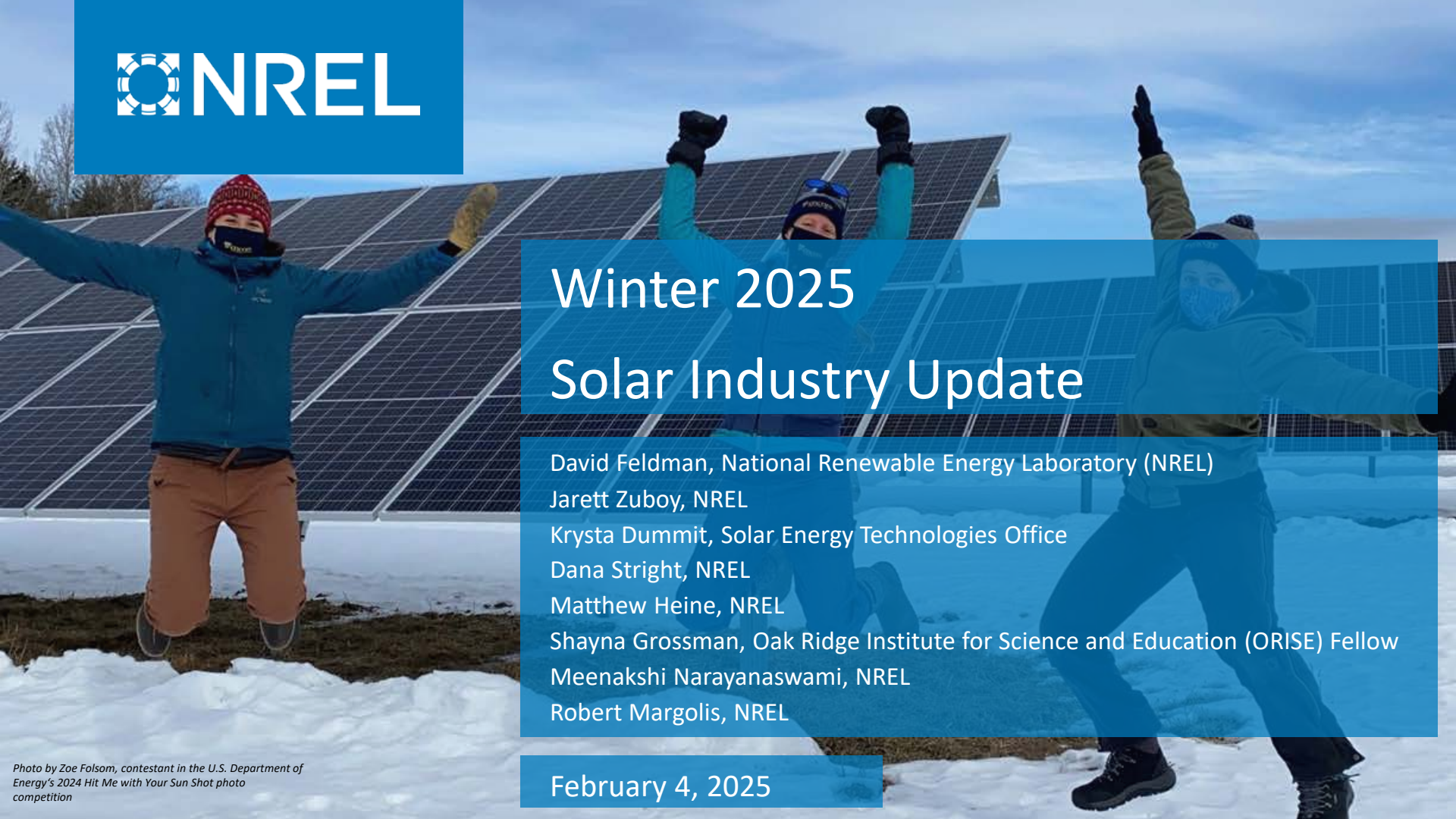

Winter 2025 Solar Industry Update

David Feldman, National Renewable Energy Laboratory (NREL)
Jarett Zuboy, NREL
Krysta Dummit, Solar Energy Technologies Office
Dana Stright, NREL
Matthew Heine, NREL
Shayna Grossman, Oak Ridge Institute for Science and Education (ORISE) Fellow
Meenakshi Narayanaswami, NREL
Robert Margolis, NREL

February 4, 2025

Photo by Zoe Folsom, contestant in the U.S. Department of Energy's 2024 Hit Me with Your Sun Shot photo competition

Agenda

1. Global Solar Deployment
2. U.S. PV Deployment
3. PV System Pricing
4. Global Manufacturing
5. Component Pricing
6. Market and Policy
7. U.S. PV Imports

Executive Summary

Global PV Deployment

- Analyst projections suggest about 460 GW_{dc} of PV were installed globally in 2024, up 14% from 2023—China, alone, installed more than 270 GW_{dc}. More than 500 GW_{dc} of PV are expected to be installed in 2025.
- At the end of 2024, China and the U.S. had collectively installed more than 1 TW_{dc} of PV.
- In 2024, wind and solar generated more electricity in the EU than coal and gas.

U.S. PV Deployment

- In the first 9 months of 2024, the United States installed 21.0 GW_{ac} of solar capacity (30.4 GW_{dc} according to SEIA)—a 37% increase from the first 9 months of 2023.
- Based on preliminary data, the United States installed approximately 36 GW_{ac} of PV (~44 GW_{dc}).
- The United States installed approximately 25.0 GWh (8.3 GW_{ac}) of energy storage onto the electric grid in the first 9 months of 2024.
- Since California NEM 3.0, stand-alone PV applications fell from 14,600/month to 3,300/month (–77%), while average PV + storage applications increased from 1,800/month to 3,700/month over the same periods (+110%).

PV System and Component Pricing

- Global module spot prices fell 22% in 2024, reaching \$0.09/W_{dc} in December.
- In 2024, global spot prices fell 43% for wafers and 27% for cells.
- Global polysilicon spot prices fell 36% in 2024, from \$8.72/kg to \$5.54/kg.
- In Q3 2024, the average U.S. module price (\$0.29/W_{dc}) was down 6% q/q and down 12% y/y, and was at a 190% premium over the global spot price.
- Analysts saw U.S. module price increases toward the end of 2024 due to higher-than-expected antidumping and countervailing duties (AD/CVD) cash deposits.
- In Q3 2024, the average imported PV cell price was \$0.12/W_{dc}.

A list of acronyms and abbreviations is available at the end of the presentation.

Executive Summary

Global Manufacturing

- In 2024, more than 60 GW_{dc} of solar manufacturing capacity were gained across the supply chain, with more than 35 GW of that from module manufacturing. The United States now has enough domestic module manufacturing capacity to meet its expected deployment.
- In Q3 2024, U.S. PV module production grew by 35% q/q and 146% y/y to about 3 GW_{dc}—7 GW_{dc} for the first 9 months of 2024.
- Between 2021 and 2024, India's domestic module production increased 4-fold, to about 15 GW_{dc}, while module production capacity increased 3-fold, to about 30 GW_{dc}.

U.S. PV Imports

- In Q4 2024, module imports fell 50% q/q, hitting only 7.7 GW_{dc}, 56 GW_{dc} for the full year 2024—approximately the same as 2023. Conversely, the U.S. imported 4.4 GW_{dc} of PV cells in Q4 2024 (+5% q/q), or 13.8 GW_{dc} for the full year 2024 (3.7X y/y).
- In Q4 2024, the U.S. Department of Commerce (DOC) issued a preliminary AD/CVD on c-Si panels and cells produced in Vietnam, Malaysia, Thailand, and Cambodia.
- According to U.S. Customs and Border Protection (CBP) Commodity Status Reports, the 12.5 GW_{dc} tariff rate quota (TRQ) was reached on 12/30/24, so all PV cells imported after that date, and before February 7, received a 14.25% tariff.

A list of acronyms and abbreviations is available at the end of the presentation.

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1. **Global Solar Deployment**
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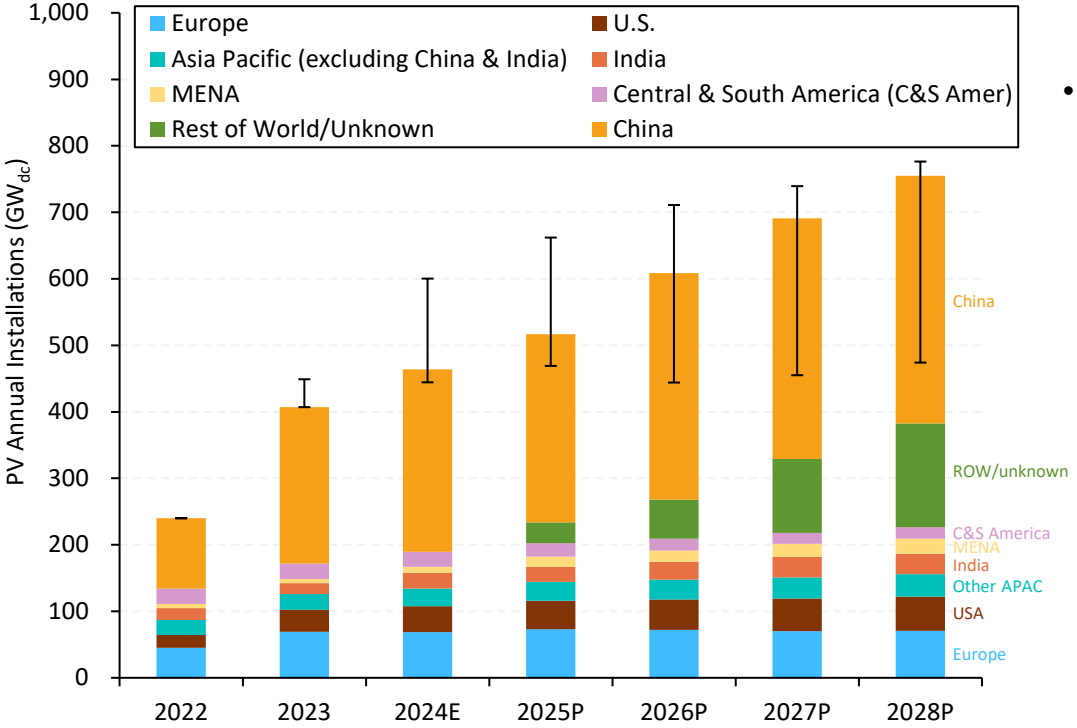
- **Analyst projections suggest about 460 GW_{dc} of PV were installed globally in 2024, up 14% from 2023—China, alone, installed more than 270 GW_{dc}. More than 500 GW_{dc} of PV installations are expected in 2025.**
- **At the end of 2024, China and the United States had collectively installed more than 1 TW_{dc} of PV.**
- **In 2024, wind and solar generated more electricity in the EU than coal and gas.**

Annual Global PV Deployment

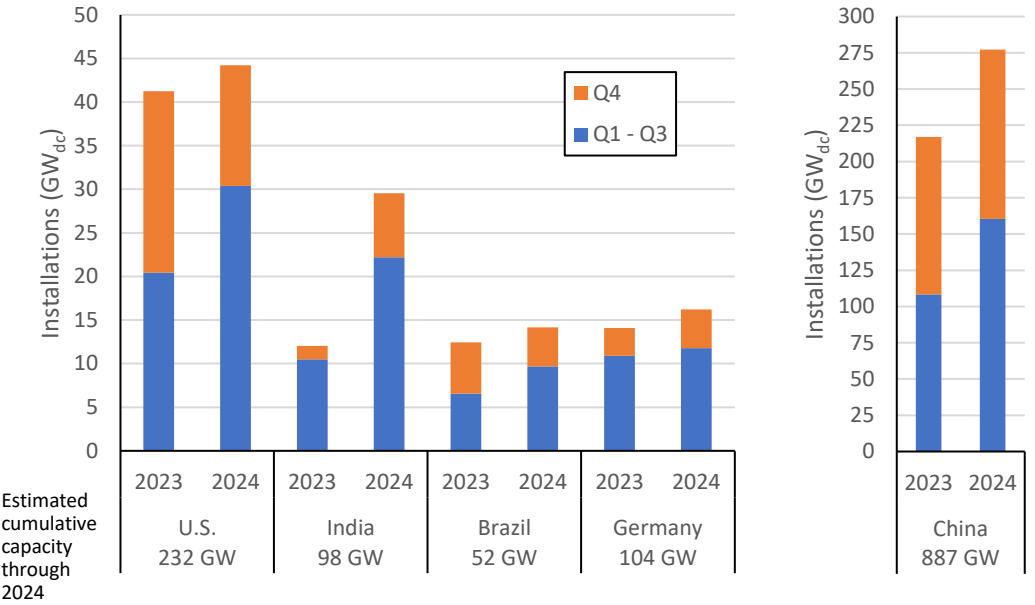


- The median of several analyst projections suggests about 460 GW_{dc} of PV were installed globally in 2024, up 14% from 2023.
- Projections suggest continued increases in annual global installations of 10%–20% per year, reaching a median of 760 GW_{dc} in 2028.
- Among analysts covered in the Summer 2024 edition of the *Solar Industry Update*, global projections increased in this edition, e.g., by 1%–6% for 2026 projections.

	Total share, 2025–2028	Change in annual installs, 2025–2028
China	53%	+32%
Europe	11%	–3%
USA	7%	+21%
Other APAC	5%	+19%
India	4%	+33%
C&S Amer	3%	–12%
MENA	3%	+47%

Notes: E = estimated; P = projection. Bar totals represent median global projections across analysts who provide a global projection. Error bars represent high and low global projections. Regional bar segments represent medians of all available regional projections. Where regional medians do not sum to global medians, the differences are reconciled by adjusting the Rest of World/Unknown segments so that the correct global median values are retained. **Sources**: BloombergNEF (BNEF), 4Q 2024 Global PV Market Outlook, November 2024; Goldman Sachs Equity Research, America's Clean Technology: Solar, December 2024; IEA, Snapshot of Global PV Markets, April 2024; Wood Mackenzie, Q4 2024 Solar Executive Briefing, October 2024.

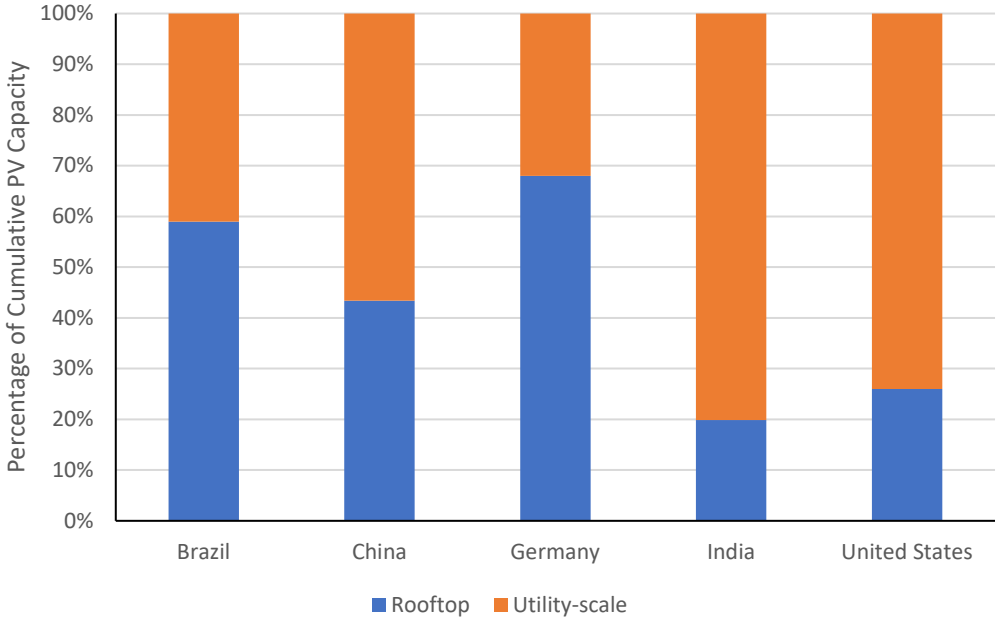
International Q1–Q3 & Full-Year 2024 Installations



- In the first 9 months of 2024, PV installations increased significantly (y/y) in India (111%), the U.S. (49%), China (48%), Brazil (47%), and Germany (8%).
- For the full year 2024, China installed ~277 GW_{dc}, the United States installed ~44 GW_{dc}, India installed ~30 GW_{dc}, Germany installed ~16 GW_{dc}, and Brazil installed ~14 GW_{dc}—all records.
  - Analysts report countries benefiting from falling module prices and robust rooftop PV markets.
  - India also benefited from a booming off-grid PV market, installing more than 1.5 GW_{dc}—a 200% increase y/y.
  - ABSolar reported some issues with the Brazilian market: electricity distributors refused to connect some solar systems (alleging reversal of electricity flow); utility-scale PV projects were curtailed; and, in November 2024, the Brazilian government increased the import tax on PV modules from 9.6% to 25%.
- At the end of December, these countries together had cumulatively installed around 1.37 TW_{dc} of PV.

Sources: China Daily, Solar power installations hit new highs, December 2024; Mercom India, India Adds an Unprecedented 16 GW Solar Capacity in 9M 2024, November 2024; PV Magazine, Brazil added 6.8 GW of new PV in H1, August 2023; PV Magazine, China adds 160 GW in January-September period, October 2024; PV Magazine, India sets new record with 17.4 GW of solar in first nine months of 2024, November 2024; PV Magazine, Germany deploys 16.2 GW of solar in 2024, January 2025; PV Magazine, India adds record 24.5 GW of solar in 2024, January 2025; PV Magazine, PV capacity reaches 52 GW in Brazil, January 2025; PVTech, India installs record 24.5GW solar PV capacity in 2024, January 2025; Taiyang News, Brazil Expanded Solar PV Installed Capacity By Over 490 MW In Sept. 2024, October 2024; Wood Mackenzie/SEIA, U.S. Solar Market Insight: Q4 2024, 2024. Full-year U.S. data derived from EIA, Electric Power Monthly, and EIA-860 (January 2025); small-scale PV data are through November 2024, so were adjusted to account for the full year by multiplying the value by 12/11.

Distributed/Centralized PV Market Share

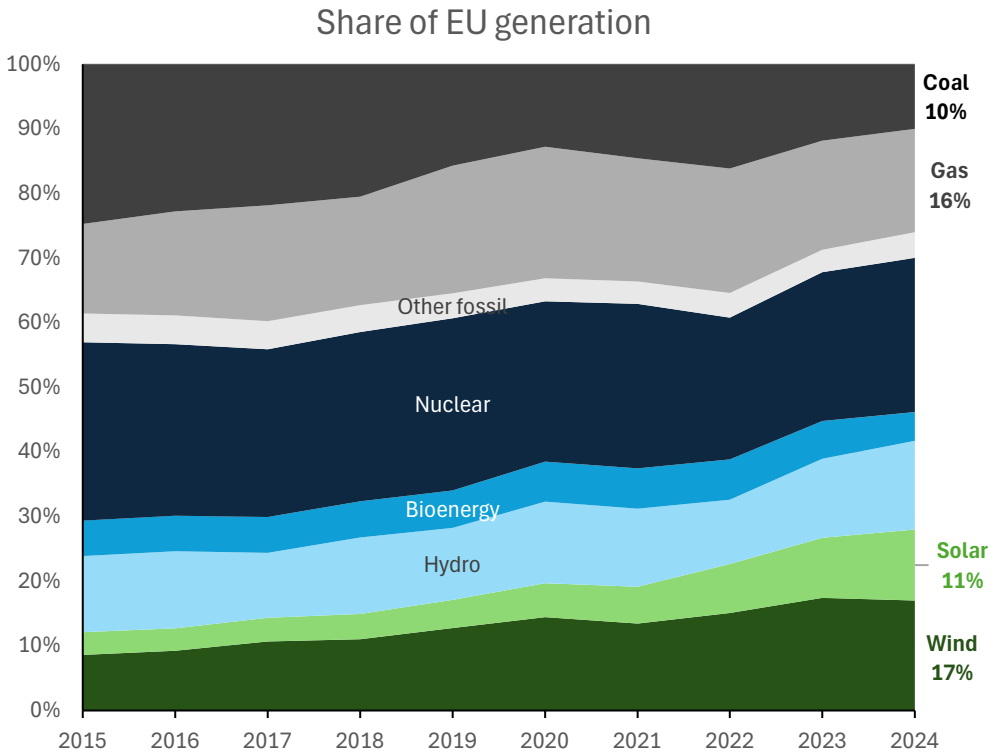


- Through 2024[a], distributed PV installations have had a varying effect on driving PV capacity in leading global markets.
- India and the United States have relied more heavily on large-scale, centralized PV systems, while Brazil and Germany have relied more heavily on distributed (typically, rooftop) applications.

[a] Cumulative data for China and the United States through mid-2024.

Sources: Energetica, Global PV Capacity to Hit 520 GW by 2024, September 2024; PV Magazine, PV capacity reaches 52 GW in Brazil, January 2025; PVTech, India installs record 24.5GW solar PV capacity in 2024, January 2025; Taiyang News, Germany Exceeds 100 GW Solar PV Capacity Milestone, Says BSW-Solar, January 2025; Wood Mackenzie/SEIA, U.S. Solar Market Insight: Q4 2024, 2024.

EU Electricity Shares Continue to Change in 2024

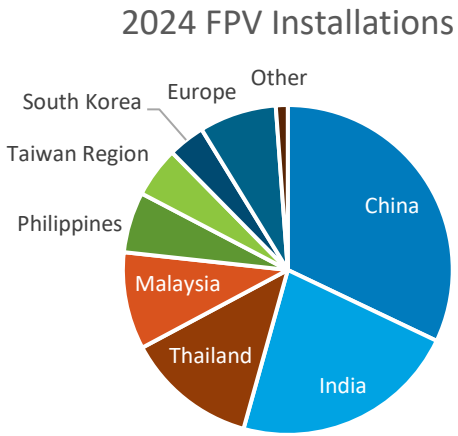


- Based on initial EU data from Ember, solar was the fastest-growing power source in 2024 in the EU, surpassing coal in electricity generation.
  - The share of coal power in more than half of EU countries is below 5%.
- EU installed solar capacity reached 338 GW_{dc} in 2024, on pace to hit its 2025 target of 400 GW_{dc}.
  - 16 countries generated more than 10% of their power from solar.

Source: Ember, European Electricity Review 2025, January 2025.

Floating PV (FPV)

- Wood Mackenzie reports that approximately 1.7 GW_{dc} of FPV were installed in 2024, bringing cumulative installations to 9.8 GW_{dc}.
  - 92% were in Asia, and the rest were overwhelmingly in Europe.
  - The United States installed 1 MW_{dc}, bringing cumulative FPV installations to 41 MW_{dc}.
- In 2024, China installed a 400-MW_{dc} offshore FPV project.



Sources: Canary Media, Floating solar has massive potential in the US, January 2025; Solar Energy, Floating photovoltaic technical potential: A novel geospatial approach on federally controlled reservoirs in the United States, February 2025; Wood Mackenzie, Floating solar landscape 2024, November 2024.

- Wood Mackenzie reports that 2024 FPV projects were delayed by clearance requirements and inconsistent technical standards (FPV module standards have not been developed yet).
- There is increased interest in FPV-hydro hybrid projects and offshore FPV projects (with potential colocation with wind).
  - Italy is developing a 120-MW_{dc} offshore FPV project.
- A recent journal article, written by NREL analysts, estimated that there is 0.9 TW_{dc} – 1.0 TW_{dc} of FPV potential on suitable areas in federally controlled reservoirs in the United States (including those with hydropower).
  - Results restricted certain low-temperature areas (due to ice flows); high current, low depth, or proximity to dams, among other factors.
  - More than half the potential sites could host a PV system between 10 MW_{dc} and 1 GW_{dc}—there are currently no FPV U.S. projects above 10 MW_{dc}.
  - Study did not consider permitting, transmission, or cost premiums.
- FPV projects minimize land use, reduce evaporation, and can improve PV performance by as much as 15% through water-cooled panels.

Ivanpah CSP Plant To Close 13 Years Early

- The 377-MW, three-tower, Ivanpah CSP plant, which opened on the California/Nevada border in 2014 with a DOE loan guarantee as the largest CSP plant in the world, may begin to close in 2026—13 years before its PPA contracts are set to expire.
- In 2021, the CPUC ordered investor-owned utilities to evaluate their energy supply portfolios. PG&E, which purchases energy from two of the towers, agreed in January with project owner NRG and DOE to terminate the contracts. If approved by the CPUC, the plants would be deactivated and decommissioned.
    - SCE, which purchases energy from the third tower, is in discussions with DOE to buy out its contract as well.
    - Utilities determined they could save customers money by terminating the PPAs, which were signed in 2009 for a price of $174/MWh.
    - PG&E also has a PPA with the 250-MW_{ac}, each, parabolic trough Mojave and Genesis CSP projects, which both have higher PPA rates. The remaining trough plant funded through the DOE loan program is the 250-MW_{ac} Solana plant, which has a PPA with APS.
- The project has been criticized by environmental groups since it began development for its environmental impact due to its impact on birds, tortoises, and native plants. The plant also experienced lower-than-expected production, particularly during the longer-than-expected ramp-up.
- In 2019, NV Energy terminated the PPA for the other CSP tower project, Tonopah/Crescent Dunes, to receive a DOE loan guarantee, and the plant shuttered in 2020.
    - If the three Ivanpah projects shutter, U.S. CSP capacity would fall from a previous peak of 1.8 GW_{ac} to 1.1 GW_{ac} (when accounting for the closure of the SEGS and Tonopah facilities as well).

Concentrating Solar Power Update

- The Chinese province of Qinghai recently set the feed-in-tariff rate for CSP projects at 7.5 cents/kWh (or 0.55 yuan/kWh)—almost 7% lower than the target 2025 goal set by China in 2012.
- In January, the Chinese province of Xinjiang connected the world's largest linear Fresnel CSP project, with a capacity of 100 MW_{ac}, to the state's electrical grid; it is paired with a 900-MW_{ac} PV plant.
  - There are currently 30 CSP plants under construction in China, with a combined capacity of 3 GW.
- An Australian startup, FPR Energy, spun out of Australia's national laboratory CSIRO, has raised $10M to commercialize particle-based concentrated solar thermal technology, which uses ceramic particles to absorb and transfer CSP. The technology increases temperatures from 500°C to 800°C, as well as overcoming some of the limitations of traditional heat transfer fluids.
  - The company is planning a 50-MW_{ac}, 16-hour storage facility to demonstrate the technology.
- In December, U.S. developer Glasspoint announced the demonstration phase of its $1.5B Saudi project, which will use its glasshouse CSP technology for aluminum processing.

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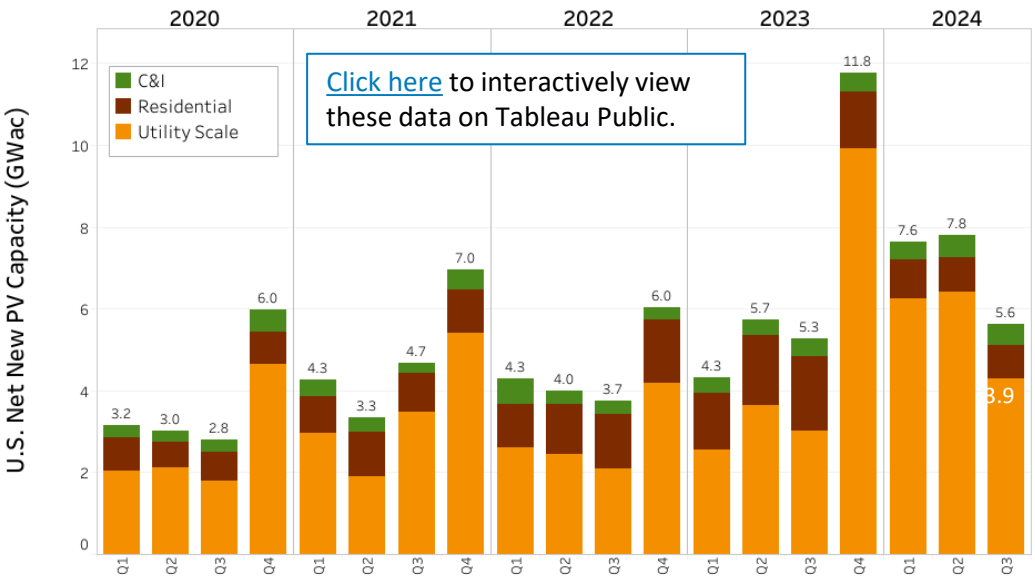
- **In the first 9 months of 2024, the United States installed 21.0 GW_{ac} of solar capacity (30.4 GW_{dc} according to SEIA)—a 37% increase from the first 9 months of 2023.**
- **Based on preliminary data, the United States installed approximately 36 GW_{ac} of PV (~44 GW_{dc}) in 2024.**
- **The United States installed approximately 25.0 GWh (8.3 GW_{ac}) of energy storage onto the electric grid in the first 9 months of 2024.**
- **Since California NEM 3.0, stand-alone PV applications fell from 14,600/month to 3,300/month (–77%), while average PV + storage applications increased from 1,800/month to 3,700/month over the same periods (+110%).**

U.S. Installation Breakdown Quarterly: EIA (GW_{ac})

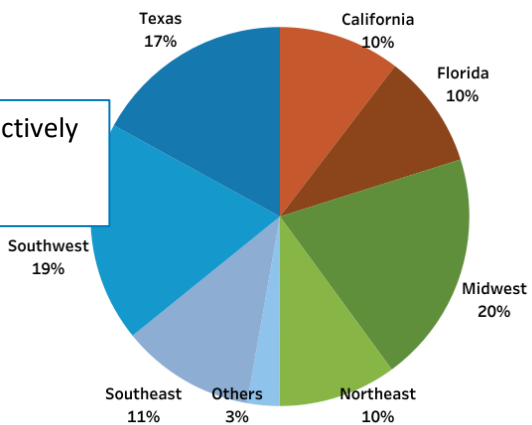
- In the first 9 months of 2024, the United States installed 21.0 GW_{ac} of solar capacity (30.4 GW_{dc} according to SEIA)—a 37% increase from the first 9 months of 2023.
- Based on preliminary data, the United States installed approximately 36 GW_{ac} of PV (~44 GW_{dc}) in 2024.



Click here to interactively view these data on Tableau Public.

- Residential (2.6 GW_{ac}) was down 46%; however, utility-scale (17.0 GW_{ac}) and C&I (1.4 GW_{ac}) were up 84% and 23%, respectively.
- EIA reported that Texas, Florida, and California continued to lead the way; however, they represented a much smaller percentage of the total market (37%) than in past years.
  - Six states installed more than 1 GW_{ac} in the first 9 months of 2024, eight more states installed more than 500 MW_{ac}, and another twenty-one more states each installed more than 100 MW_{ac}.

Q1–Q3 2024 PV Installations by Region (21 GW_{ac})



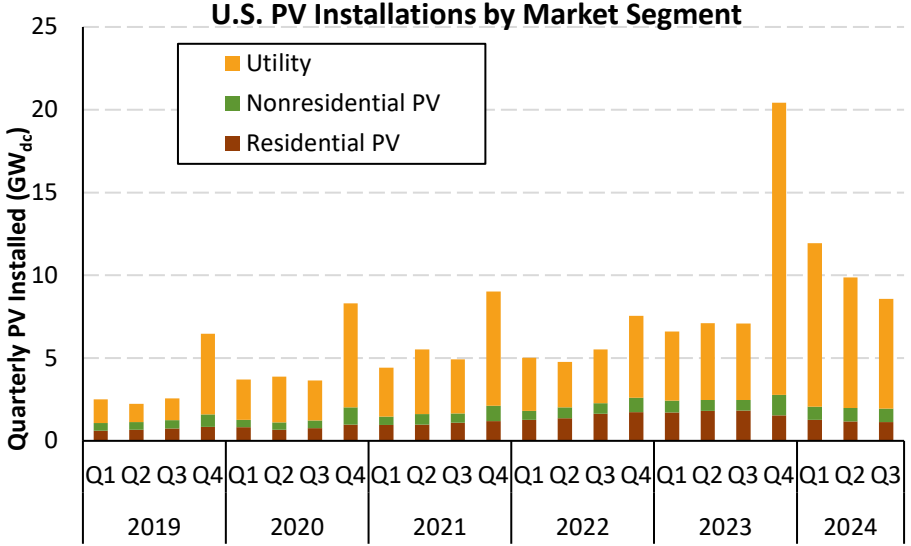
Click here to interactively view these data on Tableau Public.

Note: EIA reports values in W_{ac}, which is standard for utilities. The solar industry has traditionally reported in W_{dc}. See the next slide for values reported in W_{dc}.
Sources: EIA, Electric Power Monthly, forms EIA-023, EIA-826, and EIA-861 (January 2025).

U.S. Installation Breakdown Quarterly: SEIA (GW_{dc})

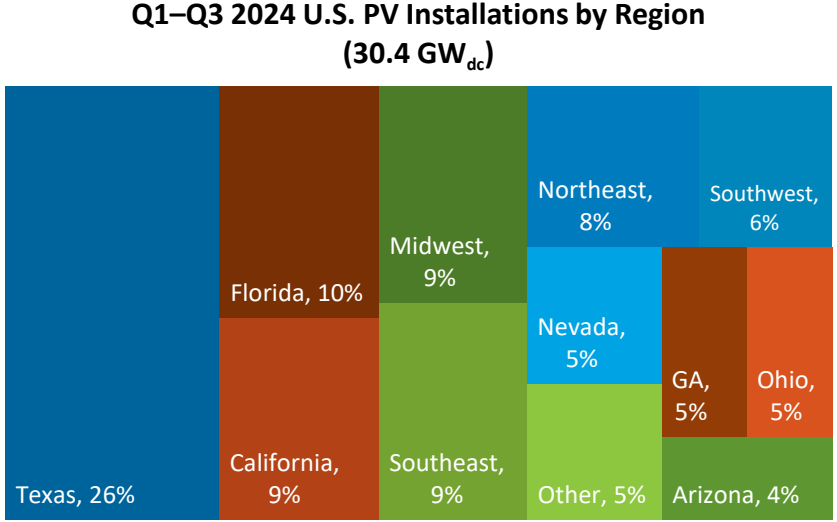
Unlike the previous slide, these values are in GW_{dc}—not GW_{ac}.

- Wood Mackenzie/SEIA reports 30.4 GW_{dc} of PV installations in the nine months of 2024—an increase of 46% y/y.
  - Over this period, utility-scale and nonresidential PV installations increased 81% and 20%, respectively, while the residential PV sector shrank by 1/3 y/y.



Note: Midwest excludes Ohio; Southeast excludes Florida and Georgia (GA); Southwest excludes Arizona, Texas, and California. **Source:** Wood Mackenzie/SEIA, U.S. Solar Market Insight: Q4 2024, 2024.

- The six states listed in the figure below installed more than 1 GW_{dc} of PV in the first 9 months of the year, with Florida, Texas, and California representing 45% of total installations.
- Although 47% of the drop in residential PV installations occurred in California, 75% of states and territories shrank, y/y, in the first 9 months of 2024.

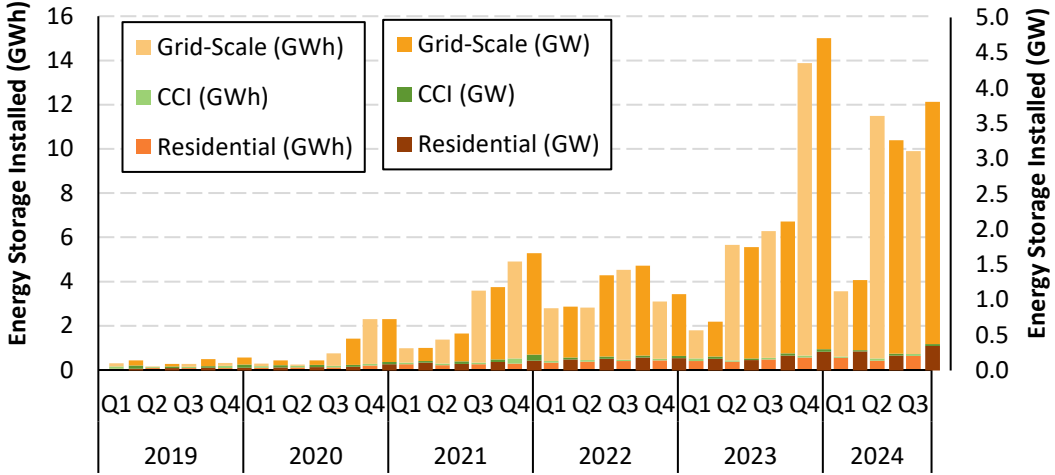


U.S. Energy Storage Installations by Market Segment

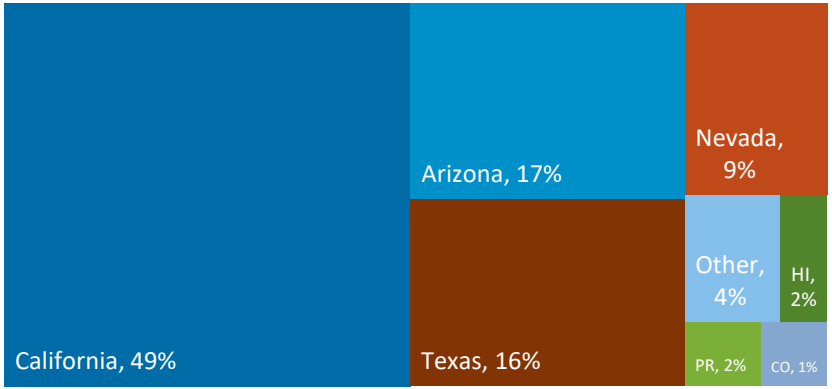
- The United States installed approximately 25.0 GWh (8.3 GW_{ac}) of energy storage onto the electric grid in the first 9 months of 2024.

- The majority of grid-scale installations were in four states: California, Arizona, Texas, and Nevada.
- California residential PV attachment rates in Q3 2024 were 75% for TPO and 52% for customer-owned systems (70% overall).
- California dominates the U.S. residential storage market, but other states, such as Arizona and North Carolina, are growing quickly, as bill credit rates reduce.

U.S. Energy Storage Installations by Market Segment



Q1–Q3 2024 U.S. Energy Storage Installations by Region (25.0 GWh)

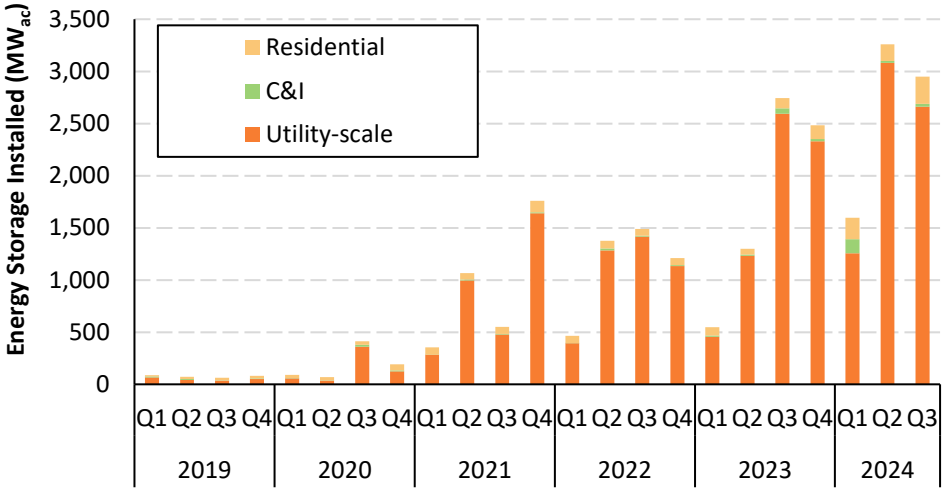


Note: CO = Colorado; HI = Hawaii; PR = Puerto Rico. "Grid-scale" refers to all projects deployed on the utility side of the meter, regardless of size or ownership; "CCI" refers to community-scale, commercial, and industrial. **Source:** Wood Mackenzie Power & Renewables and Energy Storage Association, U.S. Energy Storage Monitor: Q3 2024, 2024.

U.S. Energy Storage Installations by Market Segment (EIA)

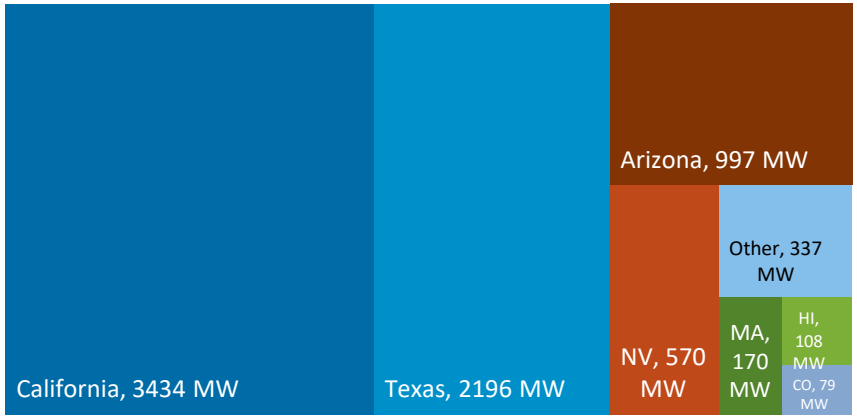
- EIA reports that the United States installed approximately 7.9 GW_{ac} of energy storage onto the electric grid in the first 9 months of 2024—up 70% y/y.
- Q3 2024 was the second-highest on record, just behind Q2 2024, because of high utility-scale BESS installations.

U.S. Energy Storage Installations by Market Segment



- California represented 44% of battery installations in the first 9 months of 2024, followed by Texas (28%) and Arizona (13%).
- Six states installed more than 100 MW_{ac} of storage in the first 9 months of 2024.

Q1–Q3 2024 U.S. Energy Storage Installations by Region (7.9 GW)



Note: CO = Colorado; HI = Hawaii; MA = Massachusetts; MS = Mississippi; NM = New Mexico; NV = Nevada. **Sources:** EIA Form 860M; EIA Form 861M.

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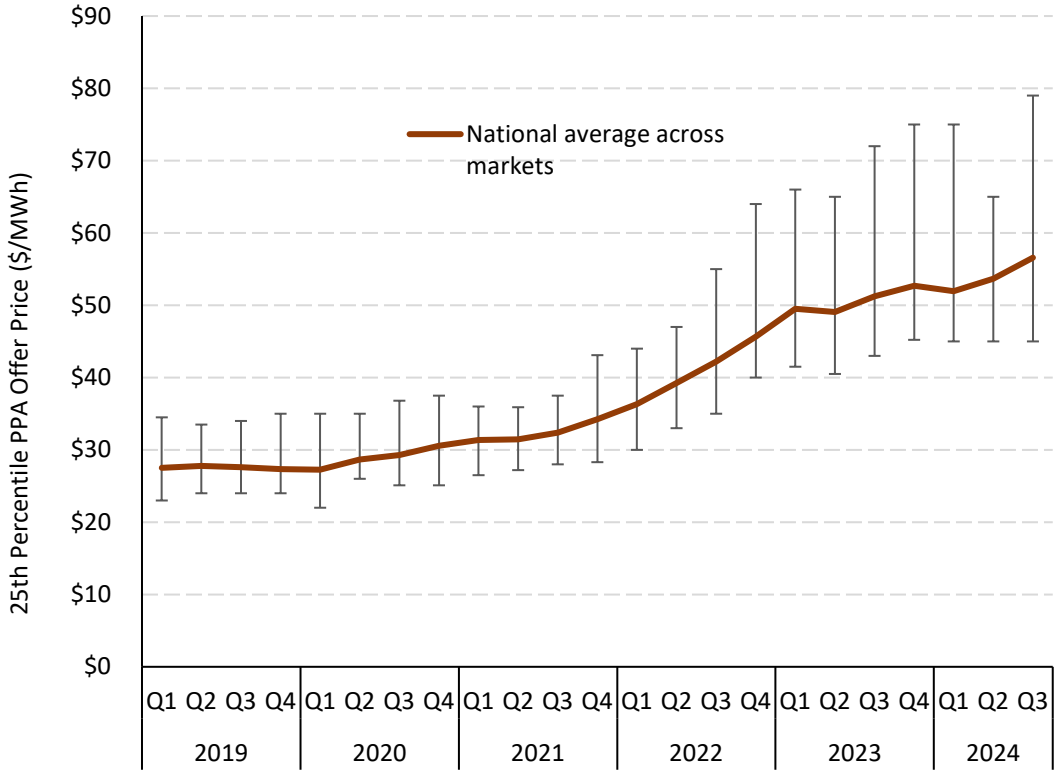
- **In 2024, the median installed price of distributed PV systems in Arizona, California, Massachusetts, and New York decreased for systems below 100 kW_{dc} but increased for systems larger than 100 kW_{dc}.**
- **In 2024, residential PV-plus-storage systems in California had a median system price of $3,012/kWh of battery, $5,694/$kW_{ac}$ of battery, and $5,133/$kW_{dc}$ of PV.**
- **LevelTen reports that in Q3 2024 the U.S. utility-scale photovoltaic PPA prices increased 5.4% q/q and 10.4% y/y.**

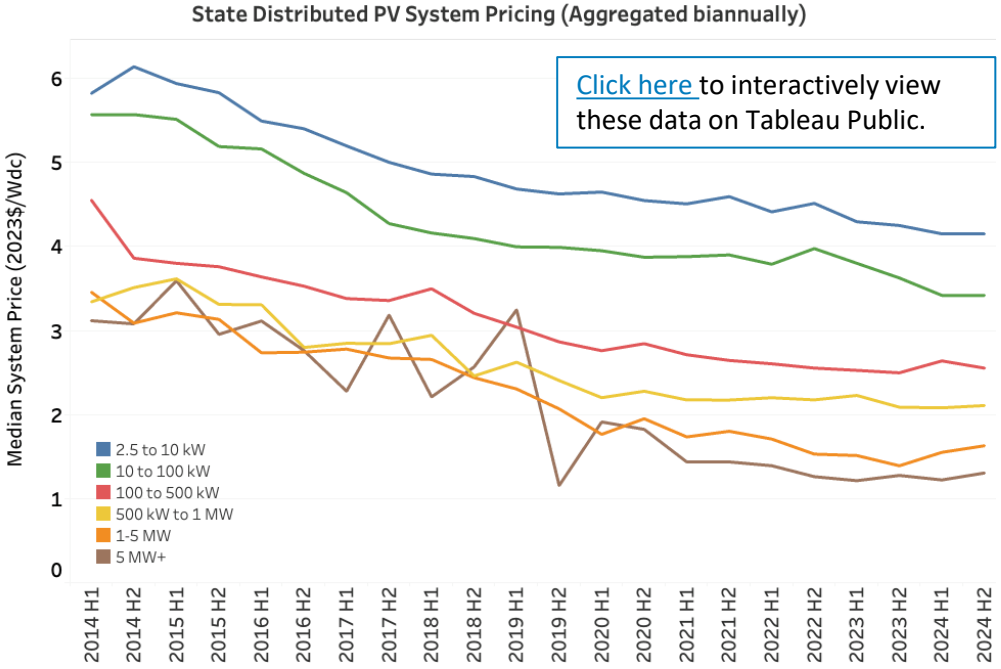
U.S. Solar PPA Pricing (LevelTen)



- LevelTen reports that, in Q3 2024, the U.S. utility-scale photovoltaic PPA prices increased 5.4% q/q and 10.4% y/y.
- LevelTen reports that the increase in PPA prices reflects the ongoing challenges developers face of tariffs on imported products as well as premiums on domestically produced products.
  - The increase in pricing may also reflect a growing amount of bundled storage with solar; however, LevelTen has not made that attribution.
- LevelTen reported that ERCOT was the lowest-price market in Q3 2024 because of land availability and easy permitting for solar. However, in Q3 2024, pricing increased in all markets LevelTen covers.

Source: LevelTen, PPA Price Index.

Distributed PV System Pricing From Select States



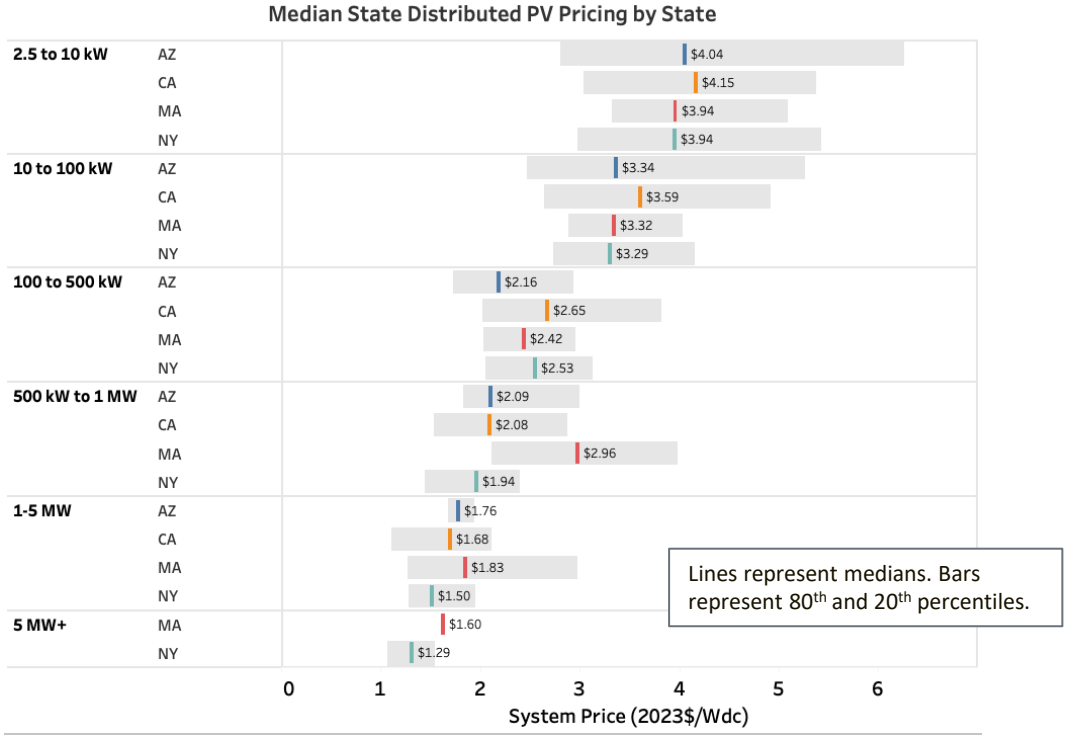
- From H2 2023 to H2 2024, the median reported stand-alone (no energy storage) distributed PV system price—**in 2023 (inflation-adjusted) dollars**—changed across Arizona, California, Massachusetts, and New York.
- Adjusting for inflation reveals the generally decreasing distributed PV system price trends in real dollars over the past several years of economic volatility.

System Size	Price H2 2024 ($/W$_{dc}$)	Change 2023–2024
2.5–10 kW$_{dc}$	$4.15	–2%
10–100 kW$_{dc}$	$3.42	–6%
100–500 kW$_{dc}$	$2.55	+2%
0.5–1 MW$_{dc}$	$2.11	+1%
1–5 MW$_{dc}$	$1.63	+17%
5 MW$_{dc}$+	$1.30	+2%

2024 MW data: Arizona (183), California (701), Massachusetts (37.4), New York (892).
Note: System prices above $10/W and below $0.75/W were removed from the dataset. The volatility in median system price among the largest systems is because of the relatively small number of systems deployed each year.
Sources: Arizona Goes Solar, January 10, 2025; California Distributed Generation, December 18, 2024; Massachusetts Lists of Qualified Generation Units, December 11, 2024; Solar Electric Programs Reported by NYSERDA, December 31, 2024.

Distributed PV System Pricing From Select States, 2024

Click here to interactively view these data on Tableau Public.

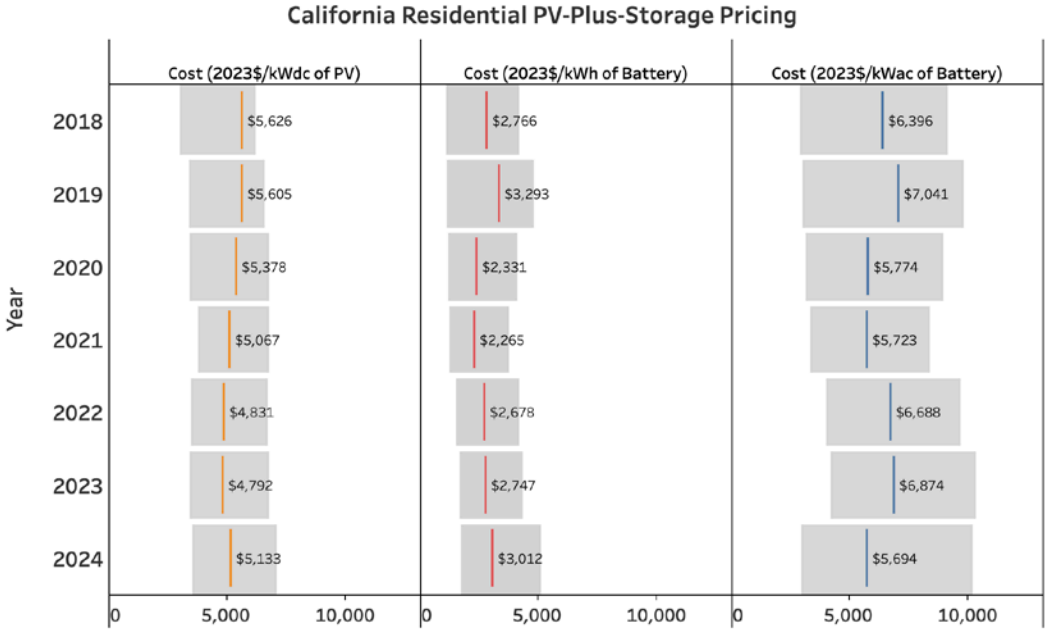


- In addition to price differences based on system size, there is variation in the price of stand-alone (no energy storage) distributed PV systems between states and within individual markets.
- Dollar-per-watt prices generally decrease as system size increases.
- For systems of 2.5–10 kW, median price changes varied between 2023 and 2024:
  - –8% in Arizona, –2% in California, –2% in Massachusetts, –8% in New York.

2024 MW data: Arizona (183), California (701), Massachusetts (37.4), New York (892).
Note: System prices above $10/W and below $0.75/W were removed from the dataset.
Sources: Arizona Goes Solar, January 10, 2025; California Distributed Generation, December 18, 2024; Massachusetts Lists of Qualified Generation Units, December 11, 2024; Solar Electric Programs Reported by NYSERDA, December 31, 2024.

Residential PV + Storage Pricing in California

Click here to interactively view these data on Tableau Public.



Lines represent medians. Bars represent 80th to 20th percentiles.

- In 2024, residential PV-plus-storage systems in California had a median system price of \$3,012/kWh of battery, \$5,694/kW_{ac} of battery, and \$5,133/kW_{dc} of PV.
  - The cost per kW_{ac} of battery fell 17% between 2023 and 2024, while the cost per kWh of battery rose 10% and the cost per kW_{dc} of PV rose 7%.
  - Most of these systems offer 2–3 hours of storage.

The data are filtered to residential rooftop PV systems between 3 and 30 kW_{dc} with a cost between 0.75 and 20 2023\$/kW_{dc}.
Source: California Distributed Generation, December 18, 2024.

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1. Global Solar Deployment
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3. PV System Pricing
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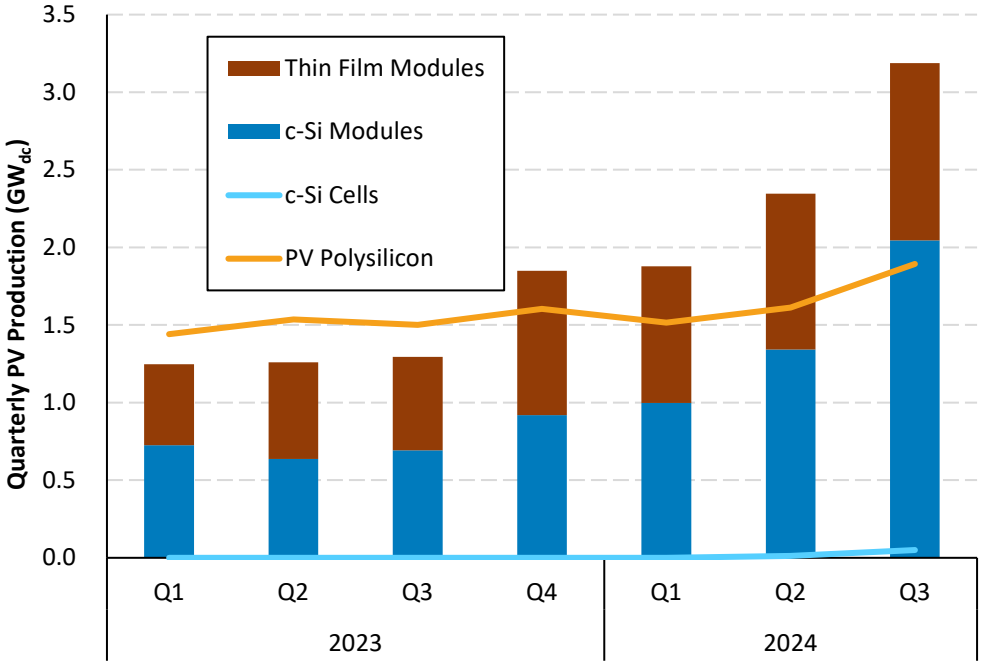
- **In 2024, more than 60 GW_{dc} of solar manufacturing capacity was gained across the supply chain, with more than 35 GW_{dc} of that from module manufacturing. The United States now has enough domestic module manufacturing capacity to meet its expected deployment.**
- **In Q3 2024, U.S. PV module production grew by 35% q/q and 146% y/y, to about 3 GW_{dc}–7 GW_{dc} for the first 9 months of 2024.**
- **Between 2021 and 2024, India's domestic module production increased 4-fold, to about 15 GW_{dc}, while module production capacity increased 3-fold, to about 30 GW_{dc}.**

U.S. PV Manufacturing

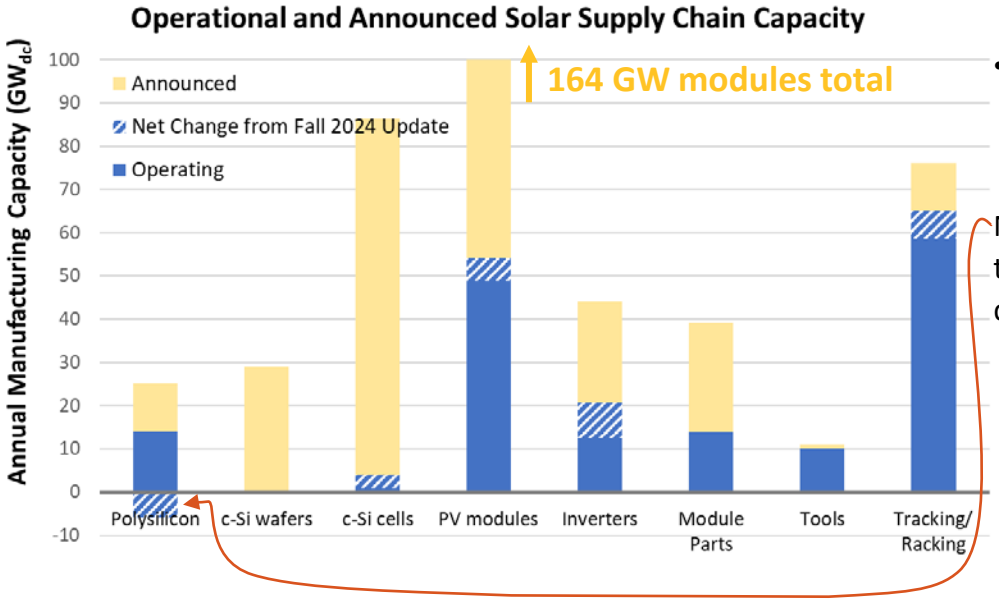


- In Q3 2024, U.S. PV module production grew by 35%, q/q, and 146%, y/y.
  - c-Si module production experienced the highest growth levels, as its ~25 GW_{dc} of capacity starts to ramp.
- Polysilicon production for PV also ramped 26% y/y, and domestic c-Si production began for the first time this decade again in Q2/Q3 2024.

Sources: Values represent the average of: PVTech: "PV Manufacturing & Technology Quarterly Report—Release 34—August 2024"; Wood Mackenzie/SEIA, U.S. Solar Market Insight: Q3 2024, 2024.

Domestic Manufacturing Growth

In 2024, the supply chain gained more than 60 GW_{dc} of solar manufacturing capacity—more than 35 GW_{dc} of that from module manufacturing.* The United States now has enough domestic module manufacturing capacity to meet its expected deployment.

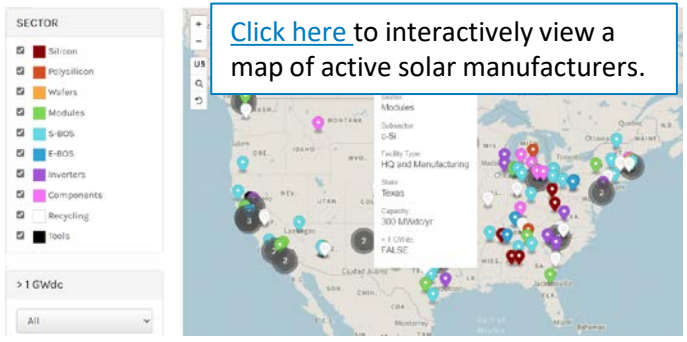


Sources: U.S. Census Bureau USA Trade Online and internal DOE tracking of public announcements as of January 30, 2025. *Not all announcements include facility locations, job, operating capacity, or investment numbers.

Several large facilities have hit big milestones in the last several months:

- **Bila Solar**: Module production in Indiana began in December for their 1-GW_{dc} facility.
- **Waaree Energies** and **FREYR Battery**: Module production began at their new facilities in Texas (1.6-GW_{dc} and 5-GW_{dc}, respectively).
- **ES Foundry**: Cell production in South Carolina began in January for their 3-GW facility. They also secured their first multi-GW multi-year contract with a solar module manufacturer.
- **Toshiba Mitsubishi-Electric Industrial Systems Corporation**: Utility-scale inverter production in Texas began in November at their 9-GW_{ac} facility.

Notably, however, **REC Silicon** halted production of polysilicon at their 6-GW facility in Moses Lake, WA, after persistent product quality issues. They will now only be producing silane gas there.



Domestic Manufacturing Announcements

For more detailed information on domestic solar manufacturing announcements, including supply chain segment, date of announcement, and whether the facility is operational, check out our map on Tableau Public!

Click here to interactively view a map of manufacturing announcements.

Despite headwinds noted by companies—including political uncertainty and cost declines—recent announcements span the supply chain, including:

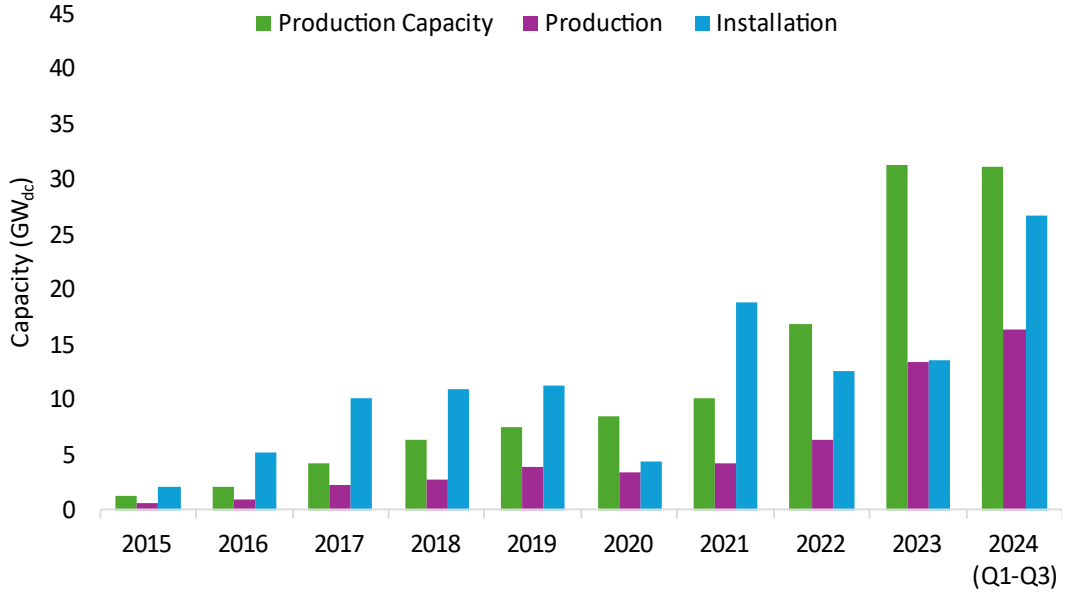
- **Boviet Solar** announced that they began construction on their 2-GW cell facility.
- **Nuvision** announced plans to build a 2.5-GW_{dc} vertical cell/module facility in Florida.
- **Canadian Premium Sand** announced plans to build a 4-GW solar glass facility. Their project will be funded, in part, by a $75 million tax credit allocation under the 48C tax credit.
- **Origami Solar and Unimacts** announced plans to manufacture module frames in Texas.
- **Solar Panel Recycling** announced completed expansions of two of their facilities, and **Solarcycle** announced plans for a new 5-GW_{dc} recycling facility in Georgia.

Heliene/Premier paused their 1-GW_{dc} cell manufacturing plans until there is more certainty surrounding the future of the manufacturing tax credits.

Sources: Internal DOE tracking of public announcements; PV Magazine, Amid uncertainty, Premier Energies halts plans for U.S. solar cell factory, February 2025.

*Not all announcements include facility locations, job, operating capacity, or investment numbers.

Indian PV Module Production and Installation

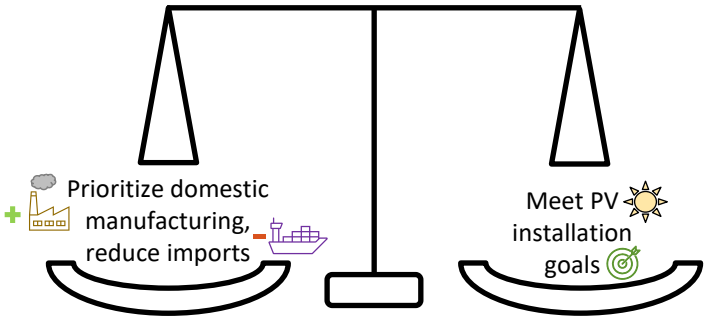


- India installed a record high of 26.7 GW_{dc} of PV through Q3 2024—42% higher than in all of 2021, the previous record year.
  - 14% of new installations were roof-mounted, 86% were utility-scale.
  - ~115 GW_{dc} of total installed solar capacity by October 2024.
- Between 2021 and 2024, India's domestic module production increased 4-fold, while module production capacity increased 3-fold.
  - On average, the facilities are operating at a 50% utilization rate.
  - Indian module manufacturers have begun transitioning to state-of-the-art TOPCon technology, away from older PERC technology.
- Domestic module production has lagged domestic installations, and some domestic modules are exported—modules have been imported to make up the difference.
  - More than 20 GW_{dc} of modules were imported in 2024.
  - Excess production capacity could be leveraged to support domestic installation as well as exports.

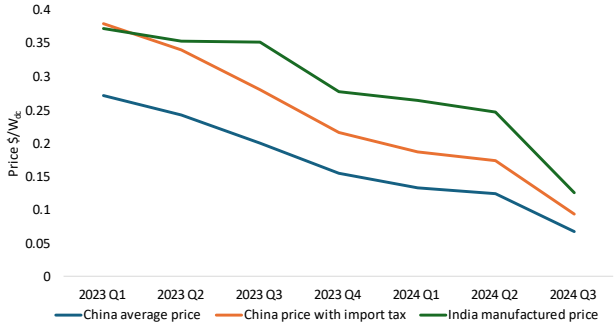
Sources: BNEF, 4Q 2024 Global PV Market Outlook, November 2024; PV Tech, PV Manufacturing & Technology Quarterly Report - Release 34, August 2024; Mercom India, Clean Energy News and Insights, December 2024; InfoLink, New prospects for India's PV industry under the ALMM, December 2024; BNEF, India Quarter in Short 4Q 2024, October 2024.

Domestic PV Manufacturing vs. Installation in India

India balances domestic PV manufacturing and installation goals



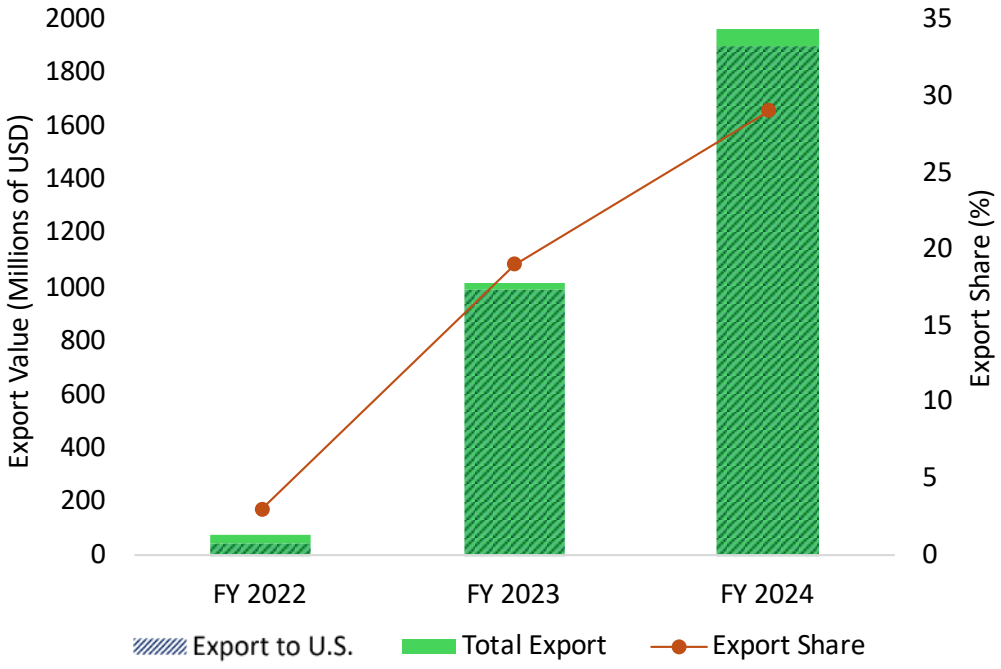
Indian module prices: domestic vs. Chinese imports with and without 40% duty



Sources: BNEF, 2H 2024 India Renewables Market Outlook, August 2024; InfoLink, PV policy frameworks and market outlook in India, February 2024; Ministry of Power Central Electricity Authority, Report on Optimal Generation Capacity Mix for 2029-30, April 2023; MNRE, Production Linked Incentive, September 2022.

- India promotes domestic manufacturing:
  - Imported modules are subject to a 40% tariff, and cells to a 25% tariff.
  - Modules used in many projects must be on the government's Approved List of Models and Manufacturers (ALMM), which contains only Indian products.
  - Select manufacturers receive a Production Linked Incentive for integrated solar PV manufacturing.
- India is targeting 220 GW_{dc} PV installed by 2030.
  - It failed to reach the 100 GW_{dc} target by 2022.
- Measures to protect domestic manufacturing are balanced against installation goals.
  - Chinese module imports cost less than domestic modules, even after the 40% tariff, making the ALMM an important protection for domestic manufacturers.
  - The ALMM was suspended in FY23-24 to increase module supply and installation; it was reinstated in April 2024.

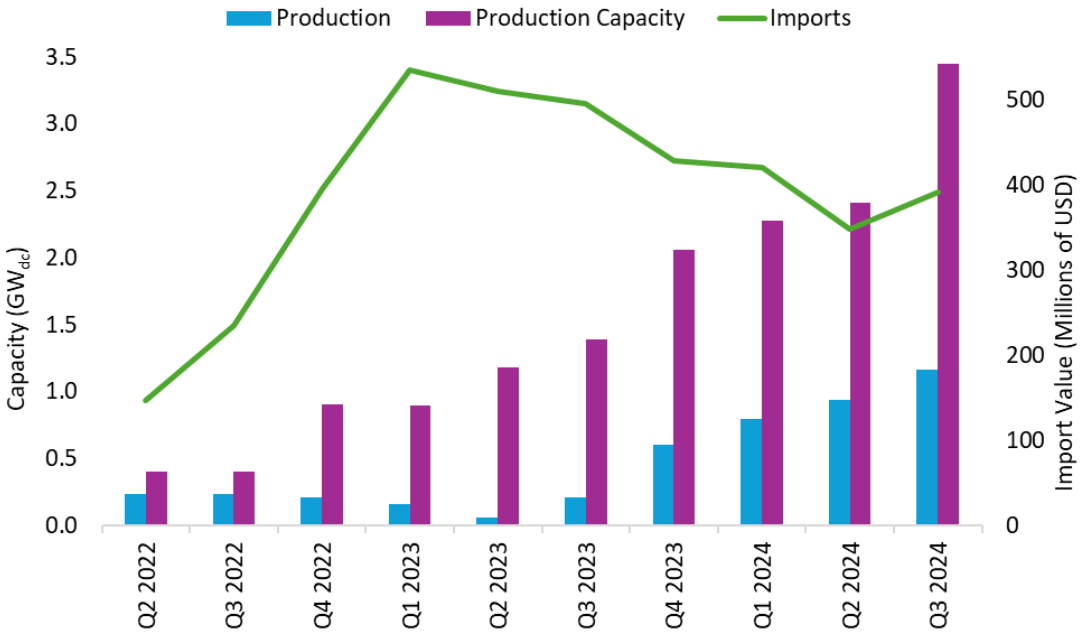
Indian Module Exports



- Indian module exports totaled nearly $2 billion in value and more than 8 GW_{dc} in FY24.
  - Exports grew by 93% between FY23-24.
  - About 30% of modules manufactured in India were exported in FY24—a 50% increase from the previous year.
- More than 99% of Indian exports went to the U.S. in FY24.
  - Exports to the U.S. increased 42-fold between FY22-24.
- According to the Institute for Energy Economics and Financial Analysis, Indian manufacturers can achieve 40%–60% higher profits on module sales in the U.S. compared with domestic sales.
  - Policies such as the Uyghur Forced Labor Prevention Act and AD/CVD tariffs have increased U.S. demand for Indian modules.
  - Some Indian companies have explored manufacturing in the U.S. to gain tax benefits; in January 2025, Waaree Energies began commercial production of modules in Texas.

Notes: Indian Fiscal Year spans April 1 of the previous year to March 31.
Sources: IEEFA, Indian Solar PV Exports Surging, November 2024; BNEF, 1H 2023 India Renewables Market Outlook, March 2023.

Indian PV Cell Production and Imports



- India manufactured a record high of ~3 GW_{dc} of cells during Q1-Q3 2024.
  - Represents a threefold increase over all of 2023.
  - Inclusion of cells in ALMM for projects commissioned starting in 2026 could further promote domestic cell production.
- India's cell production capacity was about 8 GW_{dc} in Q1-Q3 2024.
- India relies primarily on cell imports to produce its modules.
  - Domestic module production has consistently outpaced domestic cell production, e.g., module production exceeded cell production by ~13.5 GW_{dc} in Q1-Q3 2024.
  - India's cell imports reached a record high of 29.5 GW_{dc} in Q1-Q3 2024.
- Indian cell exports have been minimal to date, but the recent U.S. AD/CVD ruling against cells from Southeast Asia may promote increased export of Indian cells to the United States

Sources: PV Tech, PV Manufacturing & Technology Quarterly Report - Release 34, August 2024; BNEF, Solar Supply Chain Index, January 2025; InfoLink, New prospects for India's PV industry under the ALMM, December 2024; IEEFA, Indian Solar PV Exports Surging, November 2024; Mercom, Threat of US Anti-Dumping Duties on Indian Solar Module Exports, April 2024.

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1. Global Solar Deployment
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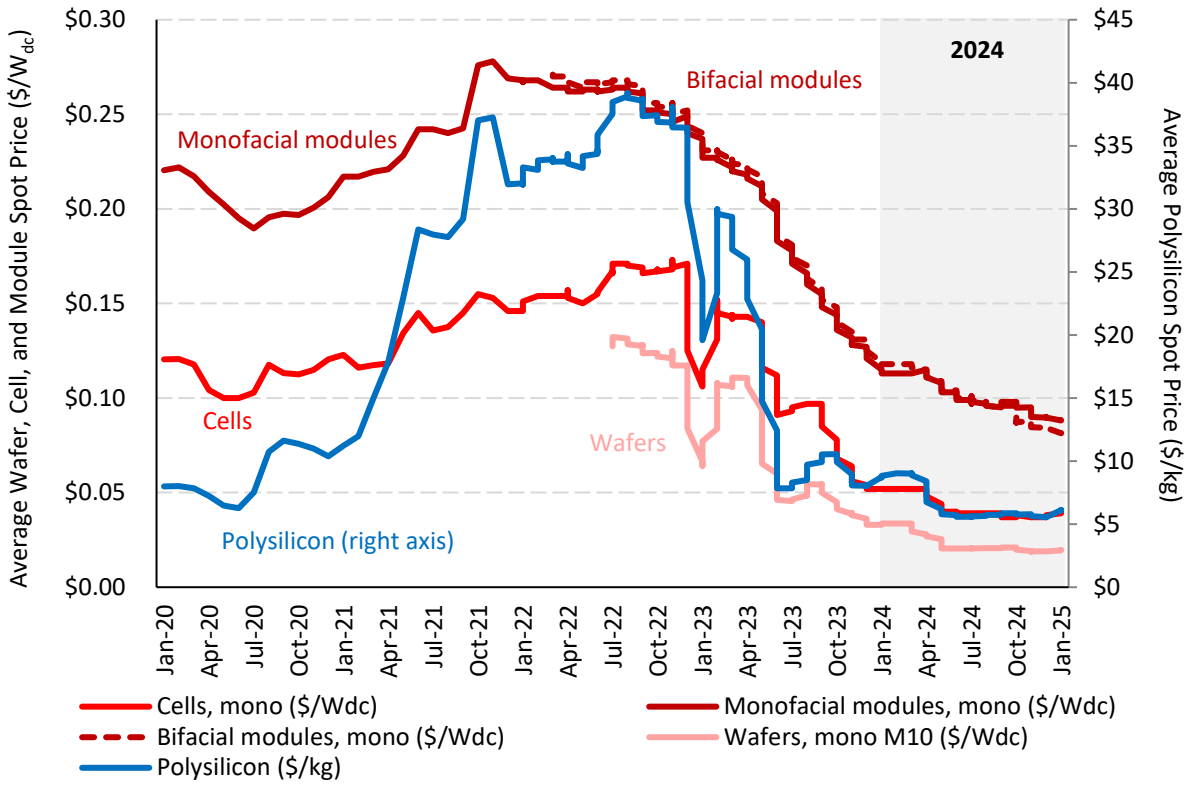
- **Module spot prices fell 22% in 2024, reaching $0.09/$W_{dc}$ in December.**
  - **In 2024, global spot prices fell 43% for wafers and 27% for cells.**
- **Global polysilicon spot prices fell 36% in 2024, from $8.72/kg to $5.54/kg.**
  - **Chinese polysilicon producers finished 2024 with substantial inventories despite a 40% cut in production between January and December.**
- **In Q3 2024, the average U.S. module price ($0.29/$W_{dc}$) was down 6% q/q and down 12% y/y, and was at a 190% premium over the global spot price.**
  - **Analysts saw U.S. module price increases toward the end of 2024 due to higher-than-expected AD/CVD cash deposits.**
- **In Q3 2024, the average imported PV cell price was $0.12/$W_{dc}$.**
- **After a small increase in 2022, stationary storage battery pack prices continued their historical downward trend in 2024, falling to $125/kWh.**

PV Value Chain Global Spot Pricing



Global polysilicon spot prices fell 36% in 2024, from $8.72/kg to $5.54/kg.

- In 2024, China produced the polysilicon equivalent to 850 GW_{dc} of modules, compared to about 460 GW_{dc} of modules installed globally in 2024.
- Chinese polysilicon producers finished 2024 with substantial inventories, despite a 40% cut in production between January and December.
- Contracts traded in early 2025 as part of China's first polysilicon futures exchange indicate prices (excluding value-added tax) around $5.35/kg for delivery in the second half of 2025.

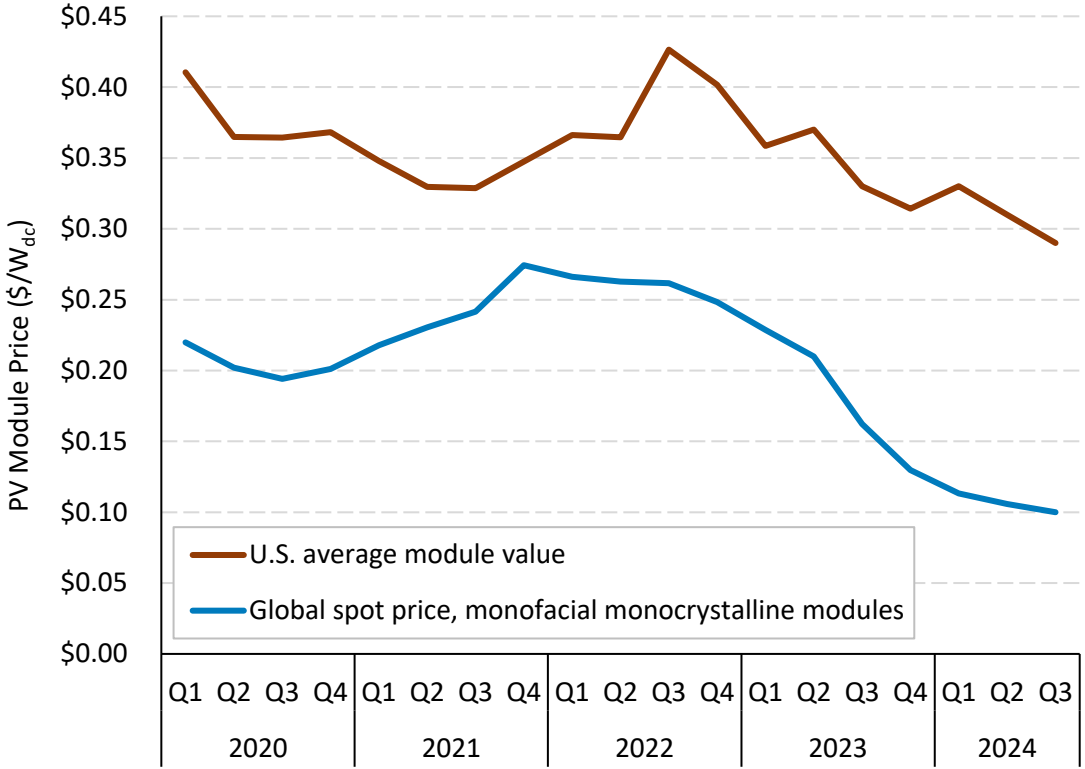
In 2024, global spot prices fell 43% for wafers and 27% for cells.

Module spot prices fell 22% in 2024, reaching $0.09/$W_{dc}$ in December.

- The China Photovoltaic Industry Association called for price stabilization and estimated module production costs in China at ~$0.09/$W_{dc}$.
- BloombergNEF expects further module price reductions in 2025.

Sources: BNEF, 4Q 2024 Global PV Market Outlook, November 2024; BNEF, Solar Supply Chain Data, January 2025; BNEF, Solar Supply Chain Index, January 2025; Goldman Sachs Equity Research, America's Clean Technology: Solar, December 2024; PV Magazine, Weakening Chinese module prices trigger CPIA minimum cost guidance, October 2024; Wood Mackenzie, Q4 2024 Solar Executive Briefing, October 2024.

Module Prices: Global vs. United States

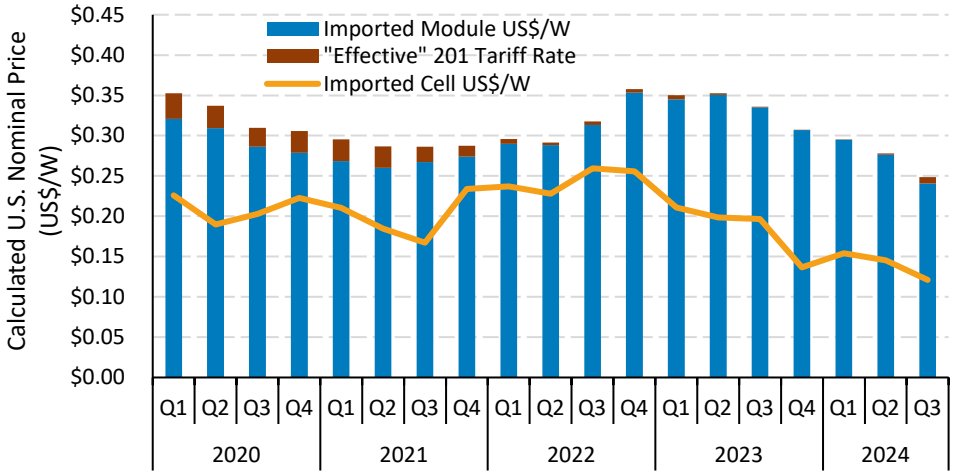


- In Q3 2024, the average U.S. module price ($0.29/$W_{dc}$) was down 6% q/q and down 12% y/y, and was at a 190% premium over the global spot price.
- Module prices were depressed partly by large inventories of modules from Southeast Asia, which had to be sold before year end to avoid AD/CVD tariffs.
- Increased domestic module manufacturing is also putting downward pressure on prices.
- The price difference between U.S. modules and global modules shrank slightly, to $0.19/$W_{dc}$ in Q3.

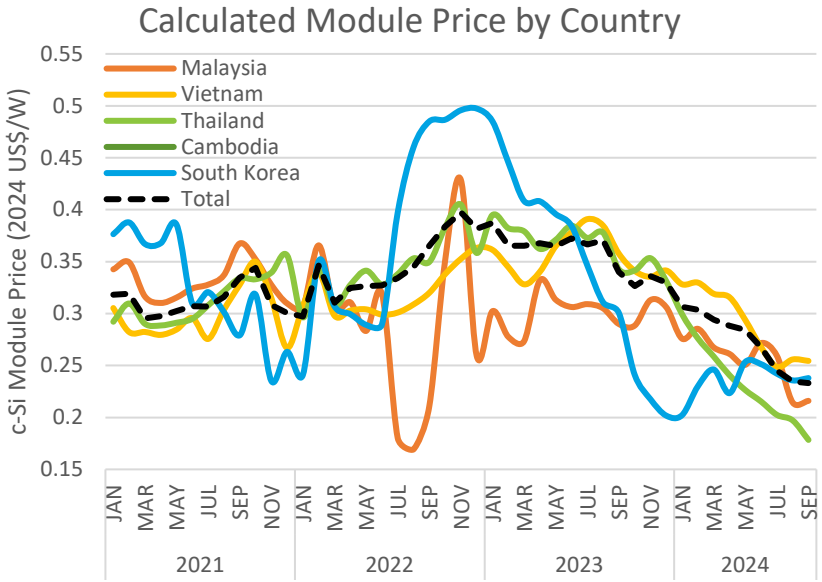
Source: BNEF, 4Q 2024 Global PV Market Outlook, November 2024; BNEF, Solar Supply Chain Data, January 2025; EIA, Monthly Solar Photovoltaic Module Shipments Report, January 2025; Wood Mackenzie and SEIA, US Solar Market Insight: Q3 2024, September 2024.

Calculated U.S. Module and Cell Import Pricing

- Based on the reported value and capacity of imported PV modules and cells, in Q3 2024, the average price of a U.S. module fell further, to just under $0.25/W$_{dc}$, while cell prices declined to $0.12/W$_{dc}$.
  - In Q3, approximately 23% of modules reported paying a tariff, up from 3% in Q2 and less than 1% in Q1.



- These module price declines were observed across all countries of import. However, prices have declined most steeply over the past several months for modules from Thailand. Current prices are now hitting all-time domestic lows, when adjusted for inflation.

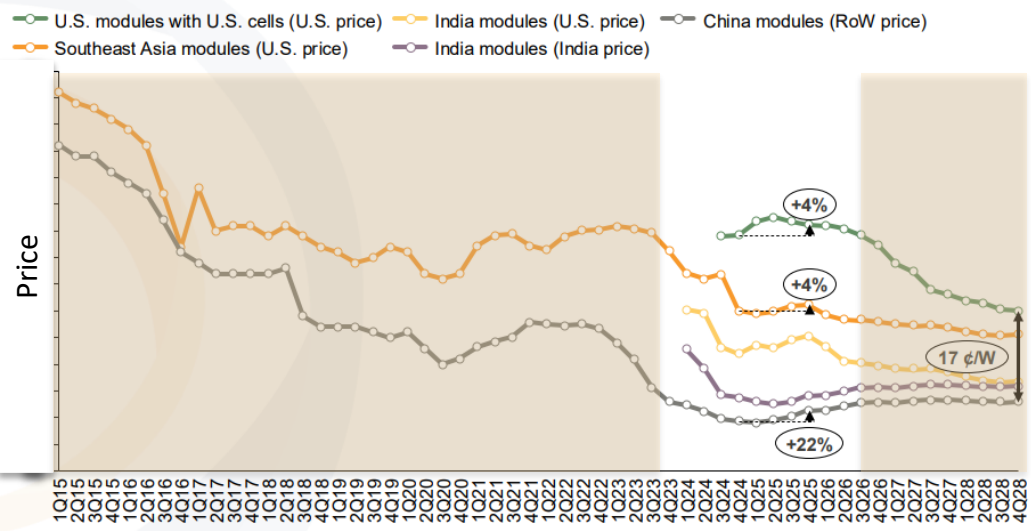


Note: The tariff rate was adjusted by the capacity subject to the tariffs. Manual corrections were made to three values because of suspected data entry errors for harmonized tariff schedule (HTS) code 8541430010: Cambodia (February 2022), Malaysia (June 2020), and Vietnam (July 2019). Several gigawatts of imports from India entered under the HTS code for thin-film modules in 2022–2024 but are believed to be c-Si based on news reports.

Sources: Imports by HTS code: 8541406015 (2018–2021)/8541430010 (2022–), 8541406035 (2018–2021)/8541430080 (2022–), and 8541406025 (2018–2021)/8541420010 (2022–). Second Quantity (watts) from the U.S. Census Bureau USA Trade Online tool and corrections page as of November 8, 2024.

Analysts Report Module Price Increases in United States

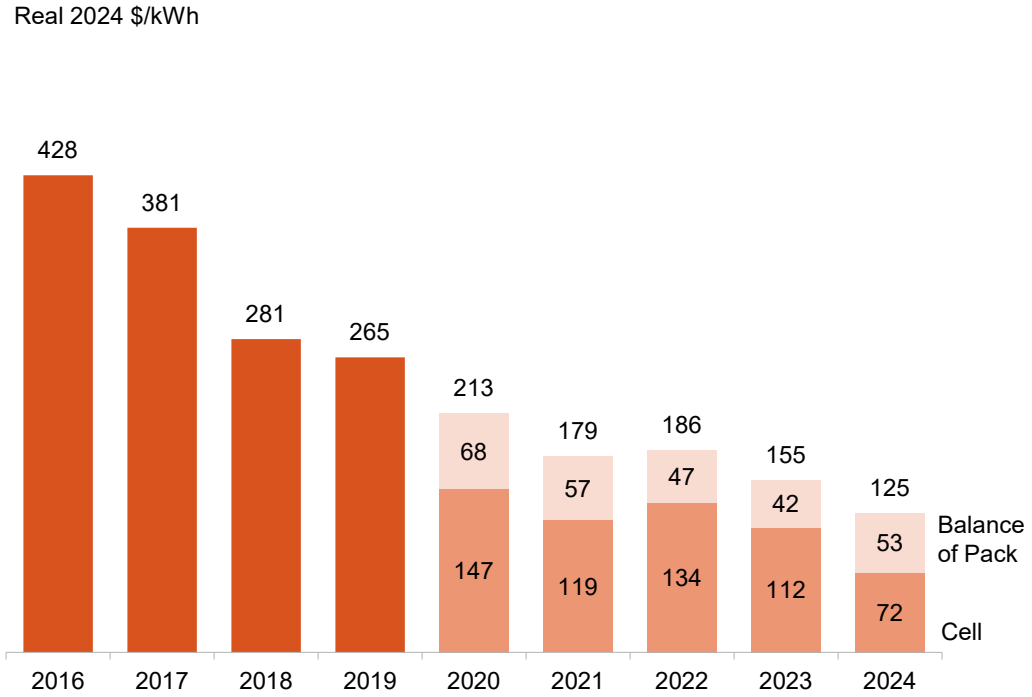
- Clean Energy Associates reports that U.S. module prices are increasing due to higher-than-expected AD/CVD cash deposits (15%–125%), with a price gap growing between modules subject to duties (e.g., Malaysia, Vietnam) and those from duty-free locations (e.g., India, Indonesia, Laos).



- Southeast Asian module prices were up \$0.05/W_{dc}, compared to \$0.02–\$0.03/W_{dc} for Indonesia/Laos (whose prices increased due to scarcity).
- Price pressure was also influenced by China's 4% cut in export tax rebate for modules at the end of 2024.
- Upward pressure was moderated by U.S. module inventories. In the long term, Clean Energy Associates still projects lower U.S. module pricing.
- Clean Energy Associates also reported slowing efficiency improvements due to R&D cuts and delays in new equipment investments, due to reduced margins as well as growing patent litigation related to new technologies (e.g., TOPCon).
  - Litigation may keep PERC as the dominant technology in the United States, with efficiencies below 24% for the foreseeable future.

Sources: Clean Energy Associates, PV Price Forecasting Report, Q4 2024, February 2025; PVTech, US solar module prices increase, efficiency improvements slow – CEA, February 2025.

Average Stationary Storage Lithium-Ion Battery Pack Price, 2016–2024



- After a small increase in 2022, stationary storage battery pack prices continued their historical downward trend in 2024, falling 71% from 2016 to 2024 and 19% between 2023 and 2024.
  - BloombergNEF reported that stationary storage battery packs were approximately 29% higher than battery packs for passenger EVs.
- BloombergNEF cited significant competition in China, massive oversupply of battery cells, and increasing adoption of low-cost lithium iron phosphate (LFP), as well as the movement to larger cell and system sizes, as reasons for the drop in pricing.
  - The increase in non-cell pack price from 2023 to 2024 may be explained by the shift to LFP technology, which has a lower cell price but is less energy dense.

Source: BloombergNEF, 2024 Lithium-Ion Battery Price Survey.

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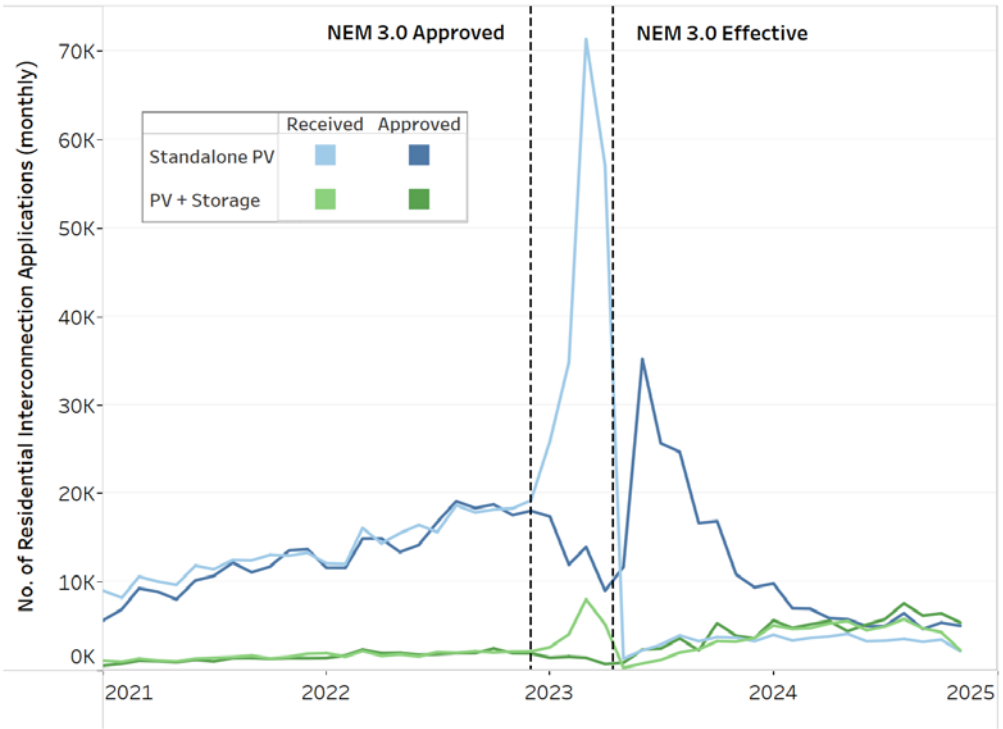
- **Since California NEM 3.0, stand-alone PV applications have fallen from 14,600/month to 3,300/month (–77%), while average PV + storage applications have increased from 1,800/month to 3,700/month over the same period (+110%).**
- **In 2024, states moved away from net metering and toward net billing or other alternate compensation structures (e.g., Kentucky and West Virginia), and utilities requested significant increases in their residential fixed charges (e.g., utilities in Arizona and Idaho).**
- **The Invesco Solar ETF fell 22% in Q4 2024, as traders anticipated the effect of potential policy headwinds on solar stocks. In contrast, the S&P 500 rose 3% and the Russell 2000 rose 1% in Q4. In addition, 10-year U.S. Treasury yields increased during Q4 due to concerns that inflation might reemerge and interrupt the Federal Reserve's cycle of interest rate cuts.**

California NEM 3.0 Update

Residential PV and PV + Storage Applications in California



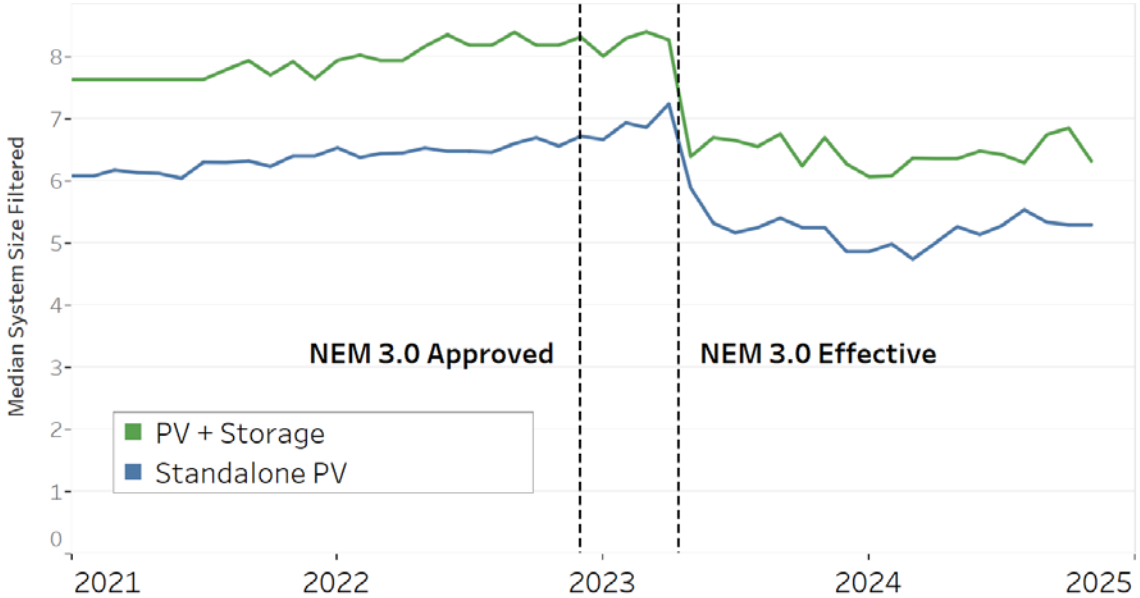
Interconnection data are for residential systems in California's Pacific Gas & Electric and Southern California Edison territories.

- California's Net Billing Tariff (aka NEM 3.0) rules were adopted in December 2022 and went into effect in April 2023.
  - The previous policy (NEM 2.0) compensated PV-generated electricity at retail rates, whereas NEM 3.0 provides compensation at avoided-cost rates that are ~75% lower than retail rates.
  - The aim is to mitigate cost-shifting from PV to non-PV customers, compensate PV based on its value to the grid, and—with differentiated time-of-use import rates—encourage electrification and use of energy storage.
- After spiking before April 2023, stand-alone PV applications trended lower than before NEM 3.0, whereas PV + storage applications trended higher.
  - For PG&E and SCE, standalone PV applications averaged 14,600/month in 18 months through November 2022 (before surge in applications) and 3,300/month in 18 months starting May 2023 (−77%).
  - Average PV + storage applications increased from 1,800/month to 3,700/month over the same periods (+110%).

Sources: California Distributed Generation Statistics, California Distributed Generation, December 2024; NREL, Winter 2023 Solar Industry Update, January 2023.

California NEM 3.0 Update

Residential PV and PV + Storage System Sizes in California (kW_{dc})



Data are for residential systems in California's Pacific Gas & Electric and Southern California Edison territories.

- Beyond the shifts in system installations, California's solar market has changed in other ways since NEM 3.0 became effective.
- The size of PV systems has decreased.
  - For PG&E and SCE, the median stand-alone PV system size was 6.4 kW_{dc} in 18 months through November 2022 and 5.2 kW_{dc} in 18 months starting May 2023 (−19%).
  - Median PV + storage system sizes under the NEM 3.0 tariff decreased from 8.0 kW_{dc} to 6.4 kW_{dc} during the same periods (−20%).
  - Lower compensation for exported electricity under NEM 3.0 incentivizes smaller PV system sizes.
  - A shift in system deployment toward new construction and less affluent households may also contribute to smaller PV systems.
- Lawrence Berkeley National Laboratory (LBNL) suggests that changes due to NEM 3.0 also include more PV adoption in less affluent zip codes, higher third-party system ownership shares, higher PV + storage system prices, and higher concentration in the installer market.

Sources: California Distributed Generation Statistics, California Distributed Generation, December 2024; Barbose, LBNL Technical Brief: One Year In, May 2024.

States: Q4 2024 Updates

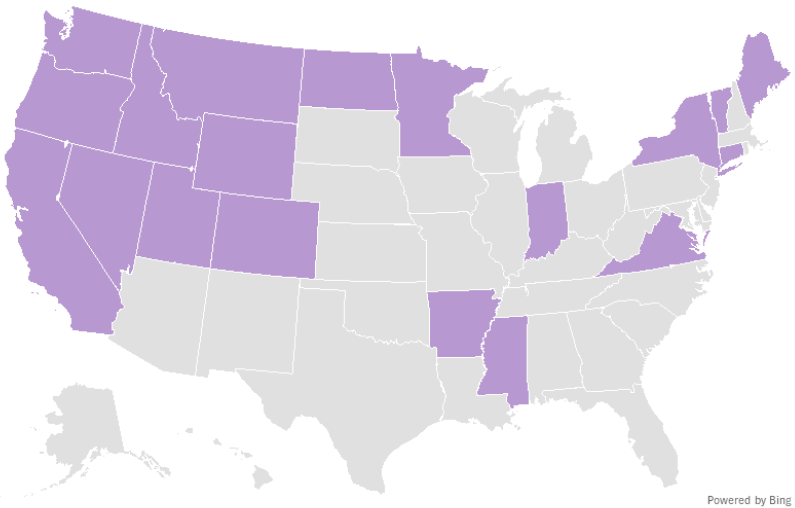
Connecticut made changes to its net metering and community solar programs, including integrating multifamily buildings in their residential net metering program and public schools into the non-residential net metering program.

Massachusetts passed a law to streamline clean energy siting and permitting. The law also lays the groundwork for incorporating battery storage and EV charging infrastructure into the grid. Additionally, utility regulators in the state revised net metering tariffs, exempting certain systems from the rule that previously only allowed one net metering facility for each individual parcel of land.

New Jersey's Board of Public Utilities increased the system size limit under its Remote Net Metering Program and initiated a stakeholder engagement process to design a successor tariff to net metering.

Maryland will soon roll out its new Maryland Solar Access Program (a residential solar rebate program). To ensure consumer protection in the program, the Maryland Energy Administration announced that it will require each solar installation contractor who wishes to participate to apply for inclusion on a participating contractor list.

Multifamily Buildings Explicitly Called Out in Distributed Generation Compensation Programs



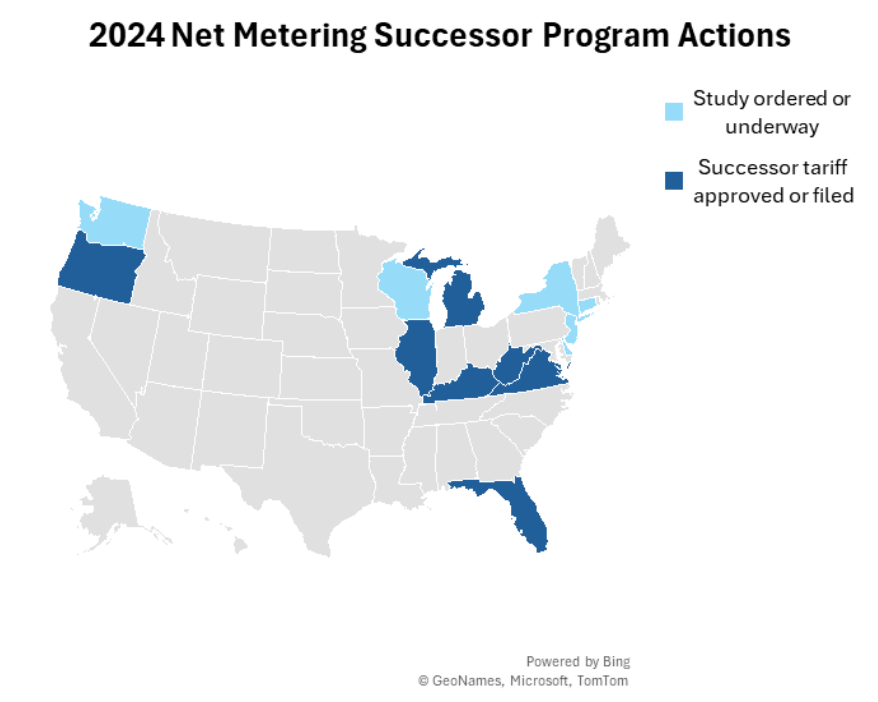
Arizona Corporation Commission upheld a monthly grid access charge for Arizona Public Service solar customers. This is a nominal fixed charge of $2–$3 per month for residential solar customers who generate their own electricity.

Sources: Solar Power World, Massachusetts legislature passes new climate bill that includes siting, permitting reform, November 2024; Massachusetts Department of Public Utilities, DPU Expands Net Metering Program, November 2024; North Carolina Clean Energy Technology Center, The 50 States of Solar: 2024 Policy Review and Q4 2024 Quarterly Report, January 2025; Solar Power World, Maryland to soon require contractor applications for new Solar Access Program, November 2024; Arizona Corporation Commission, ACC Reaffirms Grid Access Charge After Rehearing in 2024 APS Rate Case, December 2024; PV Magazine, US state-level solar policy moving away from traditional net metering, January 2025; DSIRE, Summary Tables, Accessed January 2025.

States: 2024 Year in Review

Top State Distributed PV Policy Trends of 2024

- States are moving away from net metering and toward net billing or other alternate compensation structures (e.g., Kentucky and West Virginia).
  - States or utilities are ordering studies to inform and develop new successor tariffs (e.g., Delaware and Washington).
  - States are hitting the dates or capacity thresholds they set to trigger the development of net metering successor tariffs (e.g., Illinois, Virginia).
- Distributed solar programs are integrating provisions for multifamily buildings (e.g., Connecticut and Washington).
  - Some utilities have also been separating out residential rates and charges for single-family and multifamily customers (e.g., utilities in Indiana and Oregon).
- Community solar programs are looking to garner participation from low-income customers (e.g., Colorado and New Jersey).
- Utilities are requesting significant increases in their residential fixed charges (e.g., utilities in Arizona and Idaho).
- States are revising distributed solar programs to account for paired solar and energy storage systems (e.g., Alaska and Kansas).



Source: North Carolina Clean Energy Technology Center, The 50 States of Solar: 2024 Policy Review and Q4 2024 Quarterly Report, January 2025.

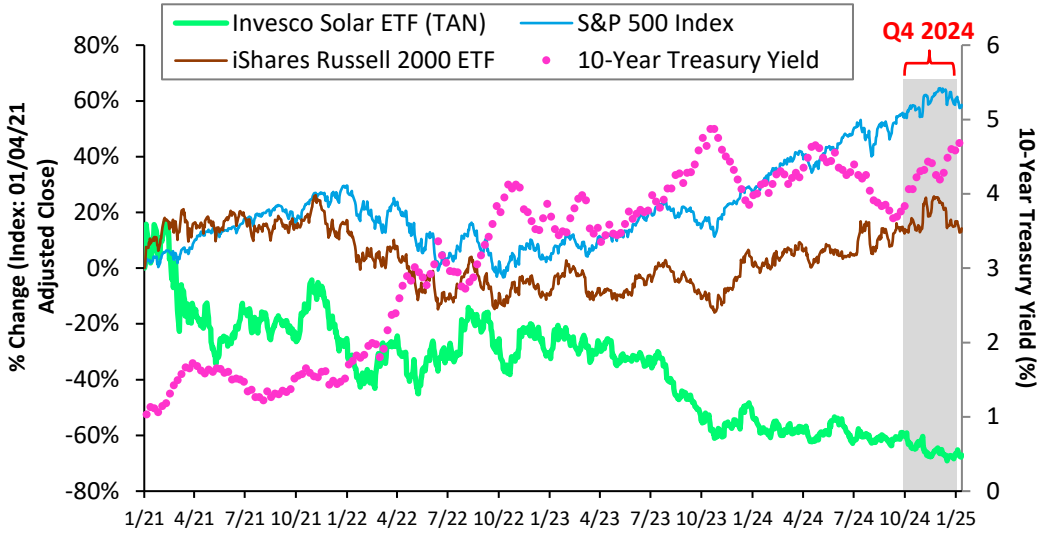
Uyghur Forced Labor Prevention Act Update

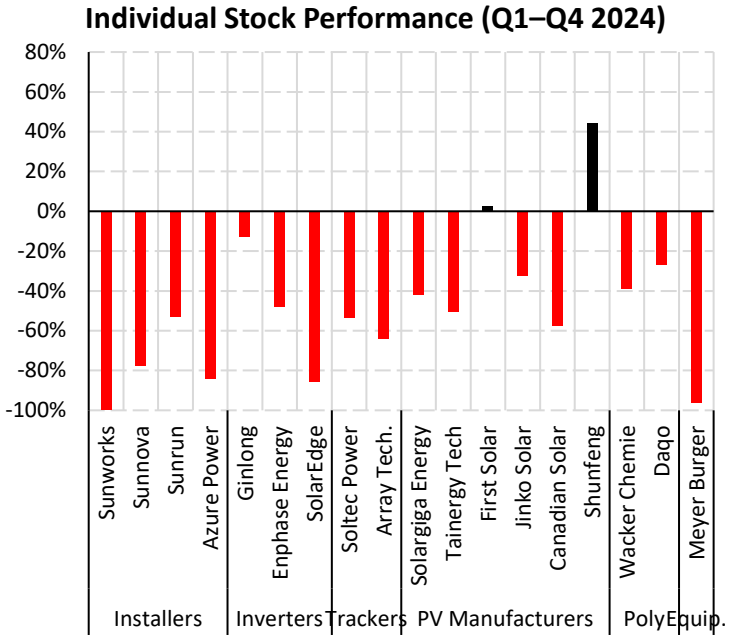
- The Uyghur Forced Labor Prevention Act (UFLPA) was signed into law in December 2021 and calls for the development of a strategy for determining that **goods produced wholly or in part with forced labor in China are not imported into the United States.**
- Under this act, a list was created of entities in the Xinjiang Uyghur Autonomous Region that use or facilitate forced labor, called the **UFLPA Entity List.** An enforcement plan was also created, which includes the use of withhold and release orders administered by U.S. Customs and Border Protection (CBP).
- In January 2025, the U.S. Department of Homeland Security added 37 new companies to the UFLPA Entity List, including **four upstream solar module component suppliers** who allegedly source polysilicon made in Xinjiang: Donghai JA Solar, Hongyuan Green Energy (and its subsidiary Hongyuan New Materials), Jiangsu Meike, and Shuangliang Silicon.
  - Ingots and wafers from these companies cannot be imported into the United States, and cells and modules made overseas using these wafers are also banned from import.
  - These new bans could impact the domestic solar supply chain, with one analyst for Clean Energy Associates reporting that the list includes companies that "supply cell makers that serve the U.S. market."

Sources: Federal Register, Notice Regarding the Uyghur Forced Labor Prevention Act Entity List, January 2025; PV Tech, JA Solar subsidiary added to US forced labour list, January 2025; Solar Builder, Four Chinese wafer makers added to UFLPA ban – 'quite impactful' to U.S. solar market, January 2025.

Stock Market Activity

The Invesco Solar ETF (TAN) fell 22% in Q4 2024, including an 11% decline during the trading day after the November U.S. presidential election alone, as traders anticipated the effect of potential policy headwinds on solar stocks. In contrast, the S&P 500 rose 3% and the Russell 2000 rose 1% in Q4. In addition, 10-year U.S. Treasury yields increased during Q4 due to concerns that inflation will reemerge and interrupt the Federal Reserve's cycle of interest rate cuts. Solar projects—with their high upfront costs—are sensitive to interest rates.



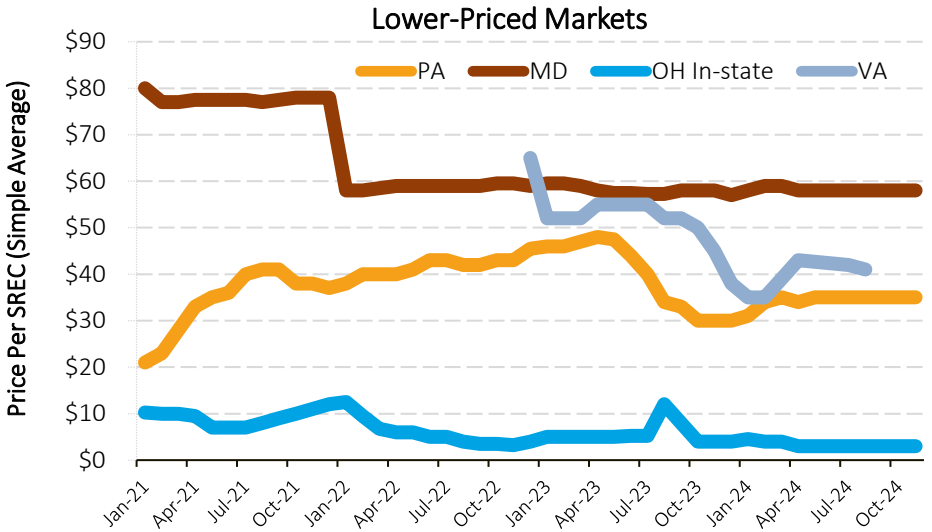


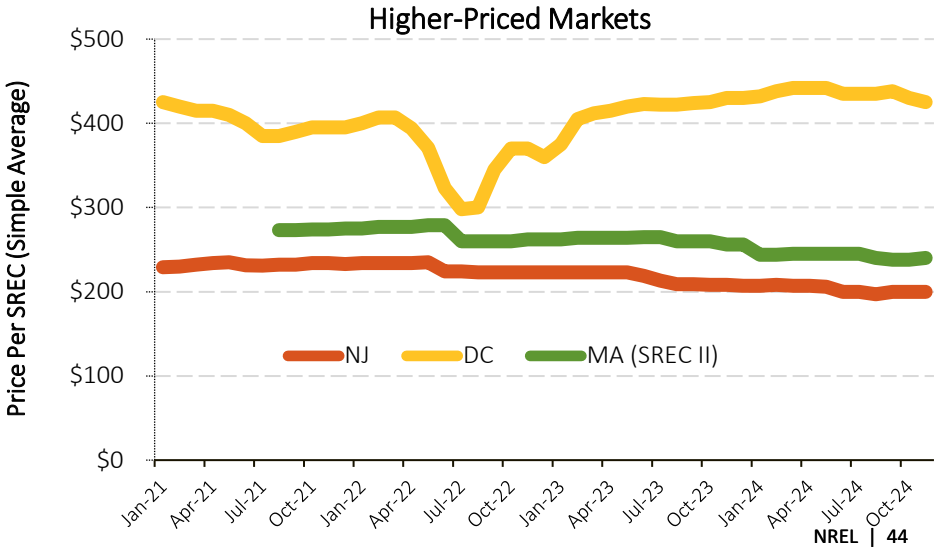
Note: The TAN index is weighted toward particular countries and sectors. As of January 14, 2025, 53% of its funds were in U.S. companies and 19% were in Chinese companies. Its top 10 holdings, representing 58% of its value, were Nextracker, First Solar, Enphase, GCL, Sunrun, Xinyi, HA Sustainable Infrastructure, Neoen, Shoals, and ARRAY.

Sources: CNBC, Solar stocks tank on fears Trump will hamper clean energy progress, repeal IRA, November 2024; Federal Reserve Bank of St. Louis, Market Yield on U.S. Treasury Securities at 10-Year Constant Maturity, accessed January 2025; Invesco, Invesco Solar ETF, January 2025; Morningstar, Utilities Down as Treasury Yields Test 2024 Highs, December 2024; PV Magazine, Solar stocks nosedive as Trump victory is secured, November 2024; PV Magazine, Solar stocks plummet, market is 'wildly emotional' about Trump, November 2024; Reuters, Fed cuts rates 25 bp, as expected, November 2024; T Rowe Price, The calm before the storm — The outlook for Treasury yields, December 2024; Utility Dive, Analysts see 'a real fear in the market', November 2024; Yahoo Finance, Invesco Solar ETF, iShares Russell 2000 ETF, S&P 500, accessed January 2025.

SREC Pricing

- Solar renewable energy certificate (SREC) pricing was relatively stable in 2024, though some price movement occurred as states switched to a new energy year in June.
- Prices vary depending on whether SRECs are sold in the spot market or for a forward contract. For example, RECmint estimates an 11%–24% and 33%–46% discount over spot prices for 3- and 5-year contracts, respectively.

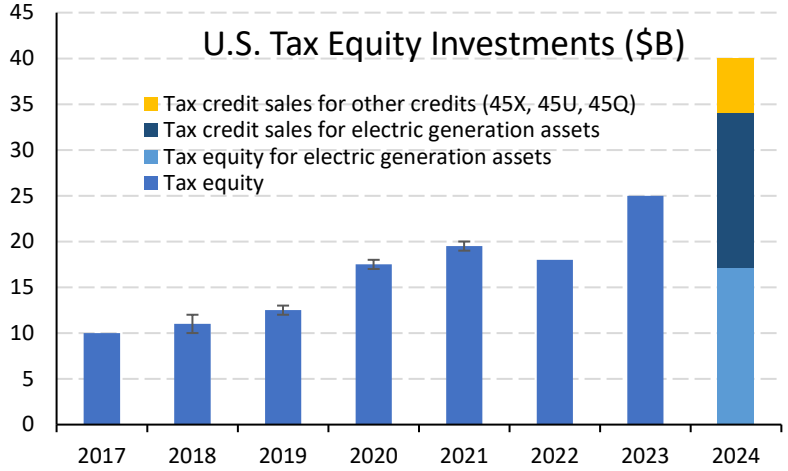




Sources: SRECTrade, RECmint, accessed 11/8/24.

Cost of Capital, Tax Equity (Norton, Rose, Fulbright)

- In 2024, tax equity investors invested ~$17 billion in electric generating assets, and another ~$17 billion of credits were sold ($10 billion of which was done through a traditional tax equity structure). Investors report:
  - $20 billion in solar, $7 billion in batteries, and $6 billion in wind
  - Another $6 billion of credits were sold from other tax credits (mostly 45X, but also 45U and 45Q).
  - 50%–60% of utility-scale solar projects are qualifying for the Energy Community bonus tax credit.
  - The domestic content bonus credit is common in wind, less common in solar, and rare for batteries. Investors expect more projects to qualify going forward.
  - 50% of solar projects are electing to use the production tax credit (PTC), though there are more investment tax credit (ITC) investors and more geographic locations where the ITC makes sense.
- In 2025, investors expect a flat year for electric generating assets and an increase in other credits like 45X and 45Z.
  - Investors see some uncertainty in the future, which may limit investment; however, they do not see issues for projects already under construction.



- Investors report that partnership-flip yields have been flat over the past two years at approximately 7.5%–8.5%.
  - A reduction in underlying interest rates could lower returns.
  - As more credits are transferred, yield is impacted by how much of the credit is transferred and who bears the tax transfer risk.
  - Some investors are moving away from yield and instead focusing on multiple on invested capital (MOIC) as the ITC has such a quick payback.
- Investors reports that PTC sales for wind, solar, and 48D have the highest price, followed by the ITC for solar and storage, followed by the ITC for renewable natural gas.

Definitions: 45X (Advanced Manufacturing Production Credit), 45U (Nuclear Power Production Credit), 45Q (Carbon Capture & Sequestration Credit), 45Z (Clean Fuels Production Credit), 48D (Advanced Manufacturing Investment Credit)

Sources: Norton Rose Fulbright, Cost of Capital: 2025 Outlook, January 2025.

Cost of Capital, Bank Debt (Norton, Rose, Fulbright)

- Investors report that in 2024, project finance debt reached $164 billion—a 20% increase from 2023.
  - Power deals represented 46% of project finance deals; renewable energy was 73% of that (35% solar, 22% BESS, and 16% wind).
  - Data centers represented a large portion of project debt.
- Investors report that debt service coverage ratios (DSCRs) for solar project finance loans were 1.25–1.30 for utility-scale projects and 1.3–1.5 for community solar projects (they were 1.35–1.40 for wind and 1.15 – 1.20 for storage).
  - Merchant solar deals have a P50 DSCR of 1.75 with a P99 of 1.40 (wind is similar, and merchant storage has a DSCR of 2.0).
- The secured overnight financing rate (SOFR; the base rate for loans) hovered around 5.3% for most of 2024 before falling to 4.3% in January. 10-year treasuries increased from 3.6% in September to 4.7% in January 2025.
  - Investors report that fully contracted plain vanilla renewables deals are priced between 150 and 187.5 basis points above SOFR (or 5.8% to 6.2%); however, loans often fix rates, which can add 1%–2% (increasing the debt rate to 7%–8%).
  - Community solar project debt is priced between 237.5 and 287.5 basis points over SOFR.

Note: P50 represents an average-level of energy production (or 50% likelihood to generate that much or more electricity), and P99 represents a production level at which the project has a 99% chance of exceeding.

Sources: Norton Rose Fulbright, Cost of Capital: 2025 Outlook, January 2025.

48E(h): Tax Credit Update

- In January 2024, the Treasury and the IRS released final guidance on the Low-Income Communities Bonus Credit (48E(h)) for the Clean Electricity Investment Tax Credit (48E, or ITC).
  - This bonus credit increases the value of the ITC by 10% for projects located in low-income communities and projects located on Indian land, or by 20% for projects built on a qualifying low-income residential building and qualifying projects that benefit a low-income community.
  - Projects must apply for this bonus credit. DOE reviews applications and makes recommendations to the IRS, which allocates credits to 1.8 GW_{dc} of qualifying projects annually.
- The final guidance included a few key changes to the program:
  - New technologies beyond solar and wind were added to the list of eligible investment technologies. Newly eligible technologies include hydropower, marine and hydrokinetic, geothermal, and nuclear.
  - Clarification was given for eligibility requirements, and the list of qualified low-income residential buildings was expanded.
  - New pathways were created for small businesses in clean energy to receive priority status in the application process.
- The guidance also outlined the annual 2025 capacity allocations for four credit subcategories.
  - In addition to the annual 1.8 GW_{dc} typically allocated each year, 174 MW_{dc} of capacity is also being carried over from prior years of the program.

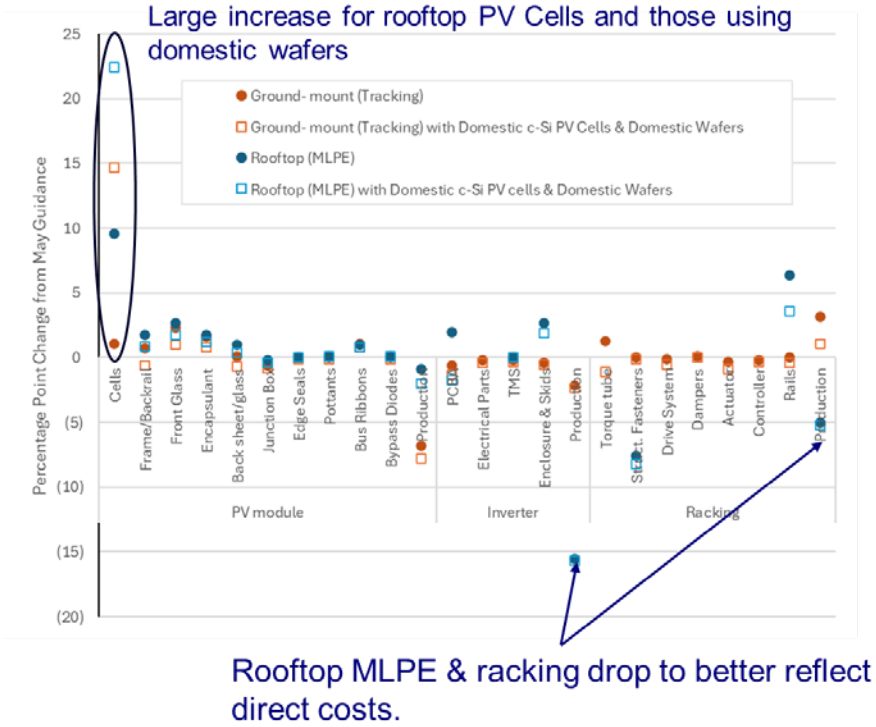
Sources: U.S. Department of the Treasury, U.S. Department of the Treasury Releases Final Rules to Expand Clean Energy Investments and Lower Costs in Low-Income Communities, January 16, 2025; Solar Power World, Treasury releases final rules for IRA low-income bonus credit, January 8, 2025.

Domestic Content Bonus: 2025 Guidance

- In May 2024, the IRS released a safe harbor table that provides clean energy developers with the option of relying on DOE-provided default, exhaustive cost percentages in lieu of obtaining direct cost information from suppliers.
  - To receive the ITC, cost of domestically produced manufactured products and components must be 40% or higher of the cost of all manufactured products (all steel products must be domestic).
- In January 2025, the IRS released updated versions of the safe harbor tables that incorporate more updated cost data from 2024. **Key updates**:
  - The cost percentages for solar and BESS were updated.
  - Names were adjusted, some components were removed, and definitions were provided for products and components.
    - DC optimizers can now receive partial credit if the optimizer or inverter is made domestically.
  - For each solar table, there are new, optional alternative cost percentages for projects using domestic solar cells manufactured with domestic wafers.
    - The value of domestic cells with domestic wafers is ~13% higher than those using foreign wafers.
    - If opting for alternative percentages, taxpayers must treat all cells made from foreign wafers (whether cells are produced domestically or not) as foreign.
- Final rules for the Clean Electricity Production and Investment Tax Credits (48E and 45Y) were also released in January 2025. **Key updates affecting the Domestic Content Bonus**:
  - Solar projects may be segmented by inverter and evaluated for domestic content separately, as opposed to at the project level.
  - Domestic content for a solar facility and BESS are evaluated separately, even if colocated.

Source: U.S. Department of the Treasury, U.S. Department of the Treasury Releases Guidance on Domestic Content Bonus for Clean Energy Credits, January 16, 2025.

Difference in PV Domestic Content Percentages



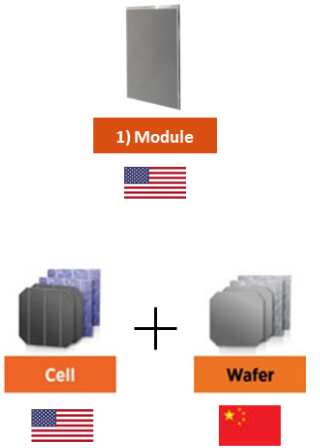
- Solar: Most values change less than 2 percentage points. There are large percentage point changes for PV cells and for products that are produced in the United States and have all domestic components.
- BESS (not shown): The Domestic Content Bonus increases the value of battery cells and adjusts packaging.

Note: MLPE is defined as module-level power electronics.

Sources: U.S. Department of the Treasury, U.S. Department of the Treasury Releases Guidance on Domestic Content Bonus for Clean Energy Credits, January 16, 2025; U.S. Department of the Treasury, IRS provides guidance for the Domestic Content Bonus Credit, May 16, 2024.

Domestic Content Bonus: 2025 Guidance Example #1

Example table for a domestically produced module **without** a domestic wafer:



Manufactured Product Component	**2024 Guidance:** % for Ground-Mounted (tracking) WITHOUT DOMESTIC WAFERS	**2025 Guidance:** % for Ground-Mounted (tracking) WITHOUT DOMESTIC WAFERS	
Cells	36.9	38.0	✓
Frames/backrail	5.3	6.0	✓
Front glass	3.7	6.0	✗
Encapsulant	2.2	3.8	✓
Backsheet/backglass	3.7	3.8	✓
Junction box	1.6	1.0	✗
Edge seals	0.2	0.3	✓
Pottants	0.2	0.3	✓
Bus ribbons	0.4	1.5	✓
Bypass diodes	0.4	0.4	✓
Production	11.5	4.7	✗

Project owners add the percentages of the domestically-produced components together to get a total domestic cost percentage.

= 54.1%
(using 2025 guidance)

The production line can only be counted if all the components of a product are also domestic.

Source: U.S. Department of the Treasury, U.S. Department of the Treasury Releases Guidance on Domestic Content Bonus for Clean Energy Credits, January 16, 2025.

Domestic Content Bonus: 2025 Guidance Example #2

Example table for a domestically produced module **with** a domestic wafer:

Manufactured Product Component	% for Ground-Mounted (tracking) with Domestic c-Si PV Cells & Domestic Wafers	
Cells	51.6	✓
Frames/backrail	4.7	✓
Front glass	4.7	✗
Encapsulant	3.0	✓
Backsheet/backglass	3.0	✓
Junction box	0.8	✗
Edge seals	0.2	✓
Pottants	0.2	✓
Bus ribbons	1.2	✓
Bypass diodes	0.3	✓
Production	3.7	✗

Project owners add the percentages of the domestically-produced components together to get a total domestic cost percentage.

= 64.2%

The production line can only be counted if all the components of a product are also domestic.

Example:

Source: U.S. Department of the Treasury, U.S. Department of the Treasury Releases Guidance on Domestic Content Bonus for Clean Energy Credits, January 16, 2025.

Domestic Content Bonus: 2025 Guidance Example #2

In this example system, all the components of the PV tracker are domestically produced, and the tracker is made in the United States, so the project owner can count all the percentage values for the tracker, or 22.5%.

2) Tracker

Manufactured Product Component	% for Ground-Mounted (tracking) with Domestic c-Si PV Cells & Domestic Wafers	
Torque tube	8.6	✓
Fasteners	0.3	✓
Drive System	1.5	✓
Dampers	0.4	✓
Actuator	2.2	✓
Controller	0.6	✓
Rails	1.6	✓
Production	7.3	✓

= 22.5%

Example:

1) Module

2) Tracker

3) Inverter

Source: U.S. Department of the Treasury, U.S. Department of the Treasury Releases Guidance on Domestic Content Bonus for Clean Energy Credits, January 16, 2025.

Domestic Content Bonus: 2025 Guidance Example #2

In this example system, the inverter is produced in China, and the tracker and most of the PV module components are produced in the United States. Adding the percentages together, the project has a domestic cost percentage of 86.7%, which exceeds the required 40% for a project to receive the bonus credit. Therefore, the project qualifies for the credit.

3) Inverter

Manufactured Product Component	% for Ground-Mounted (tracking) with Domestic c-Si PV Cells & Domestic Wafers	
Printer circuit board assemblies	1.7	
Electrical parts	0.6	
Thermal Management System	0.4	
Enclosure & Skids	0.5	
Production	0.9	

= 0%

Example:

1) Module

2) Tracker

3) Inverter

Domestic Cost Percentage = 64.2% + 0.0% + 22.5% = **86.7%** ☑

PV Module

PV Tracker

Source: U.S. Department of the Treasury, U.S. Department of the Treasury Releases Guidance on Domestic Content Bonus for Clean Energy Credits, January 16, 2025.

Agenga

1. Global Solar Deployment
2. U.S. PV Deployment
3. PV System Pricing
4. Global Manufacturing
5. Component Pricing
6. Market and Policy
7. **U.S. PV Imports**

- **According to U.S. Census data, modules imported in Q4 2024 fell 50% q/q, hitting only 7.7 GW_{dc}**
  - **The U.S. imported 56.1 GW_{dc} of modules or the full year 2024—approximately the same as 2023.**
- **Conversely, the United States imported 4.4 GW_{dc} of PV cells in Q4 2024 (+5% q/q), or 13.8 GW_{dc} for the full year 2024 (3.7X y/y).**
- **On November 29, the DOC issued a preliminary decision to impose antidumping duties (ADDs) on c-Si panels and cells produced in Vietnam, Malaysia, Thailand, and Cambodia, adding to the preliminary countervailing duties issued on October 1.**
- **According to CBP Commodity Status Reports, the 12.5 GW_{dc} TRQ was reached on December 30, 2024, so all PV cells imported after that date, and before February 7, received a 14.25% tariff.**

Preliminary AD Determination for Southeast Asian Countries

Country	Finding	Company Investigated	Duty Rate
Malaysia (12%)	Positive	**Hanwha Qcells**	0%
		JinkoSolar**	9.90%
		Baojia New Energy, CRC Solar Cell, Lynter Enterprise, Mega PP	81.24%
		All others (including LONGi)**	9.90%
Vietnam (37%)	Positive	**JA Solar**	53.30%
		JinkoSolar*	71.85%
		Blue Moon,* Boviet,* Elite,* Letsolar,* Mecen,* Nexuns,* Trina Solar,* Vietnergy,* VSUN*	60.02%
		All others	271.28%
Thailand (23%)	Positive	**Trina Solar**	77.85%
		Taihua New Energy, Sunshine Electrical Energy	154.68%
		All others	77.85%
Cambodia (7%)	Positive	All (including **Hounen Solar**, **Solar Long PV Tech**)***	117.12%

^Percentages for each country are of total Q1 and Q2 2024 cell and module imports combined.

On November 29, the U.S. Department of Commerce (DOC) issued a preliminary decision to impose ADDs on c-Si panels and cells produced in Vietnam, Malaysia, Thailand, and Cambodia.

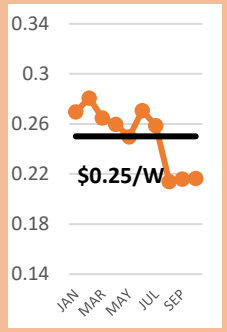
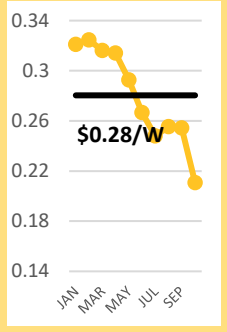
Dumping is when foreign companies sell products for less than it costs them to produce (aka less than fair value). ADDs are imposed to level the playing field for domestic manufacturers. CBP began collecting these duties immediately.

These duties are preliminary and subject to change. They will also be adjusted annually.

Bolded companies are the top 1–2 companies by volume in each country in 2023, according to DOC in this investigation.

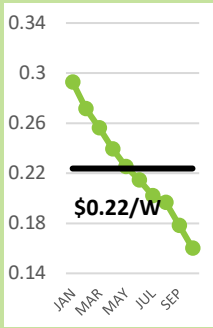
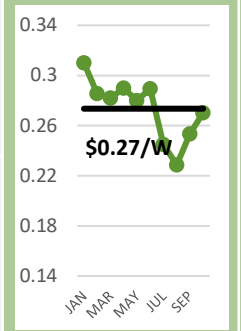
*Updated January 2, 2025 **Updated January 6, 2025 ***Updated February 24, 2025

Preliminary AD Determination for Southeast Asian Countries (Modules)

Country	Finding	Company Investigated	AD	CVD	AD/CVD	Price ($/W)	Impact
Malaysia (9% of modules)	Positive	**Hanwha Qcells**	0%	14.72%	**14.72%**		Range: $0.03 – $0.58 Majority: **$0.05**
		JinkoSolar	9.9%	9.92%	**19.82%**		
		Baojia New Energy	81.24%	124.78%	206.02%		
		CRC Solar Cell, Lynter Enterprise, Mega PP	81.24%	12.32%	93.56%		
		Pax Union Resources, Sunmax Energy	9.9%	124.78%	134.68%		
		All others (including LONGi)	9.9%	12.32%	22.22%		
Vietnam (37% of modules)	Positive	**JA Solar**	53.30%	2.85%	**56.15%**		Range: $0.12 – $1.83 Majority: **$0.77**
		JinkoSolar	71.85%	2.85%	**74.70%**		
		Boviet	60.02%	0.81%	**60.83%**		
		Blue Moon, Elite, Letsolar, Mecen, Nexuns, Trina Solar, Vietnergy, VSUN	60.02%	2.85%	62.87%		
		GEP New Energy, Shengtian New Energy Vina, HT Solar, Vietnam Green Energy	271.28%	292.61%	563.89%		
		All others	271.28%	2.85%	274.13%		

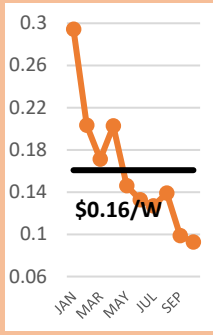
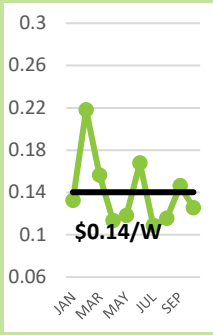
Bolded companies are the top 1–2 companies by volume in the AD or CVD investigation in each country.

Preliminary AD Determination for Southeast Asian Countries (Modules)

Country	Finding	Company Investigated	AD	CVD	AD/CVD	Price ($/W)	Impact
Thailand (27% of modules)	Positive	**Trina Solar**	77.85%	13.59%	**91.44%**		Range: $0.15 – $0.69 Majority: **$0.22**
		Taihua New Energy, Sunshine Electrical Energy	154.68%	73.79%	228.47%		
		All others	77.85%	13.59%	100.91%		
Cambodia (10% of modules)	Positive	**Hounen Solar, Jintek PV Tech,** ISC Cambodia, **Solar Long PV Tech**	117.12%	729.86%	**846.98%**		Range: $0.58 – $2.63 Majority: **$0.69**
		All others (including **SolarSpace New Energy)**	117.12%	137.07%	**254.19%**		

Bolded companies are the top 1–2 companies by volume in the AD or CVD investigation in each country.

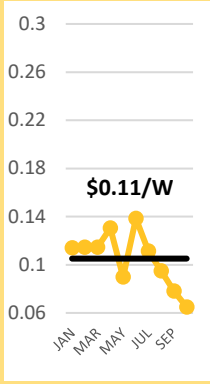
Preliminary AD Determination for Southeast Asian Countries (Cells)

Country	Finding	Company Investigated	AD	CVD	AD/CVD	Price ($/W)	Impact
Malaysia (34% of cells)	Positive	**Hanwha Qcells**	0%	14.72%	**14.72%**		Range: $0.01 – $0.61 Majority: **$0.05**
		JinkoSolar	21.31%	9.92%	**31.23%**		
		Baojia New Energy	81.24%	124.78%	206.02%		
		CRC Solar Cell, Lynter Enterprise, Mega PP	81.24%	12.32%	93.56%		
		Pax Union Resources, Sunmax Energy	21.31%	124.78%	146.09%		
		All others (including LONGi)	21.31%	12.32%	33.63%		
Thailand (19% of cells)	Positive	**Trina Solar**	77.85%	13.59%	**91.44%**		Range: $0.10 – $0.50 Majority: **$0.13**
		Taihua New Energy, Sunshine Electrical Energy	154.68%	73.79%	228.47%		
		All others	77.85%	13.59%	91.44%		

South Korea represents 32% of cell imports.

Bolded companies are the top 1–2 companies by volume in the AD or CVD investigation in each country.

Preliminary AD Determination for Southeast Asian Countries (Cells)

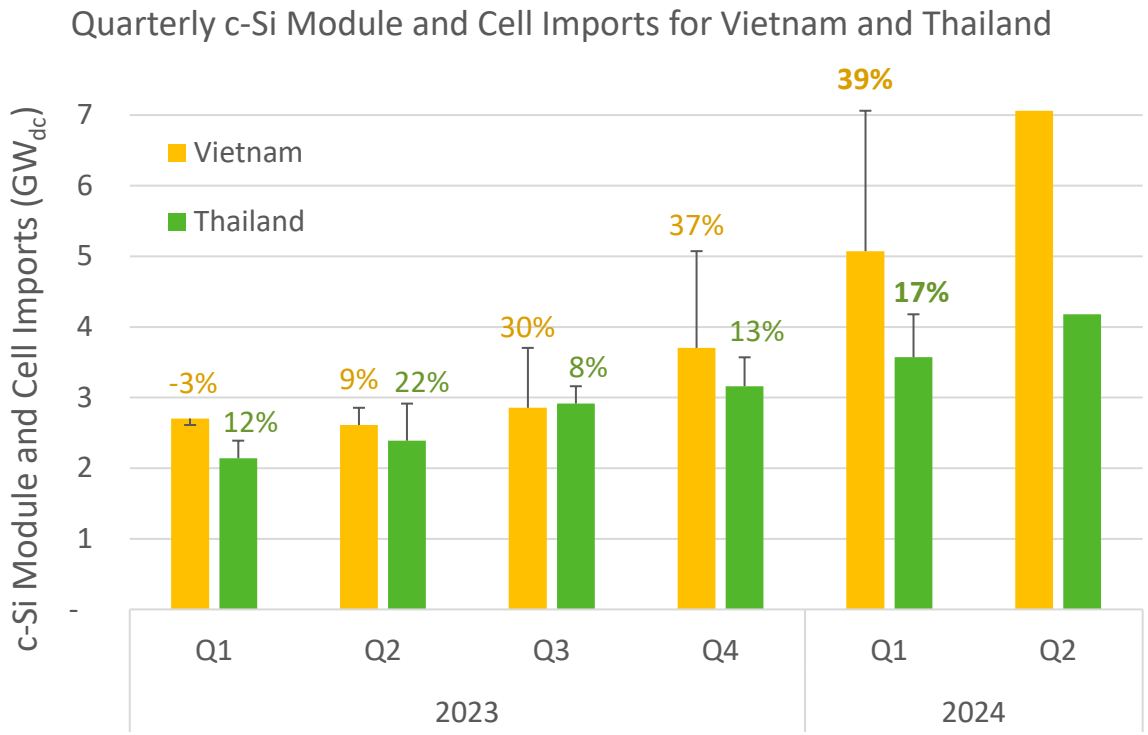
Country	Finding	Company Investigated	AD	CVD	AD/CVD	Price ($/W)	Impact
Vietnam (9% of cells)	Positive	**JA Solar**	53.30%	2.85%	**56.15%**		Range: $0.14 – $0.78 Majority: **$0.30**
		JinkoSolar	71.85%	2.85%	**74.70%**		
		Boviet	60.02%	0.81%	**60.83%**		
		Blue Moon, Elite, Letsolar, Mecen, Nexuns, Trina, Vietnergy, VSUN	60.02%	2.85%	62.87%		
		GEP New Energy, Shengtian New Energy Vina, HT Solar, Vietnam Green Energy	271.28%	292.61%	563.89%		
		All others	271.28%	2.85%	274.13%		

Overall, the impact of these tariffs is **lowest in Malaysia** and highest in Cambodia, Vietnam, and Thailand. These tariffs are likely to have the **greatest impact on domestic module manufacturers importing cells from Thailand**, but that impact is mitigated by falling global cell prices.

South Korea represents and additional 32% of cell imports.

Bolded companies are the top 1–2 companies by volume in the AD or CVD investigation in each country.

Preliminary AD Determination for Southeast Asian Countries



Sources: U.S. Census Bureau USA Trade Online tool and corrections page as of September 4, 2024.

DOC also found critical circumstances for imports from Vietnam and Thailand because they identified recent imports from those two countries as surging.

If the United States International Trade Commission rules positively that this surge resulted in injury to the U.S. industry, retroactive duties (potentially up to 90 days retroactive) would be applied for Vietnamese and Thai imports.

- **JA Solar** and **JinkoSolar (Vietnam)** will be exempt from retroactive duties.
- Notably, **Trina Solar** is not exempt, unlike for CVD.

The final AD determination is expected April 18, 2025.

The related final countervailing duty (CVD) determination is expected February 10, 2025.

Where Does AD/CVD Go?

Who collects AD/CVD?

- Upon a product's entry to the country, CBP collects AD/CVD as security in the form of either cash or a bond.
- This collection is based on an estimate of the best available AD/CVD rates at the time of entry and is not a finalized payment. AD/CVD rates are determined retroactively once the DOC has concluded an administrative proceeding.
- The final AD/CVD amount that an importer is obligated to pay is not known until a few years after the product's time of entry.
- If the final rate is higher than the initially estimated rate, CBP is required to issue a new bill to the importer to collect the additional payment. If the final rate is lower than initially estimated, companies can petition CBP for a partial refund of their payment.

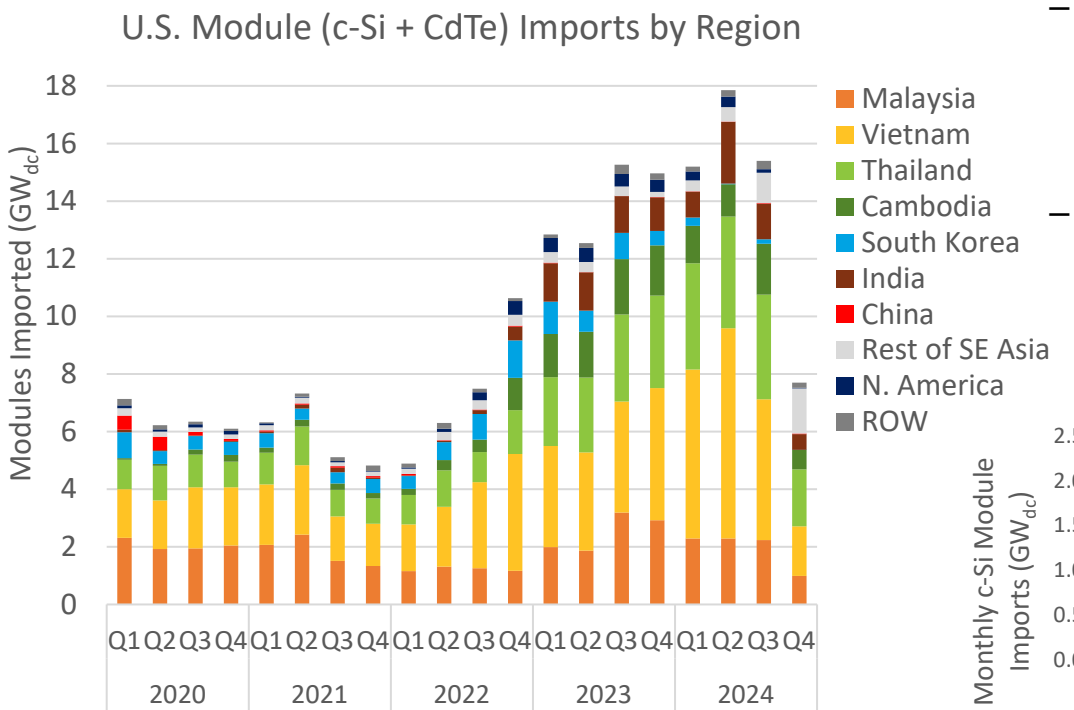
Where does the money go?

- Once CBP receives final AD/CVD payments, this money goes to the U.S. Department of the Treasury.
- For a brief time, AD/CVD payments went to the injured domestic industry.
- In 2000, Congress passed the Continued Dumping and Subsidy Offset Act (CDSOA), which authorized CBP to distribute AD/CVD duties to "affected domestic producers." Domestic producers had to meet certain requirements and petition to be eligible to receive CDSOA payments. CDSOA was repealed in 2006 by another act of Congress.
- All duties that have been collected since September 30, 2007, have gone to the Treasury.

Who has the authority to dictate where the money goes?

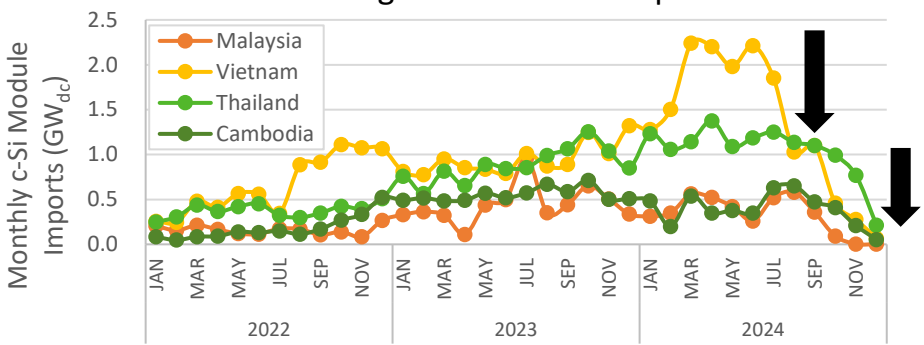
- Congress has the authority to dictate where the money collected from AD/CVD goes. Since 2006, there has not been any action by Congress to change where the money collected under AD/CVD goes.

U.S. Module Imports Q4 2024 by Region



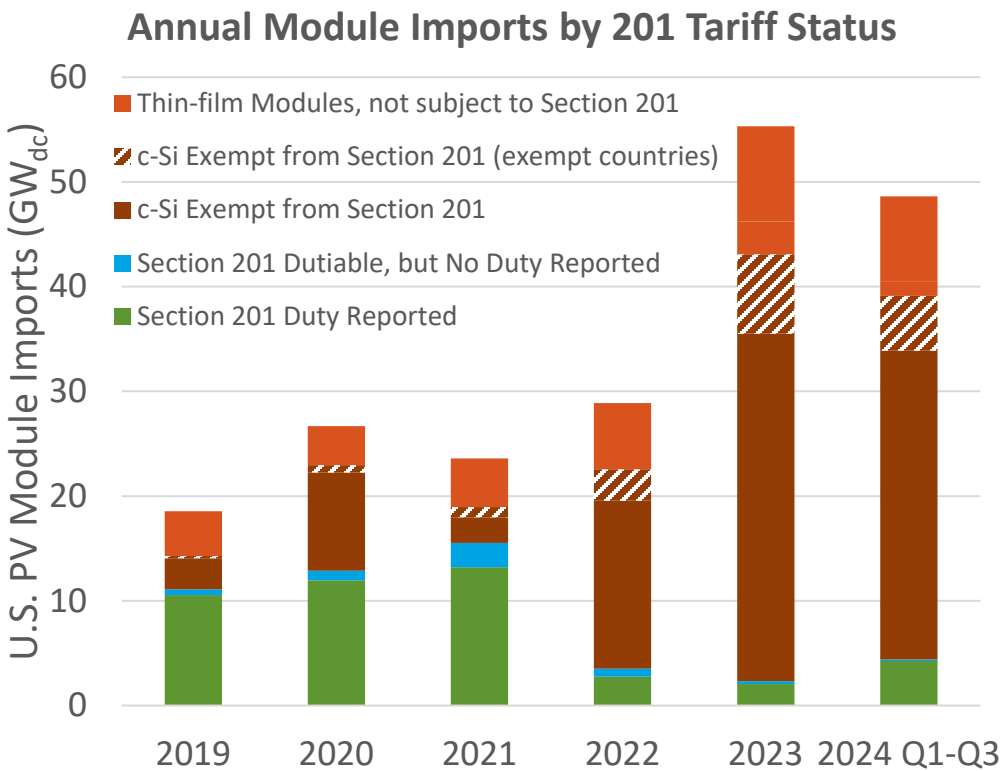
According to U.S. Census data, Q4 2024 fell 50% q/q, hitting only 7.7 GW_{dc}. 56 GW_{dc} of modules were imported total in 2024, the same as 2023.

- After falling more than 1 GW from June to September, Vietnamese c-Si module imports have continued to fall, as have imports from other Southeast Asian countries.
- This is likely in response to a combination of factors, including the end of the Chinese AD/CVD circumvention bridge over the summer, the positive Southeast Asia AD/CVD determinations in the fall, and the start of significant domestic production.



Note: Several gigawatts of imports from India entered under the HTS code for thin-film modules in 2022–2024, but classifications may be erroneous, as the volumes exceed known manufacturing capacities for thin-film panels in India. "ROW" erroneously contained values from Southeast Asian countries in previous issues. "Rest of Asia" has been replaced with "Rest of SE Asia" to better represent the data. **Sources:** Imports by HTS code: 8541460015 (2018–2021)/8541430010 (2022–) and 8541460035 (2018–2021)/8541430080 (2022-); second quantity (watts) from the U.S. Census Bureau USA Trade Online tool and corrections page as of February 5, 2025.

U.S. Module Imports by Tariff Over Time



According to U.S. Census data, in 2019–2021 a much higher fraction of imported modules (40%–60%) reported paying a tariff than 2022–2024.

Starting in 2022, that percentage began to fall off dramatically, hitting a record low of 4% in 2023. Modules can be exempt from Section 201 tariffs for a variety of reasons:

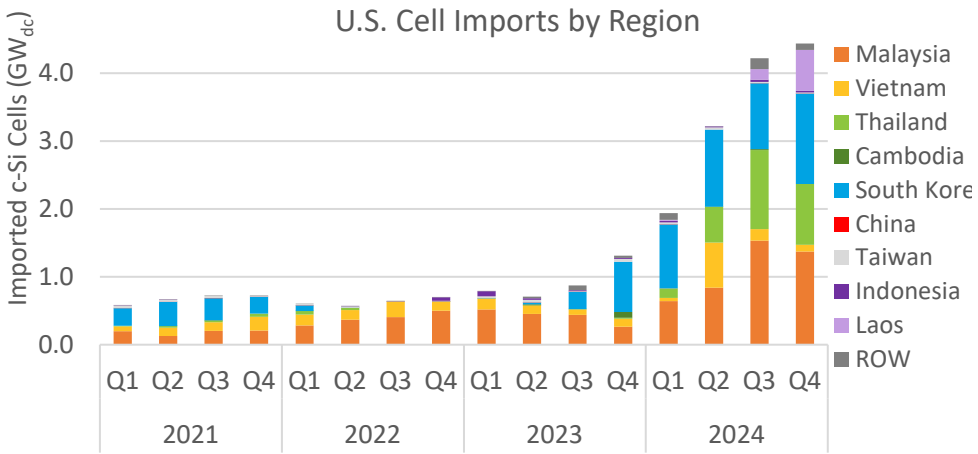
- If they are thin-film modules (including cadmium telluride [CdTe])[a]
- If they were imported from certain exempt countries (most notably Canada and Cambodia)
- If they are bifacial modules when the bifacial exemption was active (October 2020–May 2024) or interdigitated back contact modules.
  - Although country of import and thin-film modules can be differentiated in CBP data, other reasons for exemption cannot.

Sources: Imports by HTS code: 8541460015(2018–2021)/8541430010(2022–) and 8541460035(2018–2021)/8541430080(2022–); second quantity (watts) from the U.S. Census Bureau USA Trade Online tool and corrections page as of October 8, 2024. [a] Several GW of imports from India entered under the HTS code for thin-film modules in 2022–2024, but classifications may be erroneous, as the volumes exceed known manufacturing capacities for thin-film panels in India.

c-Si PV Cell Import Data Q4 2024

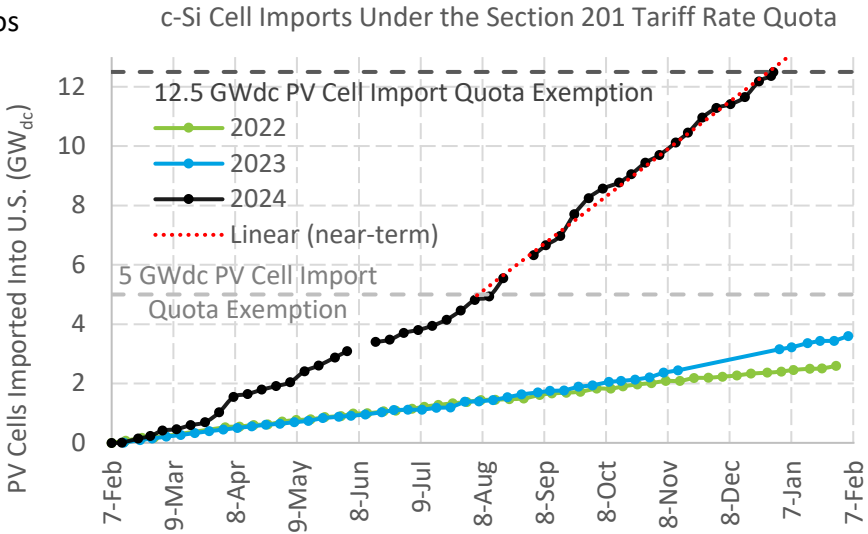
According to U.S. Census data, the United States imported 4.4 GW_{dc} of PV cells in Q4 2024 (+5% q/q), slowing the meteoric growth of previous quarters.

- The United States imported approximately 13.5 GW_{dc} of cells in 2024.
- Although the majority of imports come from Thailand (20%), South Korea (30%), and Malaysia (31%), over the last two quarters, imports from Laos have grown substantially (0% to 4% to 14%).



According to CBP Commodity Status Reports, since the annual tariff rate quota (TRQ) for cells was raised to 12.5 GW in August, imports have continued to accelerate.

On December 30, 2024, the TRQ was reached. All cells imported between then and February 7, 2025, must pay the 14.25% Section 201 tariff. On February 7, 2025, the TRQ will reset but could refill quickly.

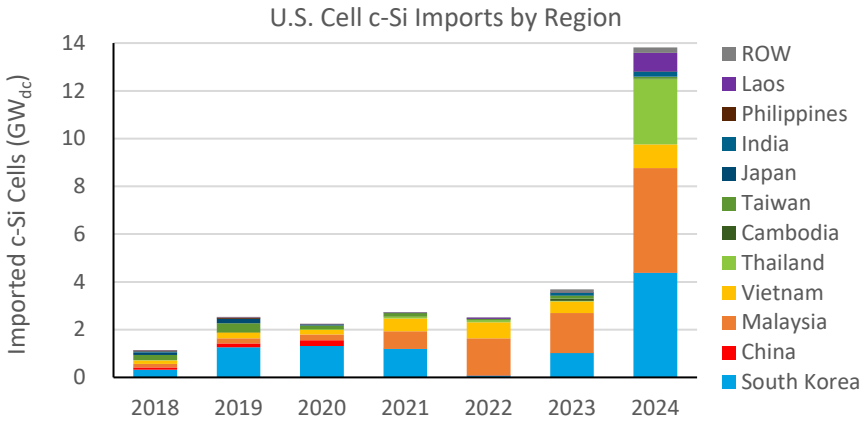


Sources: Imports by HTS code: 8541460025(2018–2021)/8541420010(2022–); second quantity (watts) from U.S. Census Bureau USA Trade Online tool and corrections page as of February 5, 2025; U.S. Customs and Border Protection Commodity Status Reports February 2019–January 2025.

Annual c-Si PV Cell and Module Import Data

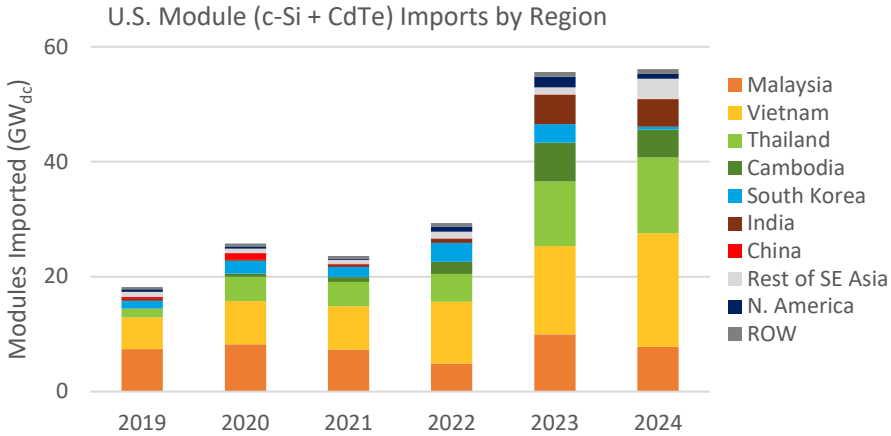
According to U.S. Census data, the United States imported 13.8 GW_{dc} of PV cells in 2024, an increase of 3.7x over imports in 2023.

Malaysia and South Korea each represented nearly a third of cell imports. Thailand (20%), Vietnam (7%), and Laos (6%) represented the remainder.



According to U.S. Census data, the United States imported 56.1 GW_{dc} of PV modules in 2024, a 1% increase over 2023.

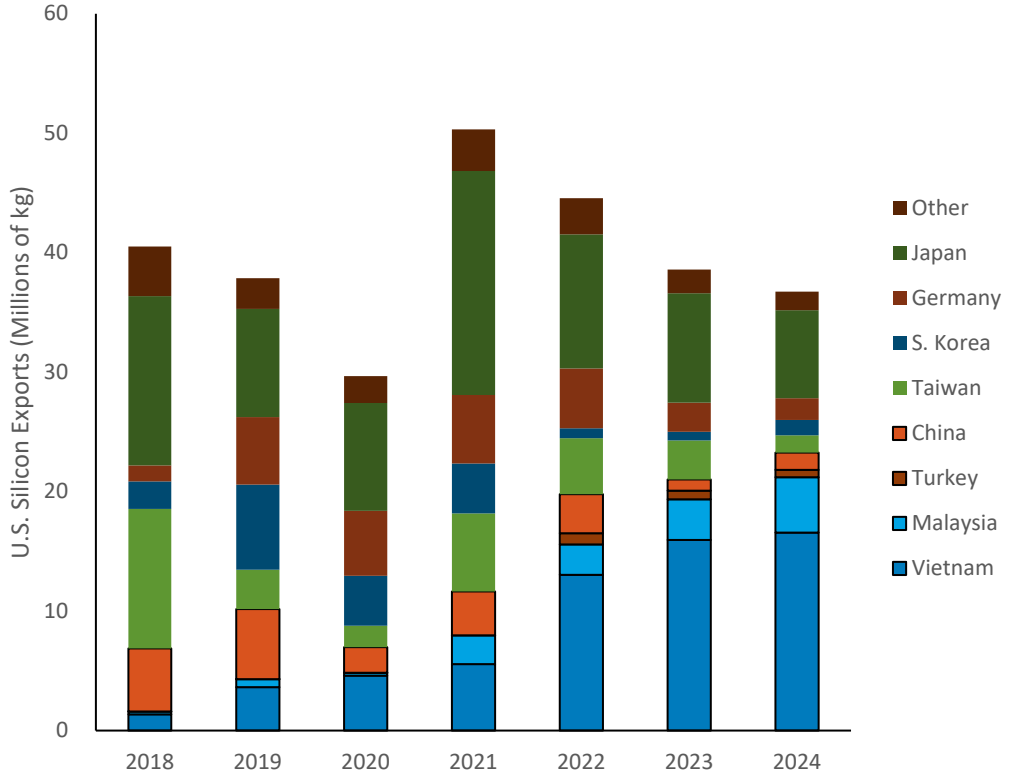
The breakdown of countries between 2023 and 2024 shifted slightly, as module imports from South Korea, Malaysia, and Cambodia fell while imports from Vietnam and the rest of Southeast Asia grew.



Note: Several gigawatts of imports from India entered under the HTS code for thin-film modules in 2022–2024, but classifications may be erroneous, as the volumes exceed known manufacturing capacities for thin-film panels in India. "ROW" erroneously contained values from Southeast Asian countries in previous issues. "Rest of Asia" has been replaced with "Rest of SE Asia" to better represent the data.

Sources: Imports by HTS code: 8541460015 (2018–2021)/8541430010 (2022–), 8541460035 (2018–2021)/8541430080 (2022-) and 8541460025(2018–2021)/8541420010(2022–); second quantity (watts) from the U.S. Census Bureau USA Trade Online tool and corrections page as of February 5, 2025.

U.S. Silicon Exports (>99.99% Purity)



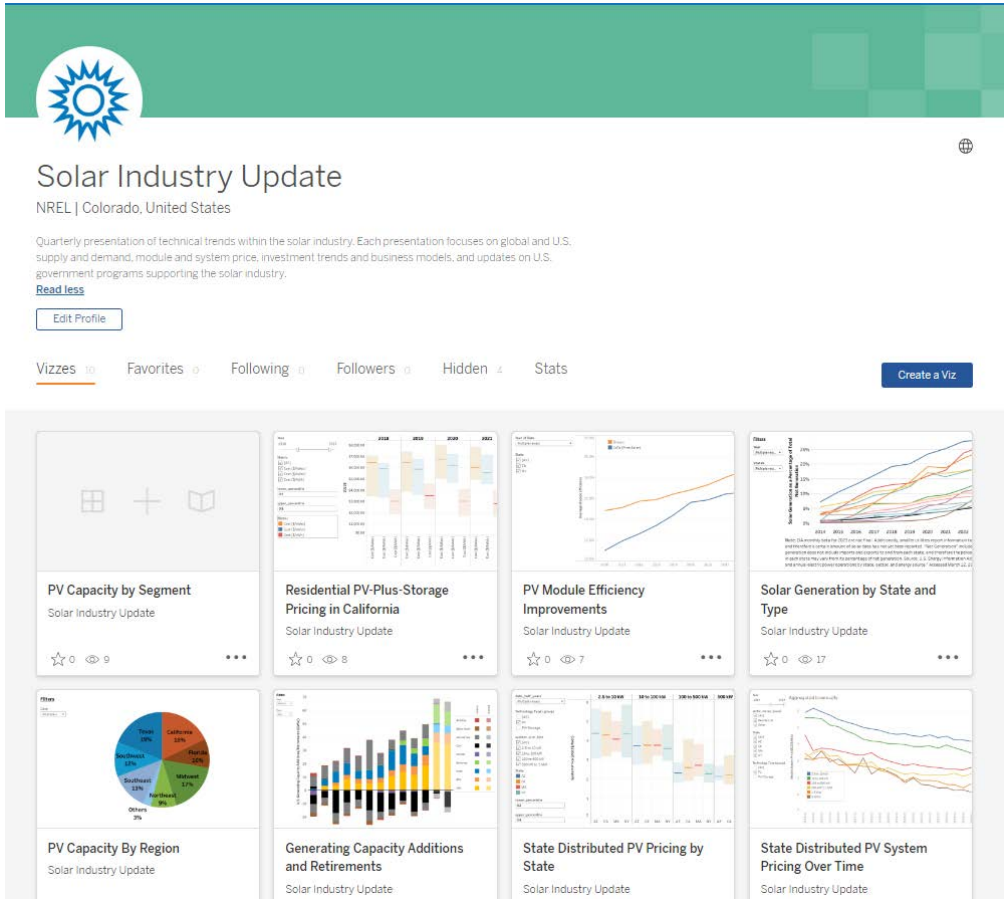
- After China placed duties of 57% on U.S.-manufactured polysilicon, the United States shifted exports to other markets.
  - Once China had fully scaled up its own polysilicon manufacturing industry, U.S. exports went almost exclusively to the semiconductor industry.
- Since 2018, U.S. silicon exports have been flat (in volume, though down in value); however, an increasing share has gone to countries that manufacture a significant amount of PV wafers (e.g., Vietnam, Malaysia, Turkey).
  - U.S. trade policies against China (e.g., UFLPA) have created a bifurcated market, resulting in more demand for U.S. polysilicon for use in PV products.

Note: The United States tracks the export of silicon with a purity exceeding 99.99% (HS Code 2804610000), which is used within the semiconductor industry (9N+) for fire-resistant material (4N+, e.g., spray coating) and for PV wafers (9N). **Sources:** U.S. Census Bureau.

U.S. Silicon Exports (>99.99% Purity)

- The value/kg of silicon exports shipped to countries with significant semiconductor manufacturing capacity was significantly higher than the value/kg of silicon exports to countries with significant PV manufacturing capacity.
  - Polysilicon for semiconductor products has historically traded at a premium price over polysilicon for PV, in part because of the higher purity requirements (though that has narrowed for higher-efficiency products like TOPCon).
  - The rise in value/kg of silicon going to Vietnam, Malaysia, and China in 2022 may be due to a scarcity of UFLPA-compliant polysilicon.
- The value of U.S. silicon exports declined from 2022 to 2024 as shipments shifted more to Vietnam and Malaysia.

Note: The United States tracks the export of silicon with a purity exceeding 99.99% (HS Code 2804610000), which is used within the semiconductor industry (9N+) for fire-resistant material (4N+, e.g., spray coating) and for PV wafers (9N). **Sources:** U.S. Census Bureau.



Interested in checking out more of our data in Tableau? Click here.

Thank You

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List of Acronyms and Abbreviations

ac: alternating current
AD/CVD: antidumping and countervailing duties
AD: antidumping
ADD: antidumping duty
ALMM: Approved List of Models and Manufacturers
APAC: Asia Pacific
APS: Arizona Public Service
ASP: average selling price
BESS: battery energy storage system
c-Si: crystalline silicon
CBP: U.S. Customs and Border Protection
CCI: Community, commercial, and industrial
CDSOA: Continued Dumping and Subsidy Offset Act
CdTe: cadmium telluride
CPUC: California Public Utilities Commission
C&S Amer: Central and South America
CSIRO: The Commonwealth Scientific and Industrial Research Organisation
CSP: concentrating solar power
CVD: countervailing duty
dc: direct current
DOC: U.S. Department of Commerce
DOE: U.S. Department of Energy
DPV: distributed photovoltaic
DSCR: debt service coverage ratio
EIA: U.S. Energy Information Administration
ERCOT: Electric Reliability Council of Texas
ETF: exchange traded fund
EU: European Union
FPV: floating photovoltaic
GW: gigawatt
GWh: gigawatt-hour
H1: first half of year
H2: second half of year
HTF: heat transfer fluid
HTS: harmonized tariff schedule
ITC: investment tax credit
kW: kilowatt
kWh: kilowatt-hour
LBNL: Lawrence Berkeley National Laboratory
LFP: lithium iron phosphate
MENA: Middle East & North Africa
MLPE: module-level power electronics
MOIC: multiple on invested capital
MW: megawatt
MWh: megawatt-hour
NEM: net energy metering
NREL: National Renewable Energy Laboratory
NYSERDA: New York State Energy Research & Development Authority
PERC: passivated emitter and rear contact
PG&E: Pacific Gas & Electric
PPA: power purchase agreement
PTC: production tax credit
PV: photovoltaics
Q: quarter
q/q: quarter over quarter
RE: renewable energy
ROW: rest of world
SCE: Southern California Edison
SE: southeast
SEGS: Solar Energy Generating Systems
SEIA: Solar Energy Industries Association
SETO: Solar Energy Technology Office
SOFR: secured overnight financing rate
SREC: solar renewable energy certificate
TAN: Invesco Solar ETF
TOPCon: tunnel oxide passivated contact
TPO: third-party owner
TRQ: tariff rate quota
TW: terawatt
UFLPA: Uyghur Forced Labor Prevention Act
USD: U.S. dollars
W: watt
Wt avg: weighted average
y/y: year over year
YTD: year to date