U.S. DEPARTMENT OF ENERGY

Acute Shortage of Solar Equipment Poses Risks to the Power Sector

June 2022

Disclaimer

Summary

Trade and supply-chain frictions have resulted in an acute shortage of solar photovoltaic (PV) equipment in the United States that risks abruptly slowing the rate of solar PV installation. Project delays and cancellations pose risks to power sector reliability, electricity prices, and energy-sector jobs.

Key findings:

- The U.S. Department of Energy (DOE) estimates that solar equipment shortages could reduce solar PV deployment by 12–15 gigawatts (GW) over the next year, equivalent to the electricity needs of more than 2 million homes.
- These shortages come at a time when the North American Electric Reliability Corporation, grid operators, utilities, and state officials have all indicated that many regions of the country have near-term electric reliability concerns related to the lack of sufficient generation capacity combined with the growing prevalence of extreme weather in the form of heat waves, drought, and wildfires.
- The war in Ukraine, in addition to the end of many COVID-19 restrictions, has led to significant increases in wholesale electricity prices. Solar is a low-cost source of supply, which means that delays and cancellations of PV projects will put upward inflationary pressure on electricity prices paid by families and businesses.
- With a potential reduction in PV deployment of 12–15 GW over the next year, DOE estimates that more than 50,000 jobs are at risk in the near term, including more than 5,000 union jobs.

To address the panel shortage, the Biden Administration is pursuing a concerted strategy to build domestic solar manufacturing capacity and reliable, domestic supply chains. Several solar companies have made recent announcements that demonstrate their interest in onshoring solar supply chains. However, establishing a solar component manufacturing facility, whether polysilicon production, ingots, cells, wafers, modules, mounting structures or inverters, requires time—from one to four years.

In the meantime, domestic solar manufacturing capability is simply not sufficient to meet demand. The nation's 7.5 GW of current domestic module production capacity comprises less than one-fourth of near-term market demand and less than one-tenth what would be required to meet the country's climate targets and energy security needs.

Meeting near-term demand will, by necessity, require reliance on both domestic and international supply chains. Absent an ability to access both sources of supply, PV project cancellations and delays will pose risks to the provision of reliable, affordable electricity supply while also imperiling achievement of the nation's energy security and climate objectives.

Shortage of Solar Equipment

Solar PV has been among the fastest-growing sources of new electricity generation in the United States. At the end of 2021, a total of 92.5 gigawatts (GW) of PV was connected to the grid and, in 2021 alone, 18.6 gigawatts (GW) were added—making solar power the largest source of new generating capacity.[1]

Previously, solar PV was anticipated to account for approximately 50% of newly installed generation capacity this year and next.[2] The Energy Information Administration (EIA) reports that utility-scale solar developers expected to add 22 GW of solar PV capacity in 2022 and 19 GW in 2023, significantly more than the 13 GW added in 2021.[3] An additional 6 GW of distributed, smaller-scale PV installations were anticipated for each year.[4]

Yet PV module (i.e., panel) imports have been falling abruptly rather than increasing to meet this demand. From July 2021 through March 2022, imports fell to 1.7 GW per month down from a prior average of 2.3 GW per month (Figure 1).[5] Two-thirds of imports (an average of 1.5 GW per month in 2020 and 2021) were crystalline silicon modules from Cambodia, Malaysia, Thailand, and Vietnam.[6] Imports from those countries appear to have ceased in the past two months.

The equipment shortage is also hitting domestic module production. In 2021, there was 5 GW of domestic module production, of which 3 GW was crystalline silicon modules that depend on imported solar cells for production.[7] In 2021, over 1 GW of solar cells were imported from Cambodia, Malaysia, Thailand, and Vietnam.[8] Ceasing cell imports from those countries would threaten at least 1 GW of domestic module production.

In aggregate, the current shortage of solar equipment could reduce domestic solar deployment over the next year by 12–15 GW, enough to power over 2 million homes.[9]

[1] National Renewable Energy Laboratory (NREL), *Spring 2022 Solar Industry Update*, at 26 (2022), https://www.nrel.gov/docs/fy22osti/82854.pdf.
[2] Energy Information Administration, *Short Term Energy Outlook* (May 10, 2022) and *Form 860* (2022), https://www.eia.gov/outlooks/steo/, https://www.eia.gov/electricity/data/eia860/
[3] U.S. Energy Information Administration, Solar Power and Batteries Account for 60% of Planned New U.S. Electric Generation Capacity (Mar. 7, 2022), https://www.eia.gov/todayinenergy/detail.php?id=51518.
[4] Wood Mackenzie, as reported in SEIA Solar Market Insight Report 2021, with DC to AC conversion.
[5] Module import data from United States International Trade Commission. 2022. "DataWeb.USITC.GOV." May 16, 2022. https://dataweb.usitc.gov/trade/search/Import/HTS. Data in MW units was used except for Thailand data for February 2021 and March 2022, which had abnormalities. For those numbers, MW were estimated from the dollar value of the imports. Data is not yet available for April 2022.
[6] Module import data from United States International Trade Commission. 2022. "DataWeb.USITC.GOV." May 16, 2022. https://dataweb.usitc.gov/trade/search/Import/HTS.
[7] Wood Mackenzie, as reported in SEIA Solar Market Insight Report 2021.
[8] Cell import data from United States International Trade Commission. 2022. "DataWeb.USITC.GOV." May 16, 2022. https://dataweb.usitc.gov/trade/search/Import/HTS
[9] Roughly 1.3 GW of solar modules are needed to supply a 1 GW solar power plant.

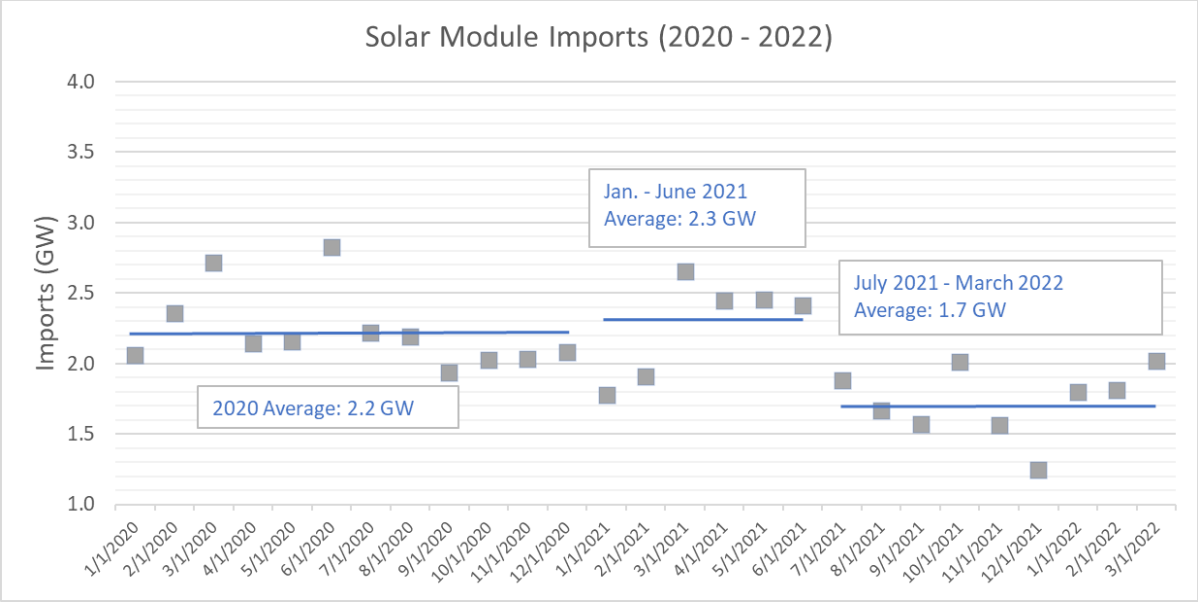

Figure 1: Solar PV Module Imports into the United States

The general cause of the reduced imports can be attributed to trade friction with China, production slowdowns due to COVID-19 restrictions, increased competition for shipping capacity, and increased global competition for solar equipment, especially from Europe as they seek alternatives to Russian energy supplies.[10] Furthermore, since March, cell and module imports from Southeast Asian countries appear to have virtually ceased since the announcement of an AD/CVD circumvention investigation[11] as duties can be (retroactively) imposed on cell and module imports from those countries.

National Ramifications

These recent developments threaten power sector reliability, put upward inflationary pressure on retail electricity rates, and pose risks to energy-sector jobs.

Resource Adequacy and Grid Reliability

The loss of 12–15 GW of solar capacity previously expected to be installed across the country over the next year threatens the availability of sufficient electricity generation capacity to serve expected customer demand, which is known as resource adequacy. This increases the risk of rolling blackouts.

Already, many regions of the country have identified near-term electric reliability concerns related to the lack of sufficient generation capacity combined with the growing prevalence of

[10] *See generally* National Renewable Energy Laboratory (NREL), *Spring 2022 Solar Industry Update* (2022), https://www.nrel.gov/docs/fy22osti/82854.pdf.
[11] *Crystalline Silicon Photovoltaic Cells, Whether or Not Assembled Into Modules, From the People's Republic of China: Initiation of Circumvention Inquiry on the Antidumping Duty and Countervailing Duty Orders*, 87 FR 19071 (Apr. 1, 2022).

extreme weather in the form of heat waves, drought, and wildfires. The North American Electric Reliability Corporation (NERC) warned in its *2022 Summer Reliability Assessment* that the entirety of the central and western United System is at high or elevated risk (Figure 2).

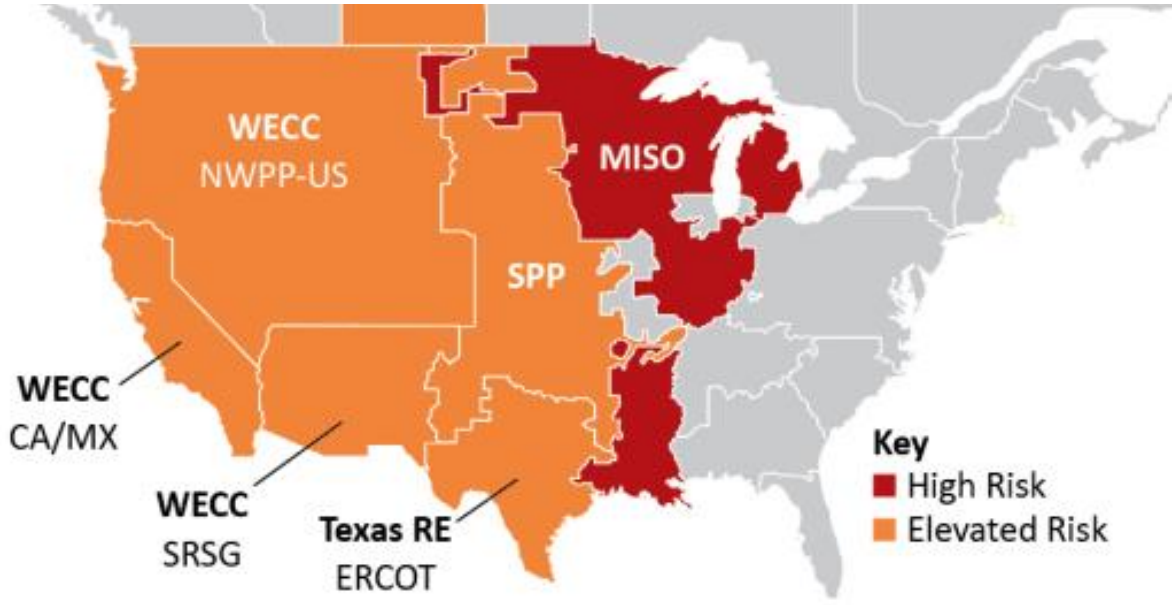

Figure 2: North American Electric Reliability Corporation (NERC) Assessment of Summer Reliability Risks[12]

Delayed and cancelled solar projects exacerbate these risks:

- NERC has warned that customers in Arizona, New Mexico, and parts of California and Texas could face reliability issues this summer, noting concerns about solar project delays.[13]
- California was counting on planned solar installations to fill a portion of a projected capacity deficit that state officials have predicted could result in electricity shortfalls as soon as summer of 2023.[14]
- The Midcontinent Independent System Operator (MISO) has noted that summer peak demand is forecasted to be greater than the projected regularly available generation within MISO.[15]

[12] *See* North American Electric Reliability Corporation (NERC), *2022 Summer Reliability Assessment*, at 5 (May 2022), https://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/NERC_SRA_2022.pdf.
[13] *Id.* at 34.
[14] Letter from California Governor Gavin Newsom to Secretary of Commerce Gina Raimondo (Apr. 27, 2022) ("The inquiry, and resulting uncertainty, is delaying at least 4,350 MW megawatts of solar plus storage projects in total nameplate capacity that we need to come online between 2022 and 2024 . . . Delays and interruptions of this magnitude hinder our efforts to combat climate change and threaten our ability to maintain energy reliability ahead of the retirement of 6,000 megawatts primarily generated by aging, gas powered once through cooling plants.").
[15] Press Release, Midcontinent Independent System Operator (MISO), MISO Projects Risk of Insufficient Firm Generation Resources to Cover Peak Load in Summer Months (Apr. 28, 2022), https://www.misoenergy.org/about/media-center/miso-projects-risk-of-insufficient-firm-generation-resources-to-cover-peak-load-in-summer-months/

- The Electric Reliability Council of Texas (ERCOT) recently asked customers to reduce their electricity consumption due to resource adequacy concerns.[16]
- A utility in New Mexico has expressed concerns about resource adequacy in summer 2023, due to solar installation delays.[17]
- In Arizona, a utility warned that 1 GW of solar and storage that it had counted on being operational by summer 2024 to ensure resource adequacy are at risk of significant delays and cost increases.[18]

Electricity Prices

The war in Ukraine, in addition to the end of many COVID-19 restrictions, has led to significant increases in natural gas and coal prices that have in turn increased electricity prices. Average wholesale electricity prices since the start of the war have been roughly double those of the same months in 2021 (Figure 3).

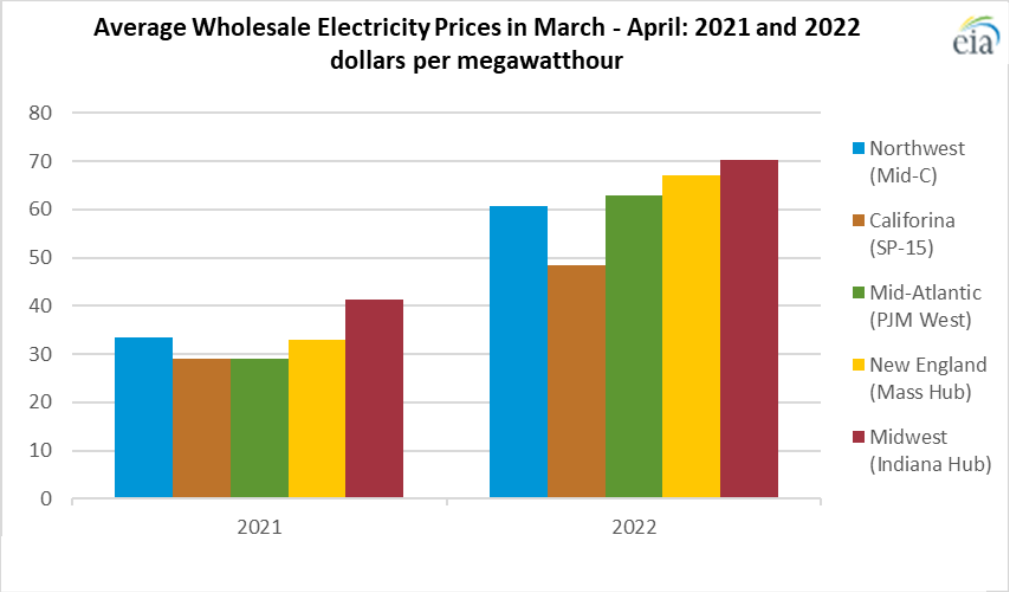

Figure 3: Average Wholesale Power Prices in March-April 2021 and 2022 at Selected Pricing Hubs[19]

Solar energy costs have plummeted over the last decade. Solar power was a cost-effective resource even before the recent increase in natural gas, coal, and wholesale electricity prices. As

[16] *See* Dahlia Faheid, After Six Power Plants Go Offline Amid Heat Wave, ERCOT Asks Texans to Conserve Energy Use, FORT WORTH STAR-TELEGRAM (May 13, 2022).
[17] *See* Public Service Company of New Mexico (PNM), *PNM Request for Proposals* (accessed May 23, 2022), https://www.pnm.com/rfp; *see also* Kevin Robinson-Avila, Solar Trade Dispute Impacts PNM Power Supplies, ALBUQUERQUE JOURNAL (May 11, 2022).
[18] *See* In the Matter of the Application of Salt River Project Agricultural Improvement and Power District, Docket No. L-00000B-21-0393-00197, Arizona Corporation Commission, at 6 (May 16, 2022), https://docket.images.azcc.gov/0000206818.pdf?i=1652784129087 .
[19] U.S. Energy Information Administration based on data from the Intercontinental Exchange.

shown in Figure 4, recent contract prices for utility-scale solar PV have averaged around $35/MWh.[20,21]

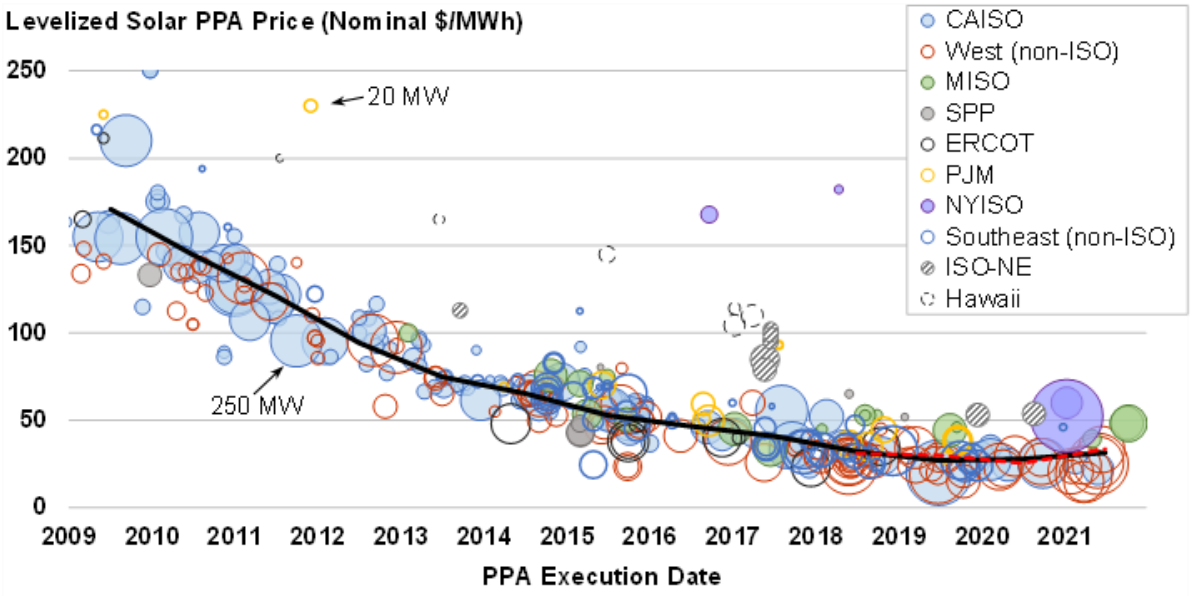

Figure 4: Solar PV Power Purchase Agreement (PPA) Prices Over Time. Each bubble reflects a separate contract, from a database assembled by Lawrence Berkeley National Laboratory. The black line reflects the generation-weighted average of these contract prices. The red dashed line is derived from data from Level10 Energy.[22, 23]

At these prices, solar power is a low-cost source of electricity supply. Delays and cancellations of solar projects are therefore likely to put upward inflationary pressure on retail electricity rates over time.

Energy Sector Jobs

The solar industry employed 317,000 Americans in 2020, [24] with 231,000 being majority-time in the solar industry.[25] Of those 231,000, the greatest share is in project installation and construction (Figure 5). Solar component manufacturing comprises 13% of the total, mostly related to the manufacture of mounting, racking, tracking, and ancillary equipment. Roughly

[20] *See* Level10 Energy, Q1 2022 PPA Price Index: North America (Apr. 13, 2022), https://www.leveltenenergy.com/post/leveltens-q1-2022-ppa-price-index-now-available-for-purchase.
[21] Updated data from Bolinger et al., Lawrence Berkeley National Laboratory, *Utility-Scale Solar, 2021 Edition* (Oct. 2021), https://emp.lbl.gov/utility-scale-solar/.
[22] Updated data from Bolinger et al., Lawrence Berkeley National Laboratory, *Utility-Scale Solar, 2021 Edition* (Oct. 2021), https://emp.lbl.gov/utility-scale-solar/.
[23] *See* Level10 Energy, Q1 2022 PPA Price Index: North America (Apr. 13, 2022), https://www.leveltenenergy.com/post/leveltens-q1-2022-ppa-price-index-now-available-for-purchase.
[24] U.S. Department of Energy. *United States Energy & Employment Report 2021: Key Findings*, at xvi (2021), https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20Executive%20Summary.pdf.
[25] U.S. Department of Energy. *United States Energy & Employment Report 2021*, at 50 (2021), https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20Main%20Body.pdf.

10% of solar workers are represented by a union, similar to the overall economy and to construction trades.

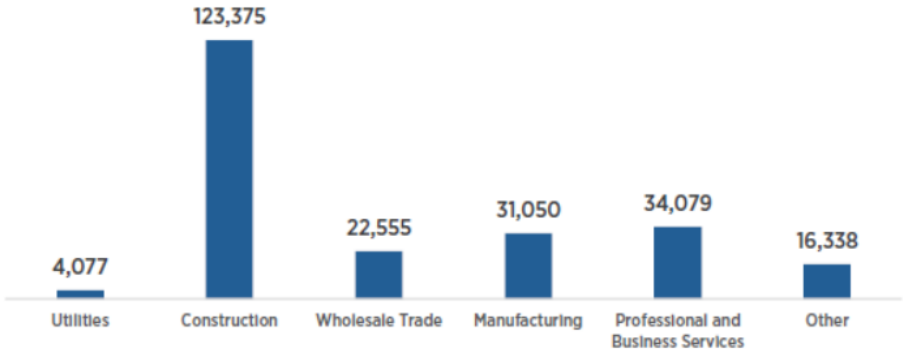

Figure 5: Solar Jobs in 2020, by Trade[26]

With a potential reduction in PV deployment of 12–15 GW over the next year, DOE estimates that more than 50,000 jobs are at risk, including more than 5,000 union jobs.[27] Project cancellations and delays, and related job losses, also threaten the nation's energy security and climate objectives. DOE's *Solar Futures Study* finds that as many as 500,000 to 1.5 million solar jobs would be needed by 2035 to meet decarbonization goals.[28]

A Bridge to the Future

As DOE recently detailed in its *Solar Photovoltaics: Supply Chain Deep Dive Assessment*,[29] the Administration is pursuing a concerted strategy to build domestic solar manufacturing capacity and reliable, sustainable, domestic solar supply chains. Among other tools, this includes financial support for domestic production of solar components and related incentives for solar deployment.

Today, the United States maintains 5.5 GW of crystalline-silicon module production capacity,[30] and most of the polysilicon, ingots, wafers, solar glass, and cells for those modules come from imports.[31] The United States also has approximately 2 GW of thin-film capacity.[32] Combined,

[26] *Id.*
[27] DOE's *United States Energy & Employment Report* indicates that 19.4% of solar workers in 2020 were related to utility-scale solar, or 45,000 jobs. With 10.74 GW of utility-scale solar installed in 2020, this equates to 4,180 jobs/GW. Assuming the 12 GW of at-risk solar is entirely utility-scale and applying 4,180 jobs/GW means that 50,000 workers are at risk. Assuming the solar unionization rate of 10% applies here, 5,000 union workers are at risk. Even more jobs would be at risk if using the 15 GW figure, or if some portion of the lost capacity came from the more job intensive distributed solar market segment.
[28] U.S. Department of Energy, *Solar Futures Study*, at 19 (2021), https://www.energy.gov/sites/default/files/2021-09/Solar Futures Study.pdf.
[29] U.S. Department of Energy. *Solar Photovoltaics: Supply Chain Deep Dive Assessment* (Feb. 24, 2022), https://www.energy.gov/sites/default/files/2022-02/Solar%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf.
[30] *Id.* at 49-50.
[31] *Id.* at 5-6.
[32] *Id.* at 71.

this totals 7.5 GW of solar module production capacity in the U.S. today. Since President Biden took office, solar companies have announced their intention to increase domestic module production capacity by 10 GW, which would more than double current capacity.[33]

These recent announcements demonstrate strong commercial interest in onshoring solar supply chains. But today's domestic module production capacity comprises less than one-fourth of near-term market demand and less than one-tenth[34] what would be required to meet the country's climate and energy security needs. Further, establishing a solar component manufacturing facility, whether polysilicon production, ingots, cells, wafers, modules, mounting structures or inverters, requires time—from one to four years.[35] Thus, meeting solar demand in the next several years will, by necessity, require both domestic and international supply chains.

New policy tools can help to build on the existing momentum to reestablish America's domestic solar manufacturing leadership, creating tens of thousands of jobs, and with benefits for the economy and the climate.

[33] Data compiled from public statements (on file with DOE).
[34] U.S. Department of Energy, *Solar Futures Study*, at 33 (2021), https://www.energy.gov/sites/default/files/2021-09/Solar Futures Study.pdf
[35] U.S. Department of Energy. *Solar Photovoltaics: Supply Chain Deep Dive Assessment*, at 12 (2022), https://www.energy.gov/sites/default/files/2022-02/Solar%20Energy%20Supply%20Chain%20Report%20-%20Final.pdf.

U.S. DEPARTMENT OF
ENERGY

June 2022