

WHITE PAPER

BUILT IN AMERICA:

Transforming the U.S. Clean Energy Supply Chain

inter
solar
connecting solar business



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INTRODUCTION

One of the cornerstones of the Biden administration’s [strategy](#) to achieve net-zero emissions by 2050 is to fully decarbonize U.S. electricity generation by 2035. In 2023, renewables, including solar, wind and hydropower, accounted for about [25 percent](#) of the electricity generated in America.

Closing that gap requires simultaneous progress in multiple areas, including streamlining and speeding interconnection and permitting, expanding transmission capacity, and building a large and skilled workforce. Importantly, it also demands a rapid and large-scale buildout of its domestic manufacturing capacity.

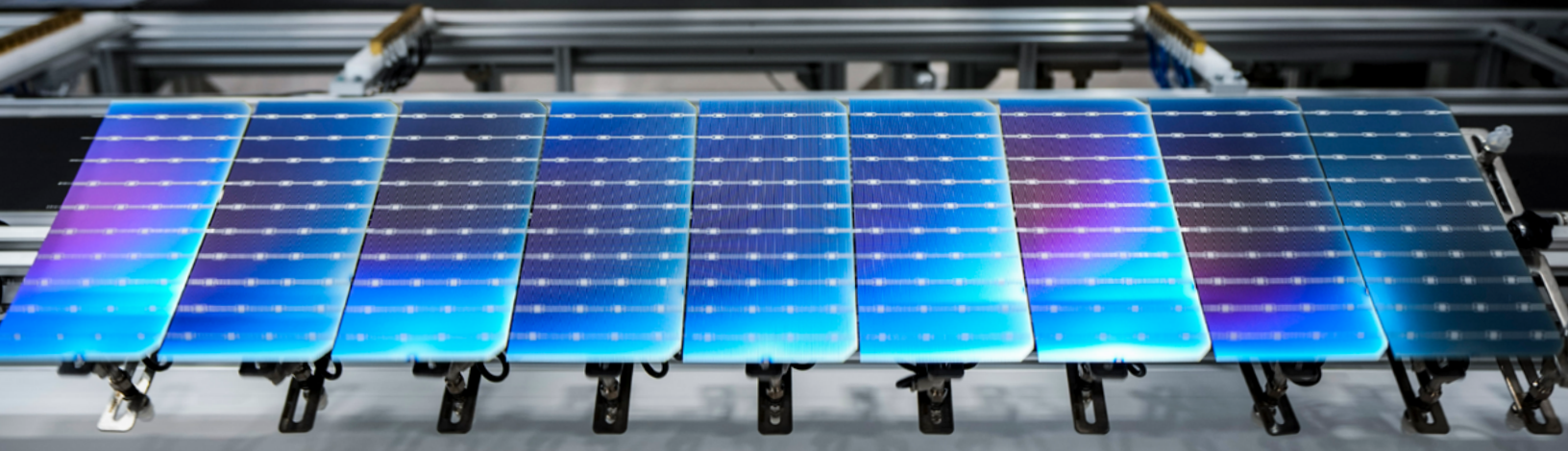
The policymakers who crafted the Inflation Reduction Act (IRA) understood the national security, economic, and environmental imperatives of building a robust clean energy supply chain. The IRA provides both domestic manufacturing incentives, including the \$10 billion [Advanced Energy Project Credit](#), as well as [bonuses](#) for the use of domestic content.

These incentives combined with growing demand from the U.S. market have catalyzed significant investment in domestic manufacturing. According to American Clean Power, over [160 new clean energy manufacturing announcements](#) have been made since the IRA was passed in 2022. In just two years, 42 of those factories are already operating, and at least another 119 are under development.

Does all this activity move the U.S. closer to a resilient and reliable supply chain? Is domestic manufacturing alone a realistic pathway to affordably and reliably meeting America’s clean energy and climate goals?

This paper explores the progress and challenges of building out a diversified supply chain for solar and energy storage, including:

- The balance of onshoring, nearshoring, and forging alliances
- The solar supply chain
- The battery supply chain



SCOPING THE PROBLEM

It would be impossible in just two years for the IRA-driven boom in domestic manufacturing to create a resilient supply chain able to fully meet America's demand for clean energy products. In particular, the critical minerals, components, and manufacturing capacity for both solar and energy storage are concentrated overseas, mostly in China, which accounted for [about three-quarters](#) of all global investment in clean energy manufacturing in 2023, according to the International Energy Agency (IEA).

China's dominance of clean energy manufacturing is well documented. A few data points illustrate the dominance China has across the solar and energy storage value chain:



- In 2023, China produced almost [82 percent](#) of the world's solar modules and is expected to manufacture 80 percent of all modules by 2030.
- China also produces over [90 percent](#) of all polysilicon, cells, and wafers. According to the IEA, China's share of polysilicon production increased from less than 60 percent five years ago to more than 90 percent today.
- Similarly, China manufactured nearly [83 percent](#) of all the batteries produced in 2023.
- China produces 84 percent of the anode materials, including graphite, along with 63 percent of the cathodes and nearly 70 percent of the electrolytes used in lithium-ion batteries.



ONSHORING, NEARSHORING, AND FRIENDSHORING

There are many risks to America's clean energy goals if the industry continues to rely on imports. Dependence on solar and battery components from China means that the U.S. is always facing the risk that supplies could be cut off if geopolitical tensions escalate. And relying on products shipped thousands of miles both compounds transportation emissions and introduces the potential for delays due to pandemics, [labor disputes](#), and dramatic shipping [price fluctuations](#).

But what exactly constitutes a resilient and reliable clean energy supply chain? For solar and batteries, there are three main factors:

Onshoring. The process of onshoring, or reshoring, involves building new manufacturing facilities in the U.S. or bringing back manufacturing capabilities that had previously been operating in another country. While the IRA kick-started big investments in manufacturing, the [vast majority](#) of those are factories that only produce finished modules and assemble battery packs. While this is an important first step, it must include follow-on investment for upstream and midstream manufacturing, which make the components that go into the modules and batteries.

Nearshoring. Geographic proximity and the U.S.-Mexico-Canada free-trade zone have tightly integrated the economies and supply chains of the three nations, especially in the automotive sector. The U.S., Canada, and Mexico made a collective [pledge](#) to relocate the production of 25 percent of the current Asian imports to North America. The Brookings Institution [called](#) the push to relocate clean energy manufacturing to Mexico "a golden opportunity to revitalize its industrial platform, modernize its infrastructure, grow its skilled labor force, create well-paid jobs, and significantly decarbonize and boost its economy." While the opportunity is clear, [questions](#) remain about the ability of Mexico's

grid to reliably serve manufacturers and the country's willingness to move beyond fossil-fuel-focused economic development.

Friendshoring. To achieve the goals of the clean energy transition, the U.S. Department of Energy's (DOE) supply chain [strategy](#) acknowledges the importance of working with "reliable" foreign partners. Friends can be defined as the nations with which the U.S. has comprehensive [free-trade agreements](#), including Australia, Canada, Chile, El Salvador, Colombia, and South Korea. The Center for Strategic and International Studies (CSIS) released a [paper](#) advocating for friendshoring the lithium-ion battery supply chain as a way to move away from China's dominance. CSIS identified natural partners like Japan — home of battery makers Mitsubishi, Panasonic, and Toshiba — and South Korea, which currently holds 37 percent of global market share in lithium-ion batteries. Additionally, groups like the Carnegie Endowment for International Peace [emphasize](#) the value of using development finance tools to help developing nations build up their own clean energy manufacturing capacity.





SOLAR SUPPLY CHAIN

The recent emergence of a domestic solar manufacturing industry is really a story about U.S. module production. In 2020, for example, the DOE [reported](#) that America produced about 2 gigawatts of silicon modules using imported cells and had no ingot, wafer, or silicon cell manufacturing capacity. The polysilicon made in the U.S. at the time was not used for solar applications.

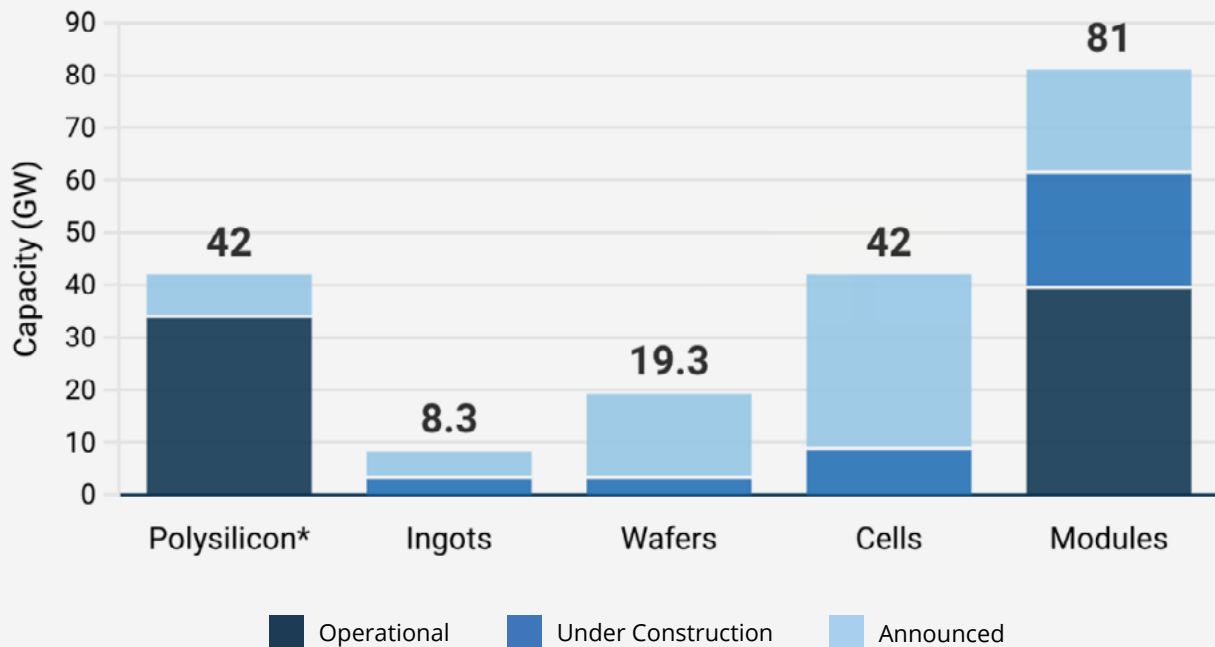
According to the Solar Energy Industries Association (SEIA), domestic module manufacturing capacity online today is 39.5 gigawatts as of September 2024, with another 22 gigawatts under construction. An additional 19.5 gigawatts has been announced but not yet started. As for domestic ingot, wafer, and cell manufacturing production, several facilities are under construction and others have been announced. In fact, 3.3 gigawatts of new capacity for ingots and 3.3 gigawatts for wafers are being built along with nearly 9 gigawatts of cell capacity.

The domestic module manufacturing boom includes facilities like Q-Cells' Dalton, Georgia, factory, which churns out [5.1 gigawatts](#) of solar panels each year, as well as SEG Solar's newly opened [2-gigawatt](#) module plant in Houston, Texas. Q-Cells has [plans](#) to become a vertically integrated domestic producer of ingots, wafers, cells, and panels, and [SEG Solar](#) hopes to produce cells in America starting in 2027.

SEG Solar, which also has manufacturing facilities in China, Indonesia, Thailand, and Vietnam, had planned to produce modules in America before the passage of the IRA, largely in response to Section 201 tariffs. The company says that domestic cell production could be accelerated by streamlining permitting for proposed facilities and with certainty that the IRA will be in effect for the next decade. This is especially important for cell production, SEG Solar says, because of its higher capital costs, energy demands, and longer timelines compared with those for modules. SEG Solar also believes friendshoring and nearshoring are important components of a secure solar supply chain, especially during the time when domestic ingot, wafer, and cell capacity is ramping up.

U.S. Module Supply Chain Capacity

By Component & Status



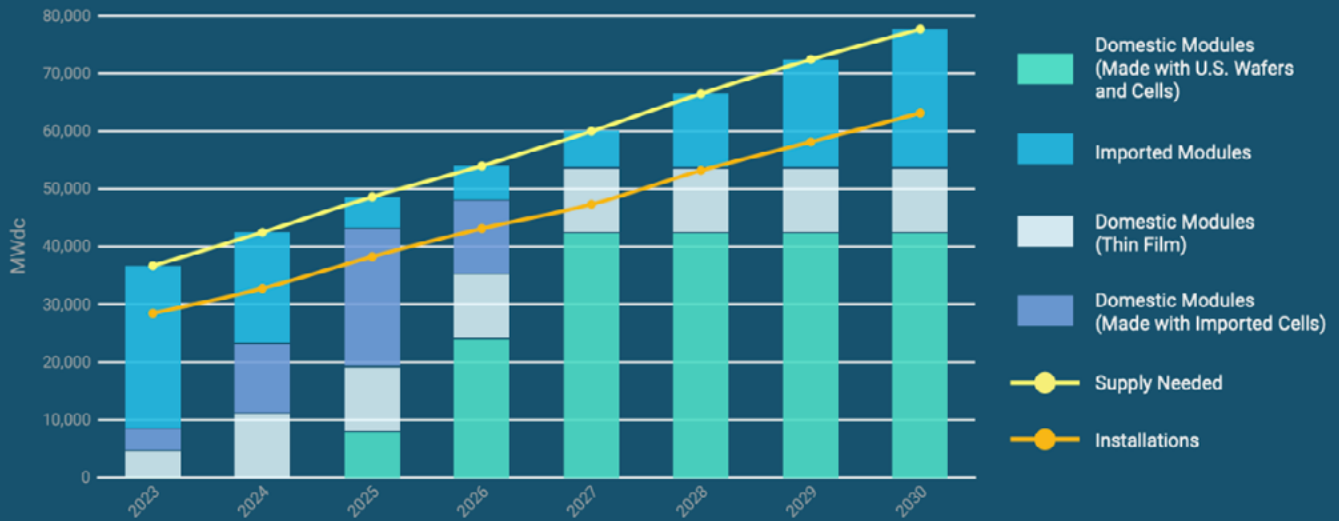
Source: [SEIA, 2024](#)

Given Q-Cells' U.S. vertical integration strategy, it's no surprise that the company sees a resilient solar supply chain as one in which enough of the critical subcomponents of solar panels needed to serve the domestic market are produced in America. Improvements to the IRA targeted to bolster domestic polysilicon, ingot, wafer, and cell production can help. But Q-Cells also notes that securing enough production equipment — like diamond saws used to make wafers — and a workforce skilled in producing module components are additional barriers to overcome.

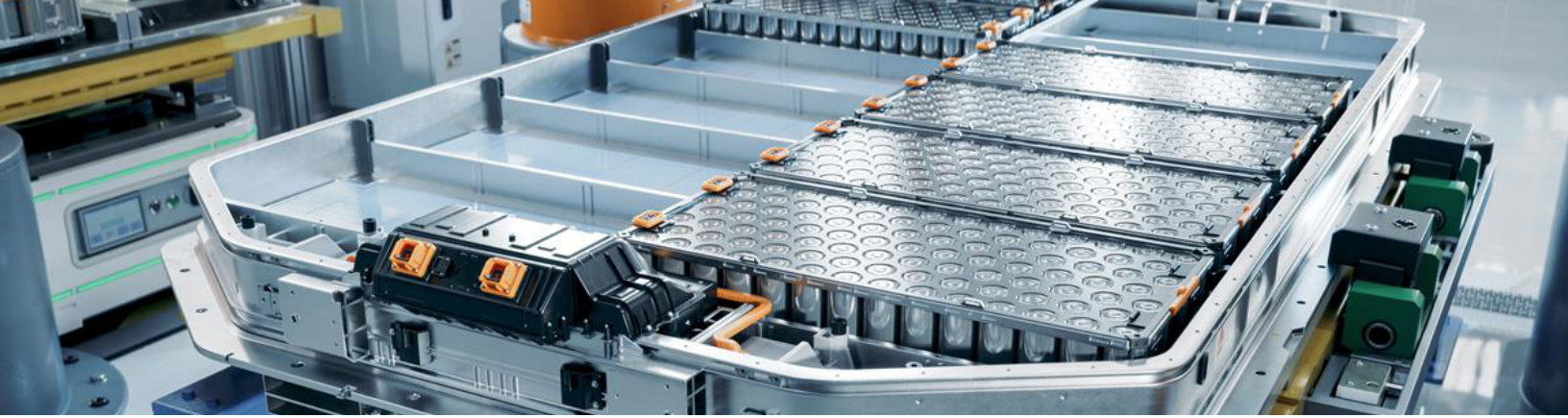
Solar Energy Manufacturers for America (SEMA) released a [report](#) earlier this year arguing that the domestic manufacturing industry stood at an inflection point. The report acknowledged that the IRA has created an opportunity to build a sustainable and reliable solar supply chain. But China's overcapacity, massive subsidies, and export-dependent economy are maintaining its manufacturing dominance, making reshoring more difficult. Even with reshoring, a portion of modules needed will still be imported, according to a 2023 SEIA report on solar and storage manufacturing.

To seize the economic and environmental opportunities of the IRA, SEMA has proposed establishing stronger standards for the use of bonus domestic-content tax credits and leveraging federal procurement power to incentivize U.S. wafer and polysilicon production. Additionally, SEMA advocates for strong enforcement of America's trade policies and for the federal government to lead by example by purchasing modules with as many U.S.-made components as possible.

Figure 5: Baseline Installation and Module Supply Stack



Source: [SEIA](#), 2023

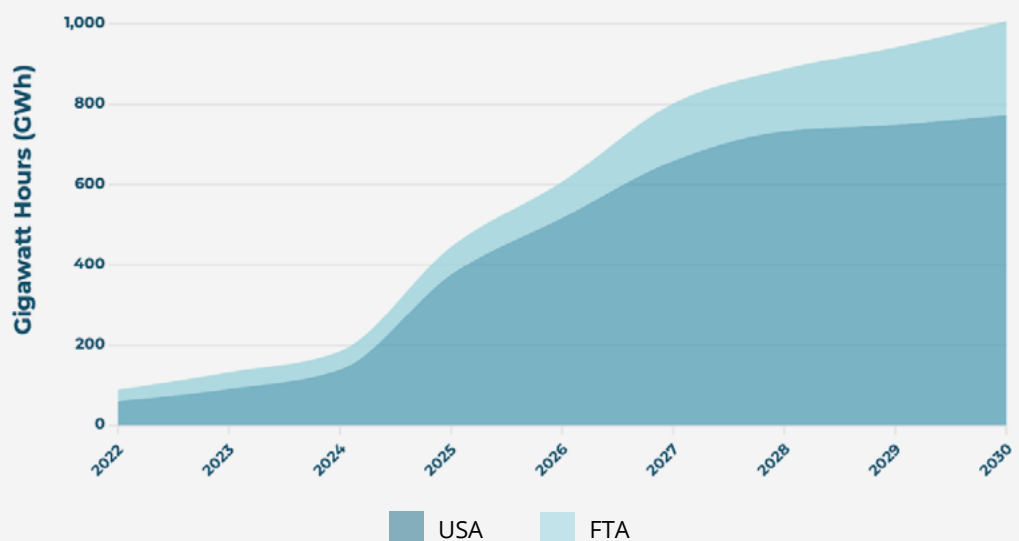


BATTERY SUPPLY CHAIN

America's demand for grid-scale storage is rising in tandem with the influx of variable renewable generation. Between 2020 and 2023, the U.S. installed about [29 gigawatts](#) of grid-scale energy storage, primarily in California and Texas. Demand for grid-scale storage is expected to reach 40 gigawatts by 2025.

How much of that demand can be met from factories in the U.S. and other friendly nations? According to a 2023 report by SEIA, current manufacturing capacity for lithium-ion batteries in the U.S. is 60 gigawatt-hours, with forecasted capacity expansions to over 630 gigawatt-hours in the next five years. That number increases to more than 1,000 gigawatt-hours when including nations that have a free-trade agreement with America.

Figure 3: USA and FTA Countries Gigafactory Capacity Pipeline*



Source: [SEIA](#)/ CRU

About 90 percent of that manufacturing capacity, however, is devoted to making batteries for electric vehicles (EVs). The manufacturing that is done in the U.S. is limited to cell production and battery-pack assembly, leaving the electrolytes, anodes, cathodes, and separators to be made elsewhere, mostly in China.

The IRA helped to kick-start the domestic manufacturing of the components of grid-scale energy storage. For example, the DOE provided conditional [approval](#) of an \$850 million loan to help finance Kore Power's Arizona factory, KOREPlex, which will produce cells for both EV batteries and grid-scale storage. Phase one of the project is expected to be completed at the end of 2025 or early 2026 and have the capacity to produce 7 gigawatt-hours of cells; phase two will add another 10 gigawatt-hours of capacity.

According to Kore Power, the buildout of a resilient energy storage supply chain has been helped significantly by the IRA, but more needs to be done. [Tariffs](#) announced against China last May are helpful to counteract the Chinese government's massive subsidization of its storage companies. Kore would also like to see an additional incentive for projects that use products made in America by U.S.-based companies. Besides the 10 percent domestic content bonus allowed by the IRA, Kore believes domestic manufacturing would benefit from a 15 to 20 percent boost for energy storage components produced by U.S.-based companies.



A NEW DAWN FOR CLEAN ENERGY SUPPLY CHAINS

Though it's true that America has a long way to go to create solar and storage supply chains insulated from the shocks of pandemics and geopolitical conflict, meaningful progress has been made. The next step is to harness the momentum of [job creation](#) that empowers communities and multibillion-dollar investments to expand and deepen the production of clean energy components domestically and by friendly nations.

Like so much in the clean energy transition, seizing this historic opportunity demands pursuing and accomplishing many things at once. Helpful steps include:

- Robustly enforcing trade policy.
- Ensure long-term health of IRA to catalyze investments in capital-intensive ingot, wafer, and cell manufacturing.
- Enhance the IRA to incentivize private investments in domestic manufacturing.
- Forge closer trade relationships with friendly nations through public investments and favorable policy.
- Leverage the purchasing power of the federal government to encourage demand for domestic manufacturing products.

KEEP LEARNING



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The 2025 edition of the [Intersolar & Energy Storage North America \(IESNA\)](#) trade show and conference is expanding its support of solar + storage production machinery and equipment manufacturing professionals. At its new Manufacturing Pavilion, solar + storage OEM manufacturers and production line integrators will be able to easily source production machinery and equipment for use in their manufacturing production lines. Additionally, IESNA's conference program will include sessions focused on onshoring solar and storage manufacturing, strategies for overcoming material shortages and disruptions, and the impact of geopolitical factors, trade policies, and sustainable practices.

Canary readers are invited to further explore this issue at IESNA 2025 this February 25-27 in San Diego, CA: [Get an exclusive 20% conference pass discount or free exhibit hall access here.](#)

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