufacture polysilicon, the raw material solar cells are made from.

By 2010, China's solar policies were successful. Subsidized mass production of Chinese solar panels drove down the global price and drove nearly all of the first generation of U.S. and European solar panel makers out of business. The extent of China's domination can be seen in Figure 1, with data for 2021 from the International Energy Agency. China dominates every one of the four stages of solar manufacturing: polysilicon, solar wafers, solar cells, and solar panels (modules). The domination is near-total in the vital stage of solar wafers, at 97%. It is a linear production process, with each stage of production dependent on the preceding stage. In other words, panels are made from cells, cells from wafers, and wafers from polysilicon. China's share in each stage

exceeds 75%. However its share of final demand (i.e. deployment or installation of solar panels) is just 36%, meaning that about half of what it produces must be exported.

Figure 1. China dominates the global solar supply chain.



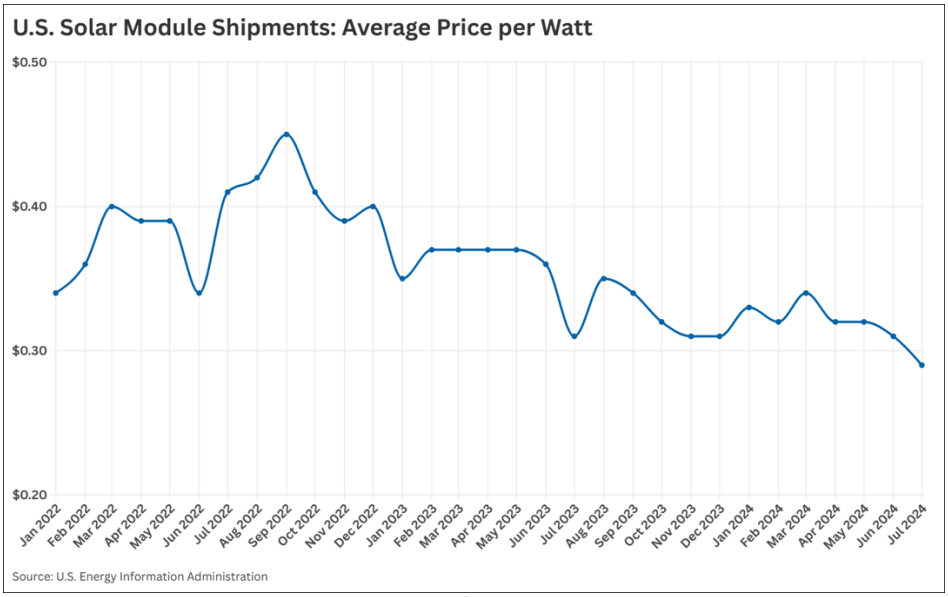
Source: International Energy Agency

In August 2022, Congress passed and President Biden signed into law the Inflation Reduction Act, a 10-year roughly $1 trillion program to support a move to the use of cleaner, lower-carbon energy in electricity generation, motor vehicles, and throughout the U.S. economy. The law accelerated investment in solar power through tax credits available for companies or individuals who install solar energy facilities, known as the Investment Tax Credit or ITC. It also provided for tax credits to solar equipment manufacturers, linked to their output of panels, cells, wafers, or polysilicon. Those are known as Production Tax Credits or Section 45X credits for the section of the tax code they appear in. All these credits are marketable, meaning organizations with no tax liability can sell the credits for cash to banks or other intermediaries. These generous tax incentives sparked the $30 billion-plus wave of investment in solar manufacturing and deployment. Today, solar energy accounts for only around 5% of total U.S. electricity generation, but it is the fastest growing energy source in the U.S. grid.

But even as companies were announcing plans, and in many cases actually building U.S. solar module factories, the price paid for solar modules was falling dramatically. Figure 2 shows that the prevailing price for solar modules was 42 cents a watt in August 2022, when the IRA passed Congress. It fell steadily through 2023 and 2024, reaching just 29 cents in July this year, according to figures from the U.S. Department of Energy's Energy Information Administration.

Industry sources say the EIA prices overstate the actual price in the market. EIA published price averages reflect long-term contracts in the industry. In the day-to-day market, prices are significantly lower, around the 20 cents per watt level, as importers and distributors try to unload large volumes of modules in their inventory.

Figure 2. Average price paid for solar modules fell below 30 cents/watt in 2024.



Source: U.S. Energy Information Administration

The low prices are due to oversupply in the U.S. market. That oversupply is due to overproduction in China and Southeast Asia. According to energy analyst Jenny Chase at **Bloomberg NEF**, global solar installations this year will be 592 GW, an impressive figure. But global production capacity is a monumental 1.2 terawatts, double the level of installations. The overproduction is driven by China, which accounts for 75% of module production (Figure 1 above). As the Chinese domestic economy has slumped in the last couple of years, the Chinese government has cracked the whip on manufacturers, urging them to produce and export more. For the solar module makers, the U.S. is the most attractive market. Within China, solar modules are selling for around 10 cents a watt (and many Chinese module makers are losing money on each panel). The European market has crumbled as European producers have mostly shut down under the pressure of low-priced Chinese panels, with European prices in the 12 to 18 cent per watt range.

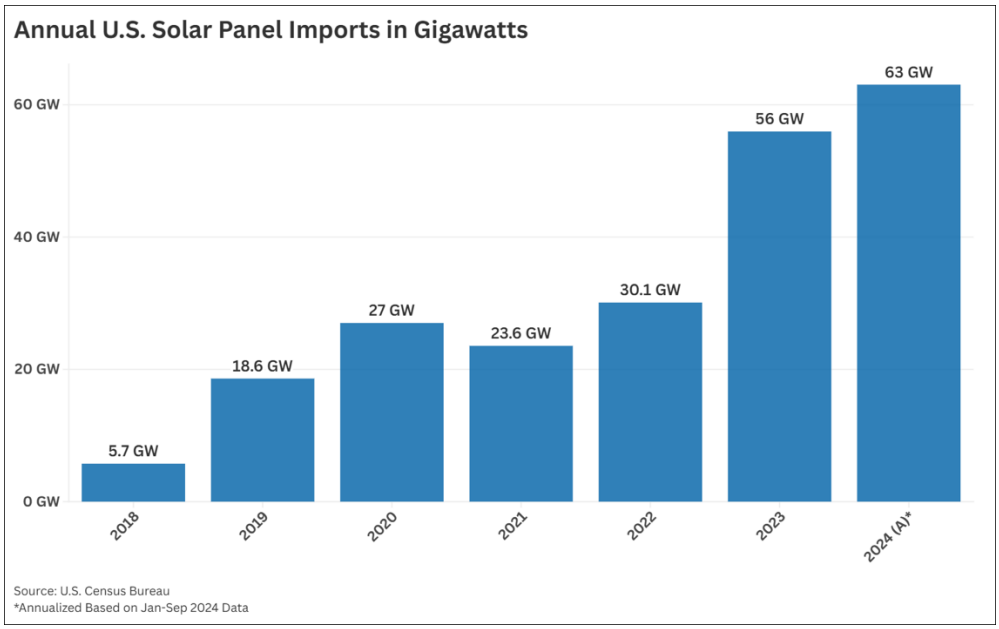
The U.S. market, with prices in the 20 to 30 cent range, is the most attractive market in the world for Chinese producers struggling to unload thousands of panels at almost any price.

The U.S. has legal remedies for nations and foreign producers that use subsidies to sell into the U.S. market at unfairly low prices. These antidumping and countervailing duties (AD/CVD) were first applied to Chinese solar panels in 2012 by the Obama administration, with large duties (tariffs) payable on panels imported from China. Chinese solar companies reacted by investing in production facilities in southeast Asia. The solar cells came from China but were assembled into solar panels in the new southeast Asian facilities.

In 2022, a California startup producer of panels, Auxin Solar, filed suit against several Chinese solar producers, arguing that the southeast Asian assembly facilities were specifically designed to circumvent the earlier U.S. duties and should therefore be subject to the same duties as were charged on Chinese panels. The Department of Commerce found in favor of Auxin, but at the same time the Biden administration issued a two-year "moratorium" on solar duties, allowing southeast Asian panels to enter the U.S. duty-free until June 2024. The Biden administration was trying to have it both ways: to give U.S. solar panel makers some protection from Chinese panels entering via southeast Asia while at the same time allow utilities and financial investors in the solar energy market access to cut-price solar panels, allegedly to meet the climate-change goals in the IRA. Neither side was happy with this situation. "Those two years became open season for Asian producers to sell everything they wanted into the U.S. and ruin the market for U.S. producers," says Mamun Rashid, co-founder and CEO of Auxin Solar.

By the end of 2023, U.S. warehouses were full of unsold solar panels. Under the inducement of the IRA subsidies, new solar module factories were coming onstream within the U.S. Yet because of the moratorium, the U.S. imported more solar panels this year than it consumed in each of the last two years. Figure 3 shows that in 2024, estimating from nine months of actual Census data, the U.S. is set to import 63 GW of panels, some 50% more than the 40 GW it is likely to install.

Figure 3. U.S. imports of solar panels have been far in excess of demand in 2023 and 2024.



Source: U.S. Census Bureau

Price per watt is the single most important number in the solar industry. That price determines whether companies can make a profit in the business. Only by making a profit can companies stay in business. When the IRA was passed in Congress, the tax credit (i.e. subsidy) of 7 cents per watt for manufacturers of solar panels made sense: with a prevailing price of 42 cents and an operating profit margin of some 15%, a 7 cent subsidy doubled the profitability of producing solar panels. It would have been, and indeed was, a substantial inducement to new investment. But the price fall of some 15 cents per watt more than wipes out the value of the 7 cent tax credit. The numbers in the 45X tax credits now appear hopelessly outdated.

The low prices of 2024, with little prospect prices will rise anytime soon, have led to several canceled plans. In January this year Cubic PV, a promising Massachusetts startup with innovative technology for producing solar wafers from polysilicon, **announced** it was canceling its plan for a volume manufacturing operation. Despite having suppliers and customers lined up, Cubic could not raise the finance in a market with such depressed prices. Other module makers, including Turkey's Elin and Singaporean Maxeon have gone quiet after initially announcing plans for U.S.-based module factories, and industry sources believe they have ceased building their factories, waiting to see if prices improve. A small number of independent U.S.-based solar module makers, including Mission Solar and Heliene, are hanging on but some industry observers wonder how long they can hold on in the current environment.

Some independent U.S. solar panel producers are gloomy about the market and seeking to sell out to foreign suppliers. India is widely rumored to be shopping for U.S. solar panel assemblers it can buy to help it route made-in-India supplies into the U.S.

market. Rashid of Auxin is optimistic that the U.S. industry can still find a way to keep out the cut-price Asian supplies and restore sanity and profitability to the U.S. market. He predicts that Auxin will win its case that Biden's moratorium was unjustified and unlawful. Importers of Asian panels would then be liable for millions of dollars of duties going back to 2022. The tortuously complex IRA rules on domestic content may yet be simplified to favor U.S-made panels assembled with U.S. cells. He is optimistic the incoming Trump administration will take a more pro-manufacturing view of the industry. Such changes could breathe new life into the suffering U.S. solar production industry

"We need production at scale," Rashid says. "With scale, we can compete with anyone in the world."

Some larger companies have continued to invest in the U.S. solar market. Unfortunately, the majority of these are foreign-owned and many of them are Chinese.

First Solar Inc. is the only U.S.-owned solar module maker in the global top 10. It is in a unique position due to its very different technology. Instead of assembling silicon-based solar cells into a solar panel, First Solar uses a thin layer of cadmium-telluride on top of glass to convert sunlight into electricity. First Solar's technology has cost advantages over silicon cells and appeals to utilities building large-scale power plants. First Solar is sold out for the next three years and is aggressively adding capacity, with new production facilities in Ohio and Louisiana. When those come online, the company will have 14 GW of capacity. With its differentiated technology and its blue-chip customer base, First Solar is still able to deliver a healthy profit. It reported an impressive operating margin of 37% on quarterly revenue of $889 million in the quarter to September.

Qcells, a division of Korea's Hanwha Group, is the only other non-Chinese solar panel maker in the global top ten. Hanwha is a Korean-owned industrial conglomerate and a major player in the U.S. market. As a $38 billion diversified company and maker of **military equipment** including tanks and ships, Hanwha played an instrumental role in rebuilding the Korean economy after the Korean War of 1950-1953. It produces solar cells and panels in Asia and is a major producer of panels at its U.S. factory in Georgia. Qcells has expanded its solar panel production in Dalton, Georgia, and is building a solar cell and wafer-making facility in nearby Cartersville. The company has also taken a large position in REC Silicon, a shut-down polysilicon production facility in the state of Washington which Qcells is reopening. Qcells' target is to increase U.S. solar panel production to 8.4 GW and ramp up an integrated supply chain by the end of 2025.

Both Qcells and First Solar are strong, well-capitalized companies with a strong commitment to the U.S. market, based on a belief that the federal government will not allow the Chinese solar industry to take over the U.S. market, as it did in 2010-2014.

The smaller independent U.S.-owned solar panel makers are in a very different position. They are troubled by the low prices in the U.S. market, the tidal wave of imports from Asia, and the large investments in U.S. facilities by other giant companies, especially those from China.

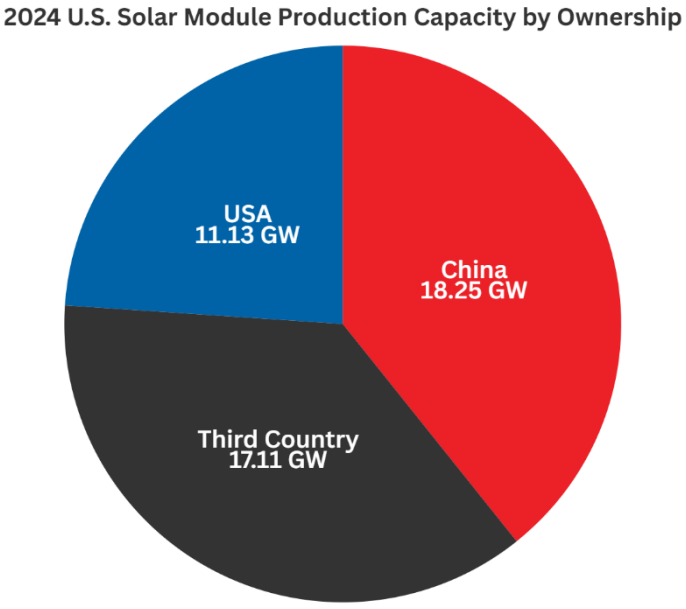
Chinese solar panel giants are currently building large production facilities in the U.S., and benefiting from the tax credits available to them under the IRA. Trina Solar is building a 5 GW facility in Texas. Canadian Solar (Chinese-owned despite the name) is also

building 5 GW in Texas. Jinko Solar is expanding its Florida facility to 2 GW. Longi is building a 5 GW facility in Ohio under a complex shareholding arrangement and the name Illuminate USA designed to mask the Chinese control of the facility.

On top of these giant Chinese facilities, a number of companies from third countries are building or seeking locations for their own solar panel facilities in the U.S., seeking to benefit from the relatively higher U.S. prices and the generous tax credits available to all U.S. factories under IRA rules. These include: Waree of India, Elin of Turkey and Merlin of the Philippines. All these companies are lured to build factories in the U.S. due to the relatively higher prices paid for modules, the generous IRA subsidies and the requirement for some part of the value of the solar panel to be built in the U.S. in order to allow the customer to claim the domestic content "adder," an additional tax credit that solar power plant operators can claim if they meet the federal criteria.

The result of the rush of foreign investment is that, as of the end of this year, U.S.-owned solar panel capacity accounts for less than a quarter of the market (24%). As Figure 4 shows, Chinese-owned capacity accounts for the largest share of U.S.-based production, 39% of the total. Third-country owned capacity accounts for 37%.

Figure 4. Chinese companies account for the largest share of U.S. solar panel production.



Source: News announcement, company reports, CPA calculations.

The large presence of Chinese-owned solar panel makers in the U.S. defeats the objective of building an independent American solar energy manufacturing industry. The Chinese companies will source solar cells from their Chinese or Southeast Asian facilities and limit the share of value created in the U.S. to that required to win the available domestic content bonuses. Since China is the source of huge excess capacity and low-cost components, every Chinese-owned U.S. factory is likely to be dependent on Chinese

supplies for components or manufacturing equipment or both. Unfortunately, the same likely applies to most of the third-country-owned facilities too. India, for example, is hostile to China and is trying to build its own independent end-to-end solar industry. But so far, its panel makers are largely dependent on Chinese components too.

Apart from the complexities of the solar supply chain, there is the shocking fact that Chinese solar companies can now claim U.S. tax credits, which are subsidies paid for by the U.S. taxpayer, on top of the ample subsidies the Chinese government has been giving them for some 15 years.

Carlos Class is a former manufacturing and operations manager for the U.S. Army and large defense contractors. In 2023, together with veteran solar cell engineer Napoli Gomez, he launched Solarix, an independent, U.S.-owned solar module startup. Solarix has acquired a factory building in southwestern Virginia. Class is working on raising $65 million to equip his factory with non-Chinese manufacturing tools to assemble 2 gigawatts of panels a year. He aims to manufacture 1 GW in 2025 and reach a run rate of 2 GW in 2026 at which point he will employ some 250 workers, in a part of Virginia where well-paid blue-collar jobs are hard to come by. But Solarix has its work cut out for it. Solarix needs to buy U.S.-made solar cells to allow his panels to qualify for the domestic content adder. Today, the U.S. is producing just 2 GW a year of solar cells. The rest come from Asia.

“Under the current IRA rules, a Chinese company can invest $50 to $100 million to build a 2 GW solar panel facility and claim $140 million a year in federal tax credits,” Class explained to us. “It can source all the solar cells from Laos or Indonesia, countries not subject to tariffs or AD/CVD duties. How can we make money or stay in business when our break-even point is 35 to 40 cents a watt and Chinese producers are selling panels today at 25 cents? We have Chinese manufacturers trying to sell us cells from their new facilities in Rumania, Turkey, and Indonesia, circumventing the US Department of Commerce’s accountability and tariff targets”.

Class adds that he has been approached by Chinese and Indian companies offering to buy his business as a route to sell solar modules made with foreign-produced components and meet the thresholds to qualify for U.S. government tax credits. “If Chinese and Indian companies can get tax credits, which are as good as cash, from the U.S. government, in a couple of years there won’t be a single American company left.”

Part II: Tariffs Haven’t Worked Because They Haven’t Been Tried

Public debate over tariffs on solar panels has raged for years, with solar manufacturers clamoring for higher tariffs on imported solar panels and power developers and installers, supported by foreign manufacturers, demanding little or no tariffs.

But effective tariffs have never been tried. The tariff discussion began in the Obama administration, as solar manufacturers facing bankruptcy from cheap solar panel imports from China pleaded with the government to take action. In 2012 the Obama

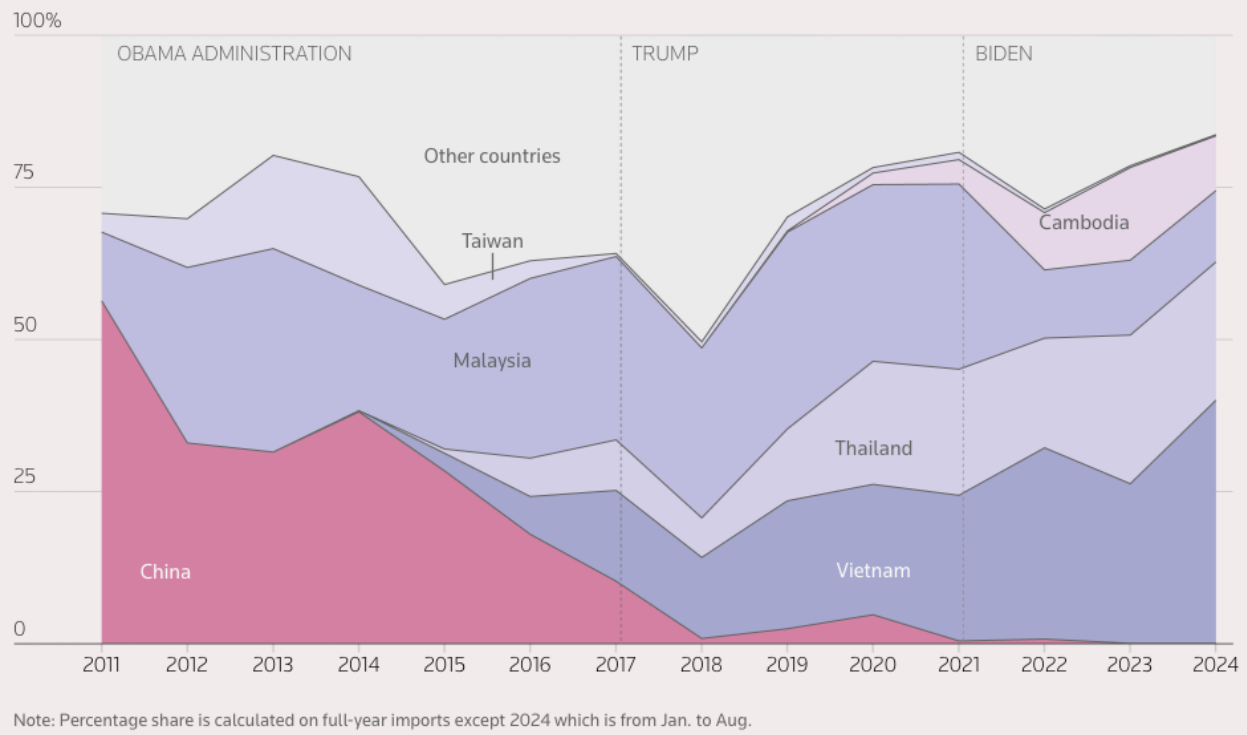
administration imposed tariffs averaging 36% on Chinese solar panels. The immediate effect of the tariffs was for Chinese panel-makers to move production with surprising speed to locations in Southeast Asia. The tariffs had little effect on the volume of imports, which continued to rise. Figure 5 shows the effect of the Obama tariffs on driving production to Southeast Asia.

Our analysis of the official import data from the government's Bureau of the Census shows that **effective** tariff rates (i.e. the value of tariff divided by the value of global imports) never approached the headline value of the tariff. The highest effective tariff rate was 11.71% in 2019. That's less than the tariff on an imported T-shirt. Effective tariffs are under 2% on the most recent available data. For the last twelve years, importers have found one loophole after another.

Table 1. Effective tariff rates on solar panels have been tiny since 2022.

Year	Solar panels, total import value	Tariffs levied	Effective tariff rate
2018	$2,871,662,737	$256,546,486	8.93%
2019	$5,726,992,469	$670,415,250	11.71%
2020	$7,855,172,304	$683,188,319	8.70%
2021	$6,306,978,652	$603,269,022	9.57%
2022	$9,516,217,705	$119,445,864	1.26%
2023	$18,618,256,592	$79,426,684	0.43%
2024 (11 months data)	$14,212,632,061	$217,056,226	1.53%

Figure 5. Tariffs on Chinese solar panels led to skyrocketing imports from Southeast Asia.



Source: U.S. Census data via Reuters

In 2018, the Trump administration imposed 30% global tariffs on solar panel imports. But at the same time, the administration specified that the tariffs would not apply to bifacial panels, which are panels that can capture sunlight on both sides of the panel. They are only slightly more expensive than monofacial. As a result of those tariffs, the industry shifted wholesale to importing and selling bifacial. While the headline or nominal tariff rate was 30%, the effective tariff rate came to just 11.71% in 2019, before declining even further in subsequent years.

Later tariff rulings, whether decided by the executive branch or courts of law, continued to include loopholes enabling importers to drive the effective tariff rate even lower, into the low single digits. With tariffs at less than 2% in 2024, it's no surprise that imports have continued to rise. But it is surprising that panel imports are set to reach around 63 GW this year, some 50% higher than demand, i.e. the volume of panels actually installed this year. This is a perverse import penetration rate of 150%, evidence of a contradictory and impotent U.S. policy on imports.

The most common way of avoiding tariffs is to shift at least one phase of the production process to a new country not covered by the tariffs. This ploy is often called "Whack-a-Mole" because imports from one location are simply replaced by imports from a new location. The whack-a-mole pattern is the result of narrowly drawn U.S. tariff laws which require findings of specific violations like

"dumping" (selling below cost in the home country), combined with China's notorious ability to shift production rapidly to a new location.

Table 2. More than a decade of Whack-a-Mole. Importers repeatedly use loopholes to avoid tariffs.

Year	Tariff	Importer workaround	Result: Imports continue to rise
2012	Antidumping tariff (36%) on Chinese panels (Obama)	New factories/shipment points in SE Asia	Total imports continue to rise.
2018	Section 201 tariff on global panel imports (Trump)	Exemption for bifacial panels	Imports up by 174%, 2018 to 2020
2022	Court ruling that SE Asia panels were actually Chinese by country of origin. (Biden)	Administration granted two-year moratorium on tariffs to panel importers	Imports up by 96%, 2022 to 2023
2024 (June)	Moratorium ended	Administration allowed importers until December 2024 to install panels imported pre-moratorium without tariffs.	Imports in 2024 set for 8% decline from 2023, but approx. 50% above 2024 consumption.

The result of near-zero tariffs from 2022 to today has been a huge surge of imports. Figure 5 shows that last year and this year, solar panel imports have exceeded domestic demand. This is almost unprecedented in industry. It shows the distortions in the market caused by Chinese overproduction combined with perceptions among importers and solar developers that possible future federal policies could raise panel prices so it is best to import huge volumes quickly. U.S. warehouses are full to bursting with solar panels.

The threat that the Auxin lawsuit and other actions against producers in southeast Asia has already kicked off the next phase of "whack-a-mole." New solar production facilities are being built in Indonesia, Laos and the Middle East, all regions that are not cited in existing lawsuits.

Part III: Economic Security and National Security

A U.S.-based solar energy manufacturing industry is essential for national security reasons and economic reasons. The national security perspective is straightforward: as America transitions to an electric power grid increasingly based on solar and other forms of renewable energy, it would be extremely foolish to allow China to monopolize the supply of the entire solar manufacturing supply chain, including raw materials, components, manufacturing equipment, and the final product, solar panels. Yet that is the direction we would be headed in without aggressive action to break U.S. dependence on China in all those areas.

The economic logic behind a complete U.S. supply chain can be seen by a closer look at the growth of First Solar and its surrounding ecosystem. Due to its unique cadmium-telluride technology, the entire First Solar supply chain is located here in the United States. A study commissioned by First Solar from the University of Louisiana found that today, each First Solar job leads to six additional jobs engaged in producing the materials that go into First Solar's panels. In total, the company's 3,000 U.S. jobs today account for 16,245 jobs nationwide. By 2026, after the current First Solar expansion is complete, the multiplier will rise to 7.3 and First Solar's 4,000 direct jobs will account for a total of 30,000 jobs nationwide. These jobs include mining the raw materials in Utah and Wyoming, manufacturing steel in Alabama and Louisiana, and producing glass in Ohio and Illinois. That's all in addition to building the solar panels in Ohio today, plus a new facility in Louisiana by 2026.

The broad reach of First Solar's supply chain and the jobs created illustrate the fundamental value of manufacturing specialized products. The products command a premium price, which leads to high pay for employees, and the opportunity for constant growth and productivity improvement in the production process leads to rising wages and contributes to strong national economic growth.

The conventional solar panel industry, i.e. the non-First Solar segment of the industry that builds their panels from silicon solar cells, is still largely dependent on imports for cells. Assembly of the panel accounts for some 15% of the value of a silicon solar panel, limiting the economic benefit to the U.S. economy, until more of the upstream segments of the production process can be relocated to the U.S.

All the issues that apply to the economic benefit apply even more strongly to the national security benefits of U.S.-located production. Assembly of panels would only give the U.S. the ability to control its own energy system if the upstream segments of the industry were also located in the U.S. But with China dominating the solar wafer industry with well over 90% of global production, China retains the ability to hold the U.S. (and the rest of the world) hostage for solar power supplies. China has demonstrated its readiness to take such hostile action before, with rare earth metals in 2010 and in health supplies during the Covid pandemic of 2020.

The establishment of solar cell manufacturing facilities has been held up by the uncertain fate of the solar panel assembly plants. With the majority of solar panel assembly facilities foreign-owned, their ability to source cells from foreign locations and most likely China has made it hard for entrepreneurs or financial institutions to back U.S.-based solar cell manufacturing facilities.

In September last year, Suniva launched operations manufacturing solar cells in Georgia, with a capacity of 1 GW rising to 2 GW by 2026. Suniva made cells years ago, but closed down in 2018 under pressure from Chinese competition. Suniva veteran Matt Card has been working since then to raise new capital to relaunch Suniva and finally succeeded last year.

Nevertheless, Suniva's 2 GW is a tiny figure compared to annual U.S. demand for solar panels of 40 GW and rising. Even if we discount First Solar, which doesn't use silicon solar cells, and Qcells, which will soon manufacture its own solar cells in the U.S., U.S.-produced cells would only account for some 5%-10% of the U.S. market. "The investment in making cells is nearly twice as much as for panels, and it takes twice as long to build the facility," Card says.

A number of other companies and entrepreneurs have expressed interest in entering the solar cell market, including startup Talon PV and Canadian panel producer Silfab. But at this point, it appears that the largest producers of solar cells in the U.S. will be Chinese-owned companies like Canadian Solar. Says one American entrepreneur: "The IRA production tax credit and investment tax credit were supposed to spur private investment [in solar cells]. It hasn't happened. Private equity investors and banks want zero risk."

The domestic content provisions of the IRA investment tax credit were originally thought to be a critical factor promoting the domestic industry. But the U.S. Treasury's detailed interpretation of the general principles in the IRA has opened the door for imported panels and imported components. The investment tax credit (ITC) is structured to give solar power developers a base tax credit of 30% of the value of each project, wherever the parts come from. There is a 10% "adder" which they can claim if the content of the solar hardware is over 40% domestic. The problem is that there are many ways to achieve the 40% threshold. In some solar projects the electrical inverter alone will bring the U.S. content up to some 36%. It then only takes a few bits and pieces to cross 40%.

According to Philip Shen, a Roth Capital Partners financial analyst who is the best informed Wall Street analyst on the solar sector, leaders in the new Republican congress of 2025 are now studying the ITC's domestic content provisions with a view to increasing the domestic content requirements. One scenario calls for replacing the basic 30% with a 6% base ITC and a 24% additional ITC contingent upon meeting domestic content requirements. But once again, the impact of such a requirement would depend on the details of how the 24% can be achieved. In our view, the goal of building an entirely U.S. solar supply chain should include specifying domestic content for the solar panels, the electrical parts (inverter) of the project, and the racking and steel parts. Unfortunately, congressional staffers are said to be looking at the ITC with multiple objectives, including not only stronger domestic content but also reducing the cost to the Treasury to help finance Republican tax cuts.

The problem with pursuing multiple objectives is the risk that none of the objectives is achieved effectively. We can only build an end-to-end solar supply chain if we make that an explicit objective and put policies in place to deliver that result. In Matt Card's

words: "There has to be pain in importing solar components. We will not build a domestic industry until there is no choice but to build a domestic industry."

Part IV: Policy Recommendations

To build a complete solar equipment manufacturing supply chain in the face of China's dominant position in the global industry and the determination of the Chinese Communist government to maintain and even strengthen that position is no simple task. For the U.S. to win that battle requires clear objectives, policies to incentivize building that supply chain, and alignment of all the players in the industry. The first Trump and outgoing Biden administrations each fumbled their way towards that objective but created too many loopholes and exceptions to allow a robust U.S. supply chain to be built.

Whatever position one holds on climate change, there is little doubt that solar energy will make up a growing share of the U.S. energy mix over the coming decades. It is therefore a matter of national security, as well as economic security, that the U.S. be able to build and maintain its own manufacturing ecosystem. Given the Chinese domination of the global industry, backed up by billions of dollars of Chinese subsidies, it is inevitable that U.S. solar equipment will cost more than Chinese equipment—that has been true for most of the last ten years. This is China's intention—to drive foreign producers out of business with ever-expanding capacity and uneconomic prices. As an illustration, leading polysilicon analyst Johannes Bernreuter points out that today, China has over 4 million tons of capacity to produce polysilicon, roughly double world demand of 2 million tons. This massive oversupply of capacity has led to a China price of some $4-$5 per kilogram as compared to a non-Chinese price of $20 a kilogram. According to Bernreuter it is a "totally bifurcated" market. It is in the U.S. interest to maintain that bifurcation while rebuilding its own industry. With investment and economies of scale, U.S. solar component and panel prices will come down over time. Today, U.S. producers can make a profit and build sustainable businesses with panel prices of some 35 to 40 cents a watt. That should be today's goal. Over time that price will descend but for today, that's how we can build an industry.

Here are some specific policy proposals that will lead to a resilient, sustainable, end-to-end U.S. industry:

- **FEOC.** Exclude foreign entities of concern from owning or benefiting from U.S.-located solar manufacturing facilities. Such bills are being drafted by member of Congress today. They would exclude any company fully or part-owned by a Chinese company from benefiting from IRA tax credits. They would likely also include U.S.-owned entities that have suspicious relationships, such as intellectual property share, with Chinese solar companies.

- **Domestic Content.** Strengthen the domestic content provisions of the IRA's investment tax credit to require a large and growing share of each of the three significant manufactured components of a solar project (Solar panels, electronics, racking/tracking) be made in the U.S.A. The 40% threshold in the IRA is a good figure but it needs to drill down to more specifics to ensure that all manufactured parts of the industry can be made profitably and sustainably in the U.S. Over time, the thresholds should rise further.

- **Tariffs.** Tariffs should be global, well enforced, and set at levels to achieve a political and economic objective. The objective should focus on domestically produced manufactured products. For example it could be a 25% market share within two years, 50% within five years, and 75% within eight years. The dollar value of the tariff to achieve such an objective might be 80% or 100%. And it would need to be adjusted regularly. For example, the 4 cents a watt tax credit for solar cells set in the IRA in 2022 is clearly obsolete in light of the lack of solar cell investment, falling import prices, and the cost of building a solar cell facility. It cries out for revision. Congress should set objectives, and empower another body to set and adjust tariff and tax credit levels. The combination of a realistic tariff, realistic tax credits, and realistic domestic content thresholds in the ITC should be sufficient to achieve the goals we propose. But they need to be monitored and updated by a government body that follows current market conditions closely.

- **UFLPA.** Many in the solar manufacturing industry would like to see the Uyghur Forced Labor Prevention Act enforced more aggressively. This would be a positive step. But we must recognize that China has already begun finding workarounds to legislation targeting Uyghur slave labor in the Xinjiang province. Chinese companies are already making polysilicon in Mongolia. China's resourcefulness in evading U.S. restrictions is speedy and impressive. With its top-down system, China moves faster than the U.S. legal system. After U.S. court decisions ruling that four Southeast Asian nations are merely "fronts" for Chinese production, Chinese solar companies are said to have already taken first steps to produce solar components in Laos, Saudi Arabia, Oman, Turkey, and Egypt. For a contrasting approach, look for a moment at France: when French cognac makers announced they were considering bottling cognac in China to meet Chinese demands on local production, French workers protested. The French workers think the cognac industry should benefit French producers, workers and communities. The French government took notice and instructed the cognac makers to halt plans for bottling facilities in China. China pays no attention to its own workers' wellbeing. There are many reports of workers being forced to work 75 hours a week, with one day off a month. In Marxist lingo, it is a "workers' paradise." In reality, workers have no voice.