NREL
NATIONAL RENEWABLE ENERGY LABORATORY

# Summer 2022 Solar Industry Update

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# Agenda

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

**Note: the material in this report was written before the introduction of the Inflation Reduction Act by Congress.**

# Executive Summary

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### Global Solar Deployment

- Xinjiang province in China announced 13 CSP projects totaling 1.35 GW would be developed. Combined with the 1.1 GW of CSP projects announced by other provinces in January 2022, and which are already hiring EPCs and breaking ground, these projects, once completed, would make China the largest CSP market in the world.
- The Global Off-Grid Lighting Association tracked 7.4 million off-grid solar products installed in 2021. They had a capacity of 69 MW.

### U.S. PV Deployment

- As of Q4 2021, the solar industry employed more than 255,000 workers.
- The United States installed 4.3 GWac of PV in Q1 2022; ~45% of that was in Texas, Florida, and California.
- EIA estimates solar will install almost 26 GWac in 2022 and 33 GWac in 2023, compared to 19 GWac in 2021.
- 29% of U.S. utility-scale PV and ~19% of all U.S. PV systems built in 2021 used CdTe panels.
- The United States installed ~2.9 GWh (0.955 GWac) of energy storage onto the electric grid in Q1 2022.
- The percentage of utility-scale PV systems paired with batteries is expected to increase to 32% of new additions in 2022, 25% in 2023, and 32% in 2024.

### PV System and Component Pricing

- Reported PV system prices from select states increased between H1 2021 and H1 2022, representing the first time consistent price increases were observed in conjunction with the PV supply chain challenges that accelerated beginning in Q2 2021.
- Prices in dollars were flat at relatively high levels for polysilicon ($33–$36/kg or about $0.09/W), wafers (~$0.12/W), cells (~$0.16/W), and modules (~$0.26/W) in Q2 2022.
- In Q1 2022, U.S. utility-scale monofacial mono c-Si module prices rose $0.03/W (y/y) and $0.02/W (q/q), and they were trading at a 54% premium over global ASP.

### Global Manufacturing

- PV manufacturers, mostly Chinese companies, have generally been profitable since 2019.
- In 2021, 10 select Chinese companies spent over $7 billion in R&D, compared to $100 million each by First Solar and Maxeon, and about $1 billion by IEA governments.

### U.S. PV Imports

- 4.9 GWdc of PV modules were imported into the United States in Q1 2022, down 23% y/y. As of May, imported modules and cells from the four countries under investigation for AD/CVD circumvention were significantly below where they were a year ago (-32%, -597 MW y/y), mainly as a result of decreased imports from Malaysia.

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

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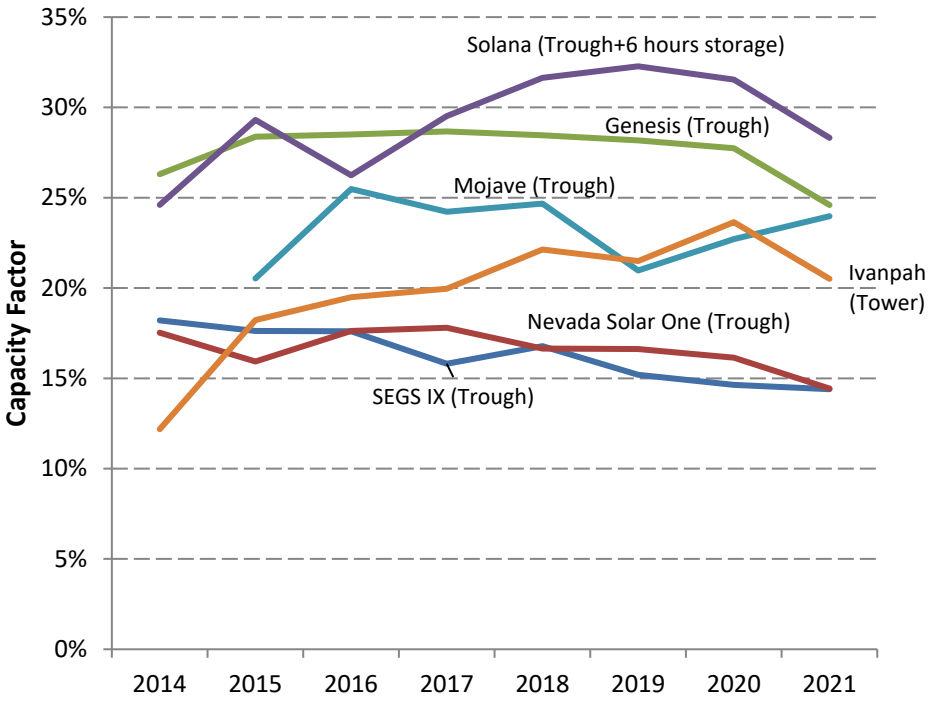
- **The Global Off-Grid Lighting Association tracked 7.4 million off-grid solar products installed in 2021. They had a capacity of 69 MW.**

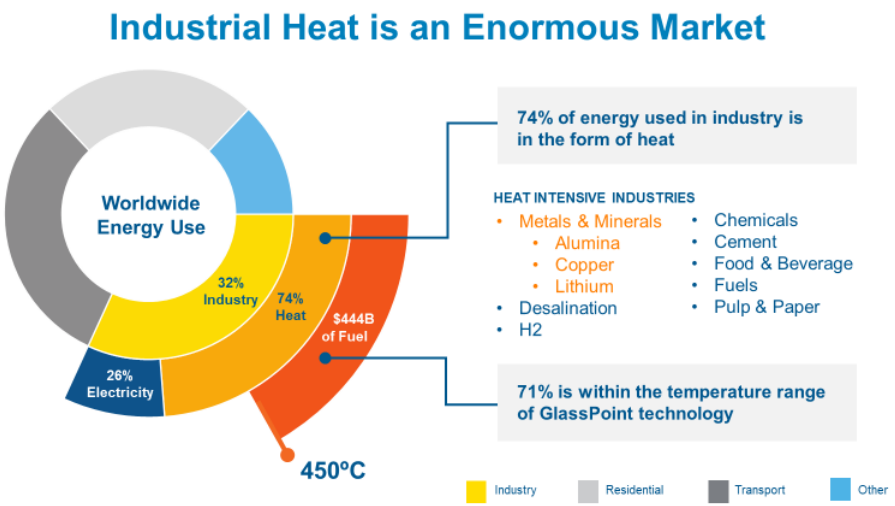
# U.S. CSP Project Generation Performance, 2010–2021




- Though it took a few years to optimize the operation of the five U.S. CSP plants brought online between 2013 and 2015, four of them now generally perform better than when they began operation.
  - Annual weather variation caused some of the differences in annual production.
  - Five of the six active large-scale U.S. CSP projects had reduced capacity factors in 2021, which likely indicates lower insolation levels for the year.
- Absolute capacity factor is not necessarily the best metric for performance, as plants can be designed and operated differently.
  - SEGS IX capacity factor has decreased over time as its original PPA expired and shifted to merchant production.
  - SEGS IX and Nevada Solar One have been operational for 32 and 15 years respectively.

**Source:** EIA, Form 923.

# GlassPoint Restarts Operations



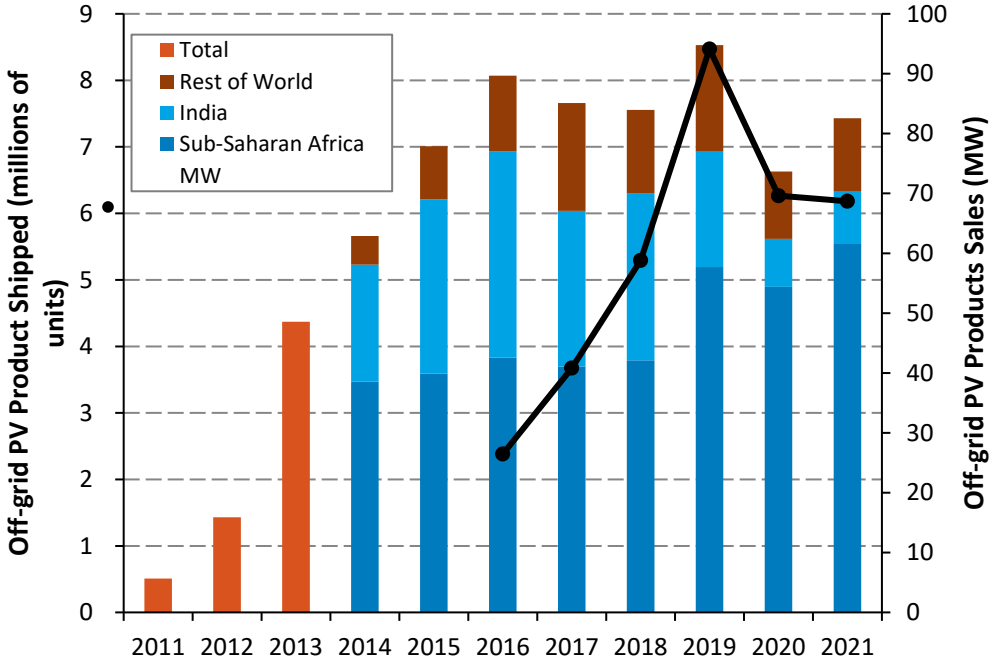

**Source:** Glasspoint

- New York based GlassPoint, Inc —producer of parabolic trough technology in greenhouses for industrial process heat use—has restarted operations and signed a memorandum of understanding to develop a 1.5-GWth steam plant to help refine bauxite ore into alumina.
  - Glasspoint Solar Inc, entered into liquidation during the onset of Covid pandemic in 2020 after key shareholders held back additional funds needed to keep the business operational.
  - Instead of selling equipment, the company will now provide renewable heat through long-term (e.g., 20 years) offtake agreements under a build-own-operate structure.
- The company claims 17% ($444 B) of worldwide energy is used on industrial heat that falls in the range of GlassPoint technology applications.

# Chinese CSP Update

- The Xinjiang province in China announced 13 CSP projects, totaling 1.35 GW, would be developed.
  - Most of these projects would include 8 hours of storage, though three would include 12 hours.
  - In January 2022, the provinces of Gansu, Qinghai, and Jilin announced 1.1 GW of combined CSP projects in 2024, and they are already hiring EPCs and breaking ground. Combined, these project announcements would make China the largest CSP market in the world.
- The Chinese Solar Thermal Alliance stated that China is pursuing CSP for three applications: firm, dispatchable power to complement wind and PV; the generation of hydrogen and jet fuels at temperatures up to 1,500 degrees Celsius; and solar heat for industrial processes. They attribute three factors to the growth of the Chinese CSP market:
  - Consistent government project deployment support
  - R&D funding at 11 major Chinese universities
  - A local CSP supply chain that now comprises more than 500 companies.

# Global Off-Grid Solar Market




- The COVID-19 pandemic significantly contracted the sale of off-grid solar products due to:
  - Regional lockdowns
  - Logistical and supply chain challenges
  - Hardware pricing increases.
- The Global Off-Grid Lighting Association tracked 7.4 million off-grid solar products installed in 2021. They had a capacity of 69 MW.
  - The association estimates it tracks roughly 28% of total off-grid sales, though it varies by product and market.
  - 75% of sales in 2021 were in sub-Saharan Africa (24% from Kenya alone), and 11% were in India.
  - Approximately 63% of the systems installed in 2021 were cash sales; however, cash sales only represented 16% of solar home systems (versus the pay-as-you-go financing model).

Source: Global Off-Grid Lighting Association, "Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data."

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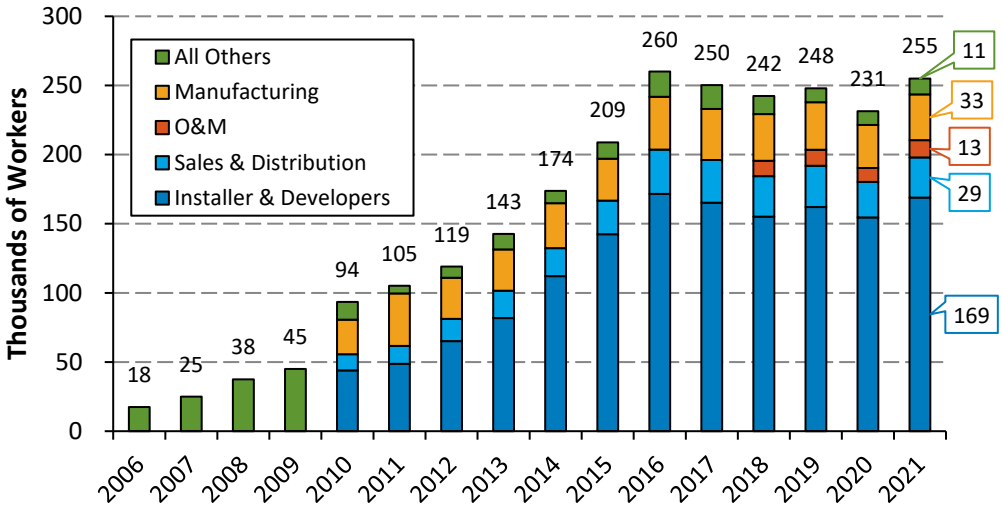
- **As of Q4 2021, more than 255,000 U.S. employees spent most of their time on solar.**
- **The United States installed 4.3 GWac of PV in Q1 2022; ~45% of that was in Texas, Florida, and California.**
- **EIA estimates solar will install almost 26 GWac in 2022 and 33 GWac in 2023, compared to 19 GWac in 2021.**
- **29% of U.S. utility-scale PV and ~19% of all U.S. PV systems built in 2021 used CdTe panels.**
- **The United States installed ~2.9 GWh (0.955 GWac) of energy storage onto the electric grid in Q1 2022.**
- **The percentage of utility-scale PV systems paired with batteries is expected to increase to 32% of new additions in 2022, 25% in 2023, and 32% in 2024.**

# U.S. Solar Workforce

- As of Q4 2021, more than 255,000 U.S. employees spent most of their time on solar. An additional 78,850 workers spent less than half their time on solar-related work, and 21,910 installation jobs at solar firms are focused on storage.

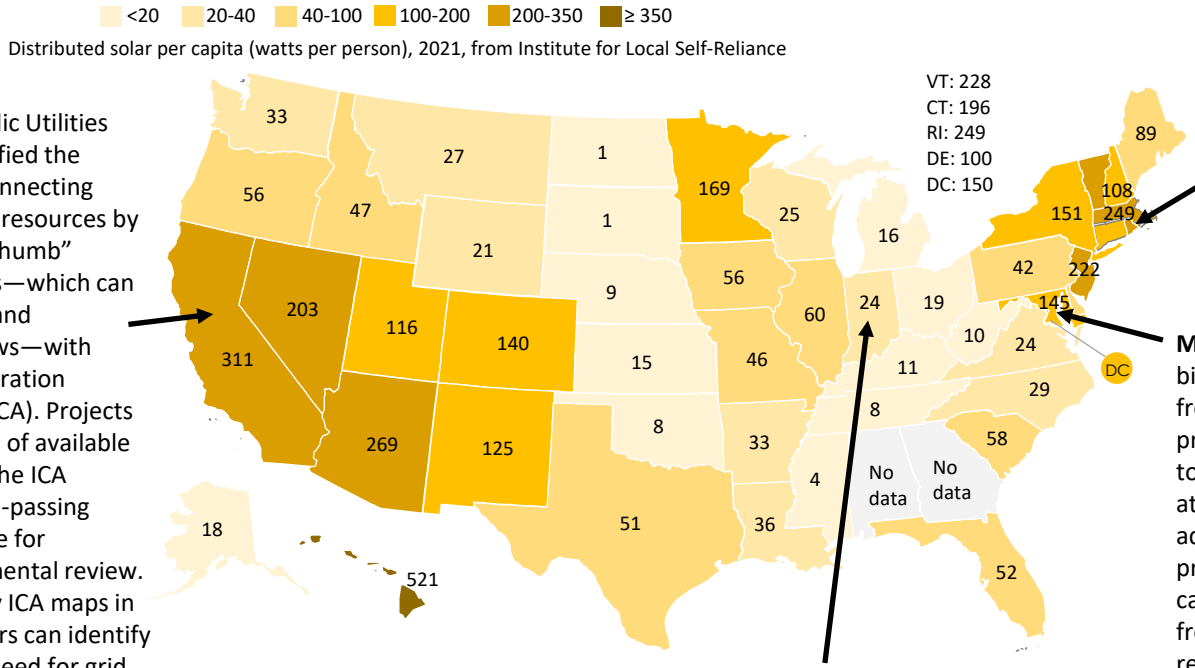



**Source**. IREC, The National Solar Jobs Census 2021. July 2022.

- This is a growth of 9.2% over 2020 and 2% growth over 2019, most of which was in the installation and project development sectors.
  - In contrast, annual PV installations grew by 78% since 2019.
- Solar jobs increased in 47 states in 2021, led by California (+7,035), Massachusetts (+1,053), Nevada (+1,019), and Arizona (+932).
  - However, 89% of solar firms reported it was very difficult or somewhat difficult to find qualified applicants—a 6% increase since 2019.
- Women are underrepresented within the solar workforce. They represent under 30% of the solar workforce, compared to an overall national workforce average of 47%.
  - Black employees and people 55 and over are also underrepresented, while solar reports a higher representation of union members, veterans, and non-Black minorities (including Asian and Latinx workers).

# Q2 2022 State Updates

**Multiple states proposed or implemented policy changes related to solar energy. Policies likely to promote solar deployment included California's new interconnection process, Rhode Island's 100% renewable electricity goal, and Maryland's community solar incentives. The compensation policies replacing net metering in Indiana likely will hinder solar deployment.**




Distributed solar per capita (watts per person), 2021, from Institute for Local Self-Reliance

The **California** Public Utilities Commission simplified the process for interconnecting distributed energy resources by replacing "rule of thumb" screening methods—which can lead to expensive and unnecessary reviews—with more-precise integration capacity analysis (ICA). Projects not exceeding 90% of available capacity can pass the ICA screening, and non-passing projects are eligible for expedited supplemental review. By reviewing utility ICA maps in advance, developers can identify locations with no need for grid upgrades and then streamline their installation processes.

**Rhode Island** adopted legislation (H277/S2274) committing to offset all electricity with 100% renewable energy by 2033—the fastest path to 100% renewables of the 10 states currently committed to this goal.

**Maryland** passed two community solar bills. HB 1039 exempts community solar from county and municipal corporate property taxes if 50% of electricity goes to low- to moderate-income customers at a reduced rate, and it establishes additional tax incentives for agrivoltaic projects. HB 440 expands the maximum capacity of a community solar project from 2 to 5 MW, and it reduces land requirements for siting projects on contiguous lots.

Net metering expired on July 1 for solar customers in **Indiana**. It is to be replaced by "excess distributed generation" tariffs with reduced compensation. Solar advocates are bringing court challenges.



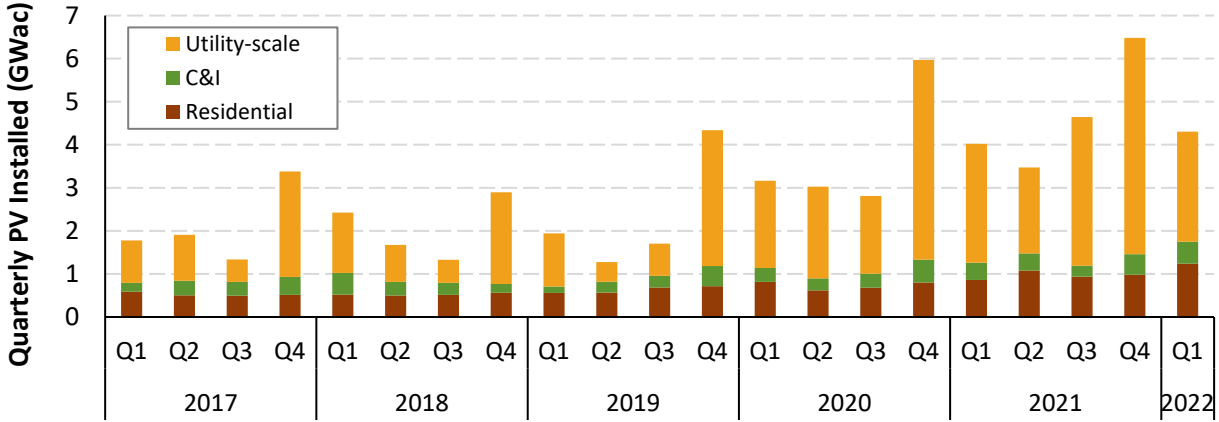
**Source:** Environment America (6/30/22), TaiyangNews (6/30/22), Indianapolis Star (6/29/22), PV Magazine (6/8/22, 6/30/22), Institute for Local Self-Reliance, accessed 2022.

# U.S. Installation Breakdown Annual: EIA ($GW_{ac}$)

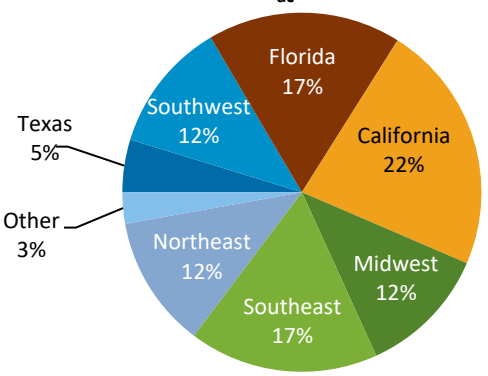
- Despite the impact of the pandemic and trade issues, according to EIA data, the United States installed 4.3 $GW_{ac}$ of PV in Q1 2022, its largest Q1 ever—up 7% y/y.
  - Residential (1.2 $GW_{ac}$) and C&I (0.5 $GW_{ac}$) were up significantly in Q1 2022: 44% and 27% y/y, respectively.
  - However, utility-scale PV was down 7% y/y, installing only 2.6 $GW_{ac}$.

- Approximately 45% of U.S. PV capacity installed in Q1 2022 was in Texas, Florida, and California.
- Despite a concentration of PV installations in the top three markets, diversification of growth continues across the United States.
  - 19 states had more than 1 $GW_{ac}$ of cumulative PV installations by Q1 2022 and 12 states installed more than 100 $MW_{ac}$ in Q1 2022.

**U.S. PV Installations by Market Segment**




**Q1 2022 U.S. PV Installations by Region (4.3 $GW_{ac}$)**

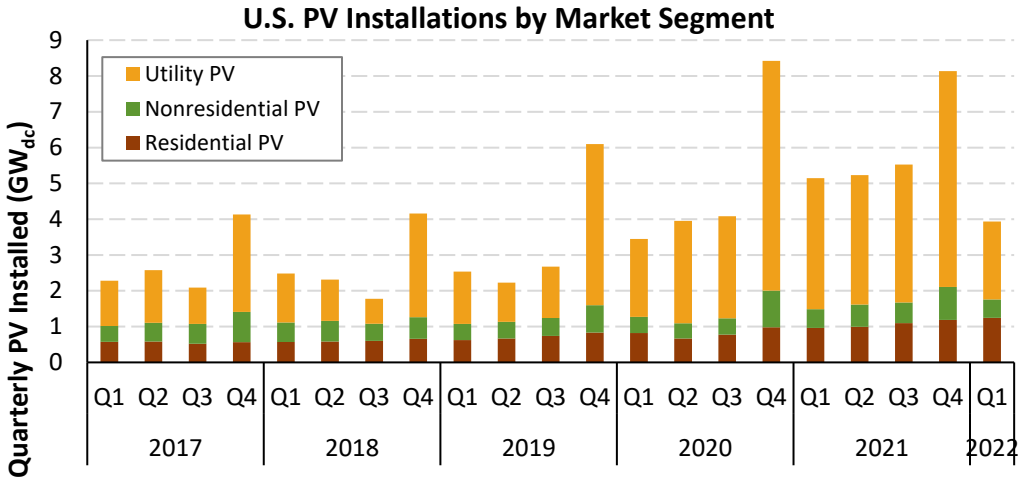



**Note:** EIA reports values in $W_{ac}$ which is standard for utilities. The solar industry has traditionally reported in $W_{dc}$. See the next slide for values reported in $W_{dc}$.
**Sources**: EIA, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861 (April 2022, February 2021, February 2019).

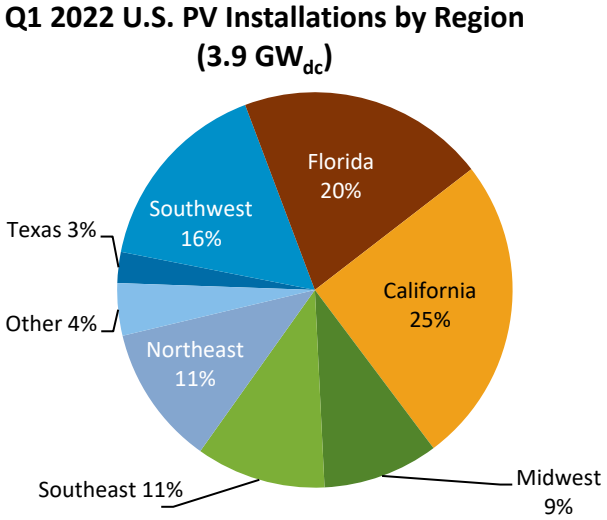
# U.S. Installation Breakdown Annual: SEIA ($GW_{dc}$)

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

- In contrast to the EIA data, SEIA reports that the United States installed 3.9 $GW_{dc}$ of PV in Q1 2022—a decrease of 24% y/y.
  - The utility-scale market accounts for most of this loss, with only 2.2 $GW_{dc}$ (-41% y/y) installed.
  - Nonresidential PV held fairly steady at 0.5 $GW_{dc}$ (-2% y/y) and Residential PV saw significant gains at 1.2 $GW_{dc}$ (+30% y/y) installed.

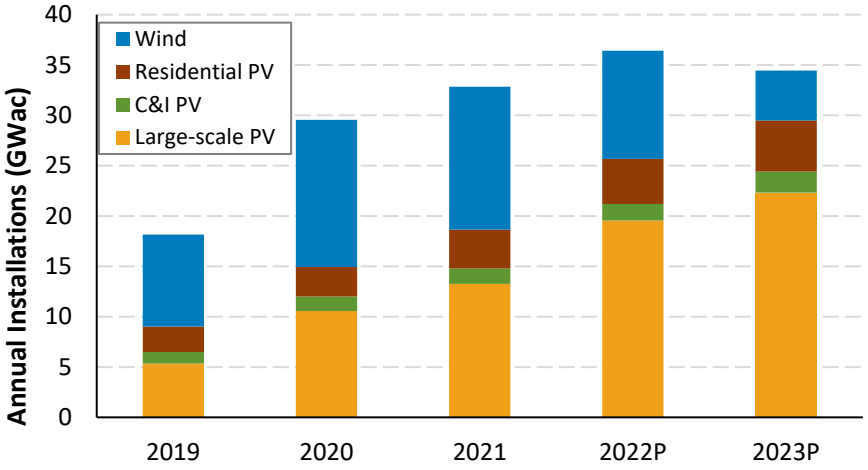



- California and Florida continue to lead installations and were the only two states to surpass 500 $MW_{dc}$ installations in Q1 2022.
- After significant installations in 2021, Texas started off 2022 more slowly, with only 100 $MW_{dc}$ installed in Q1 2022.



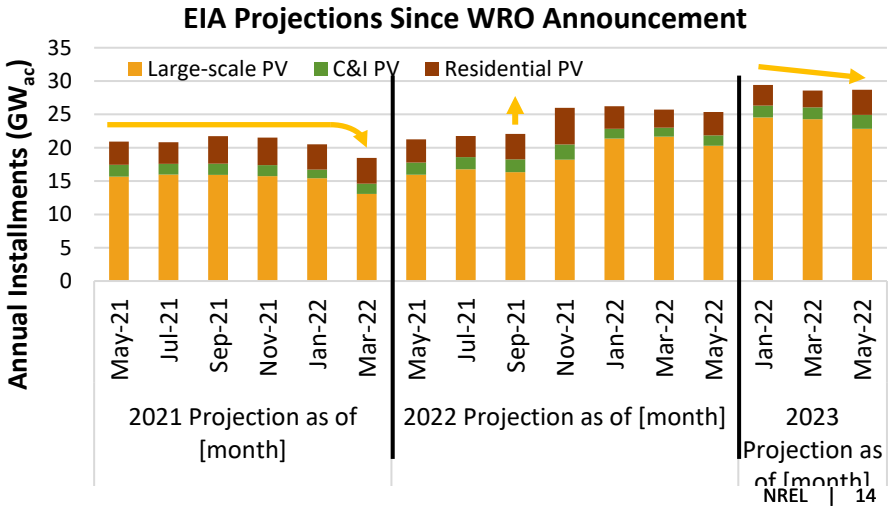

**Sources:** Wood Mackenzie/SEIA: U.S. Solar Market Insight: Q2 2022.

# Near-Term Projections for U.S. Solar and Wind Installations



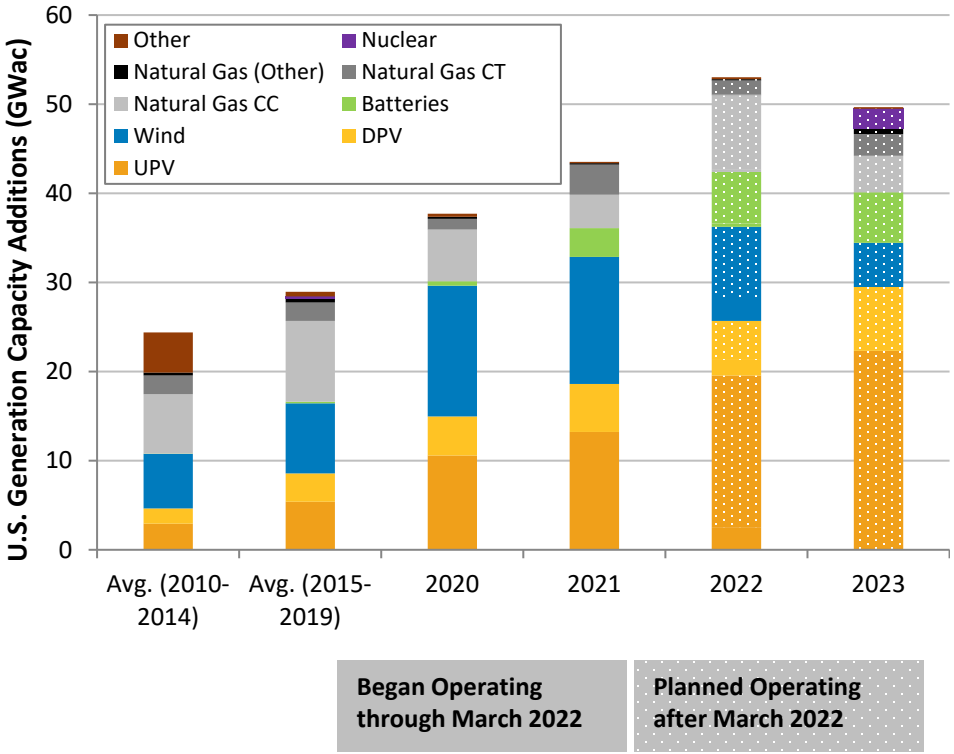

- Despite reported increases in supply chain disruptions, EIA projections have remained fairly steady over the last year, although there was an uptick in October of 2021 in the projections for 2022, and projections for 2023 have generally trended downward.
  - This was presumably as a result of 2021 projects being pushed out as 2021 installations fell short of EIA projections, as it predates the ITC and PTC changes proposed in the Build Back Better Framework.

- EIA projects U.S. solar and wind annual installations in 2022 to continue to grow from 32.9 GWac in 2021 to 36.4 GWac, but dip in 2023, mainly as a result of decreasing wind installations.
  - Annual wind installations are projected to fall from 14 GWac in 2021 to 11 GWac in 2022 and 5 GWac in 2023.
  - EIA estimates solar will install almost 26 GWac in 2022 and 33 GWac in 2023, compared to 19 GWac in 2021.
- The projected 149 GWac of cumulative U.S. solar in 2023 would surpass cumulative U.S. wind capacity for the first time.
  - EIA expects that small-scale (<1 MW) solar capacity will grow by 6 GWac in 2022 to reach a total of 39 GWac and will grow by an additional 7 GWac in 2023 to 46 GWac.




**Sources:** U.S. EIA Short-term Energy Outlook Table 8b, May 2021–June 2022.

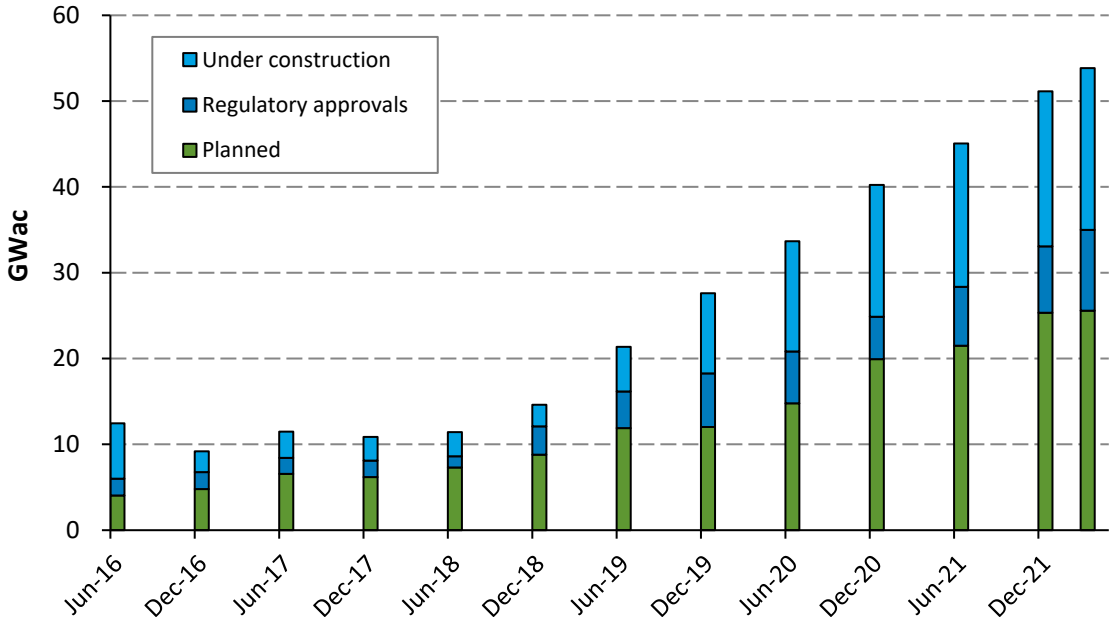
# U.S. Generation Capacity Additions by Source: 2010–2021 and *Planned* 2022–2023




- Based on EIA's Short-term Energy Outlook, renewable energy will provide 22% of U.S. generation in 2022 and 24% in 2023, up from 20% in 2021.
  - Solar PV installation delays from 2022 to 2023 account for about 1 $GW_{ac}$ of the expected installed solar capacity.
- Based on planned capacity additions, EIA estimates the percentage of U.S. electric capacity additions from solar will grow from 43% in 2021 to 58% in 2022 (37% UPV and 12% DPV).
  - It is estimated that in 2022 wind and solar will represent 68% of all new electric generation capacity and battery storage will represent another 12%.
- Despite robust projections from EIA, in June, SEIA revised its 2022 solar projections downward a further 6.3 $GW_{dc}$ from its already reduced December predictions, and it is expecting the market to shrink y/y due to uncertainty created by the anti-circumvention investigation.
  - However, it is worth noting this prediction was made before the president's announcement of a 2-year relief from AD/CVD enforcement. Given that, SEIA noted "a few gigawatts of upside potential to 2022 installations" in its Solar Market Insight.

**Sources:** EIA Form 860M/Preliminary Monthly Electric Generator Inventory ("Planned" and "Operating" Mar 2022), U.S. EIA Short-term Energy Outlook Table 8b, June 2022, Wood Mackenzie/SEIA: U.S. Solar Market Insight: Q2 2022.

# EIA PV Project Planned Pipeline

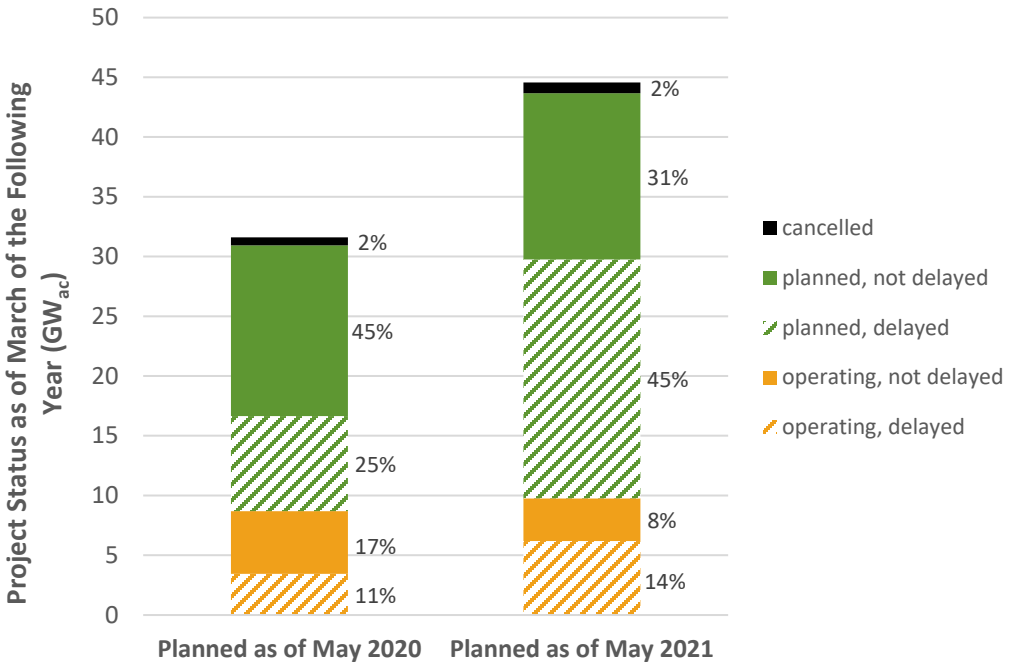



According to EIA data, the U.S. PV project pipeline of utility-scale PV projects continues to hit record highs, with 19 $GW_{ac}$ of projects under construction, 9 $GW_{ac}$ having received regulatory approval, and 25 $GW_{ac}$ planned as of March 2022.

Though the planned pipeline continues to grow, there has been a noticeable increase in delays since the announcement of the WRO in June 2021.

**Note:** Pipeline is defined as all planned PV projects that have been submitted in EIA's Form 860M. All projects have a scheduled placed-in-service date between 2022 and 2030.
**Source:** EIA Form 860M (June 2016–March 2022).

# EIA PV Project Planned Pipeline Delays



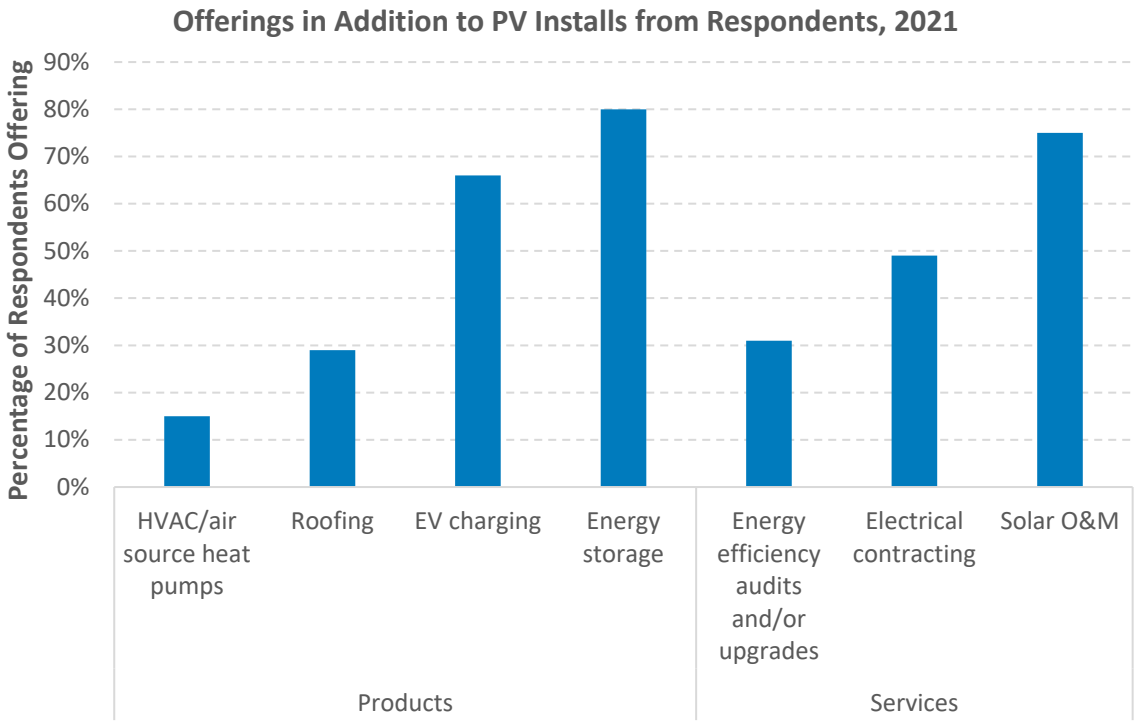

As of March 2022, 440 projects representing 26.2 $GW_{ac}$ planned in May 2021 had been delayed. Compared to the same 10-month period in 2020, that represents an increase of 23% in $GW_{ac}$ (20% planned, 3% operating).

The average length of a project delay increased by 4 months (10 months versus 6 months) across that period as well. Ninety-eight projects, accounting for more than 8 GWac, were delayed more than a year.

**Note:** Pipeline is defined as all planned PV projects that have been submitted in EIA's Form 860M. All projects have a scheduled placed-in-service date between 2022 and 2030.

**Source:** EIA Form 860M (May 2020, March 2021, May 2021, and March 2022).

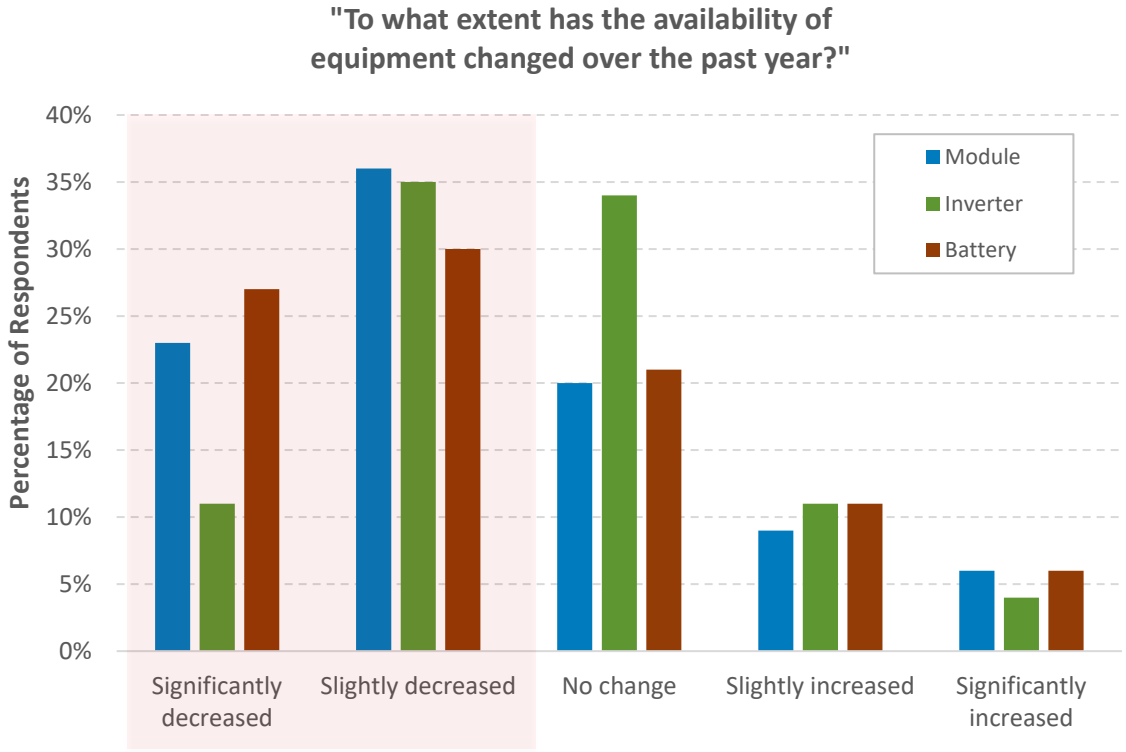
# EnergySage Installer Survey: Methods and Sample




- EnergySage and the North American Board of Certified Energy Practitioners surveyed installers in Q1 2022.
  - They received 501 responses from 43 states, Washington D.C., and Puerto Rico (not just EnergySage installers).
  - Respondents were mainly small-to-midsize and local-to-regional solar companies; over 70% installed less than 1 MW of residential in 2021 (about 2–3 projects per week).
- The survey reported that a higher percentage of respondents offered solar-adjacent products than in previous years.
  - 23% of installs included roof upgrade
  - 13% of installs included EV charger.
- The primary business lines of installers included PV (66%), electrician (8%), O&M (6%), consulting (5%), and solar hot water (3%).

**Source:** EnergySage Solar Installer Survey: 2021 Results, May 2022.

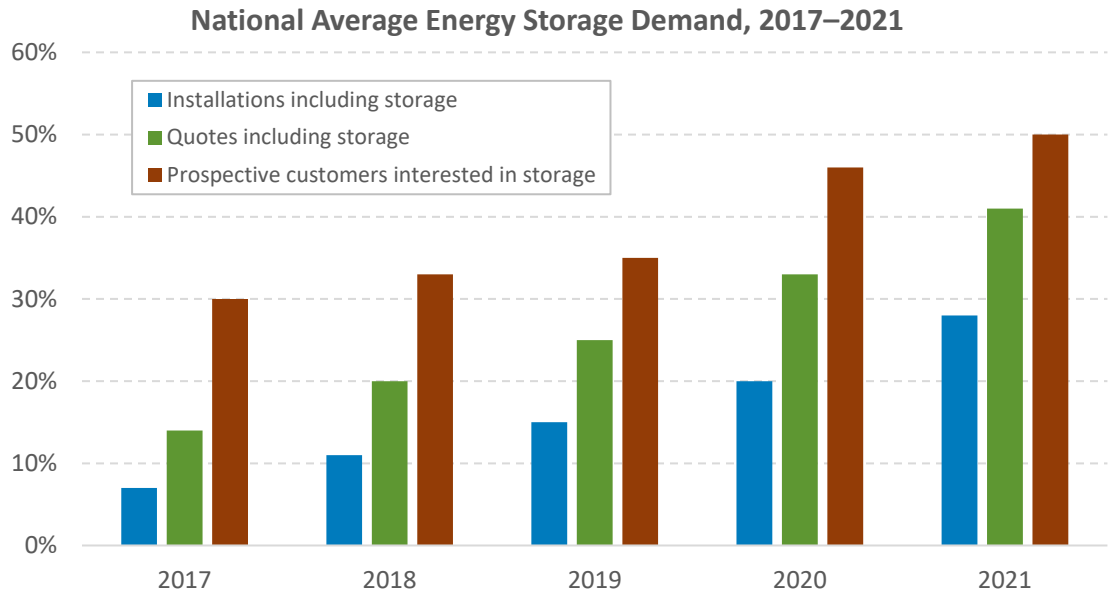
# EnergySage Installer Survey: Supply and Labor Constraints




- In 2021, 60% of respondents reported decreased sales due to supply constraints, with impacts from:
  - Freight delays (75% of respondents)
  - Withhold release order (14%)
  - Antidumping and countervailing duties (12%).
- Equipment availability declined in 2021 for most respondents, and 21% reported it as a barrier to growing business.
- Lack of trained labor was the most frequently reported barrier to growing business (44% of respondents).
  - PV installation best practices was most frequently identified as the most beneficial training category (32% of respondents).

**Source:** EnergySage Solar Installer Survey: 2021 Results, May 2022.

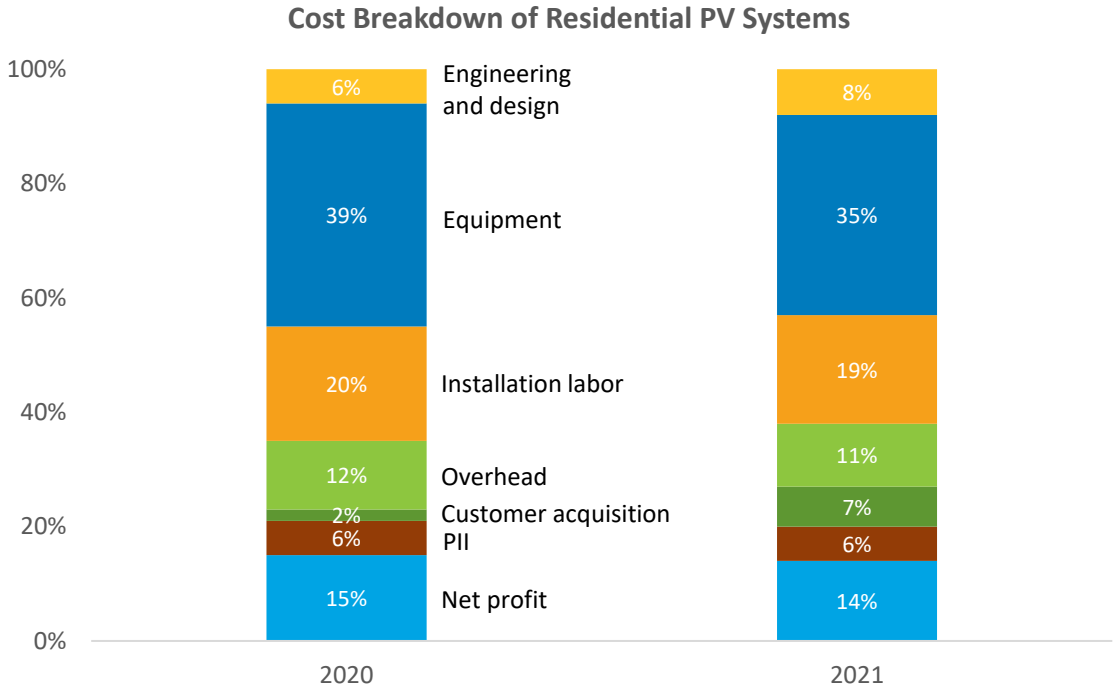
# EnergySage Installer Survey: Energy Storage




- In 2021, 28% of installations performed by respondents nationwide included storage, including:
  - 41% in Florida
  - 38% in California.
- Two-thirds of respondents said consumers are most interested in storage for emergency backup power.
  - Yet 41% of EnergySage shoppers said financial savings drove storage adoption; 36% said backup power.
- In 2021, 75% of respondents identified battery cost as a primary barrier to storage sales.
  - 44% identified insufficient incentives.
  - 35% identified battery availability issues, up from 20% in 2020.

**Source:** EnergySage Solar Installer Survey: 2021 Results, May 2022.

# EnergySage Installer Survey: Cost Breakdowns

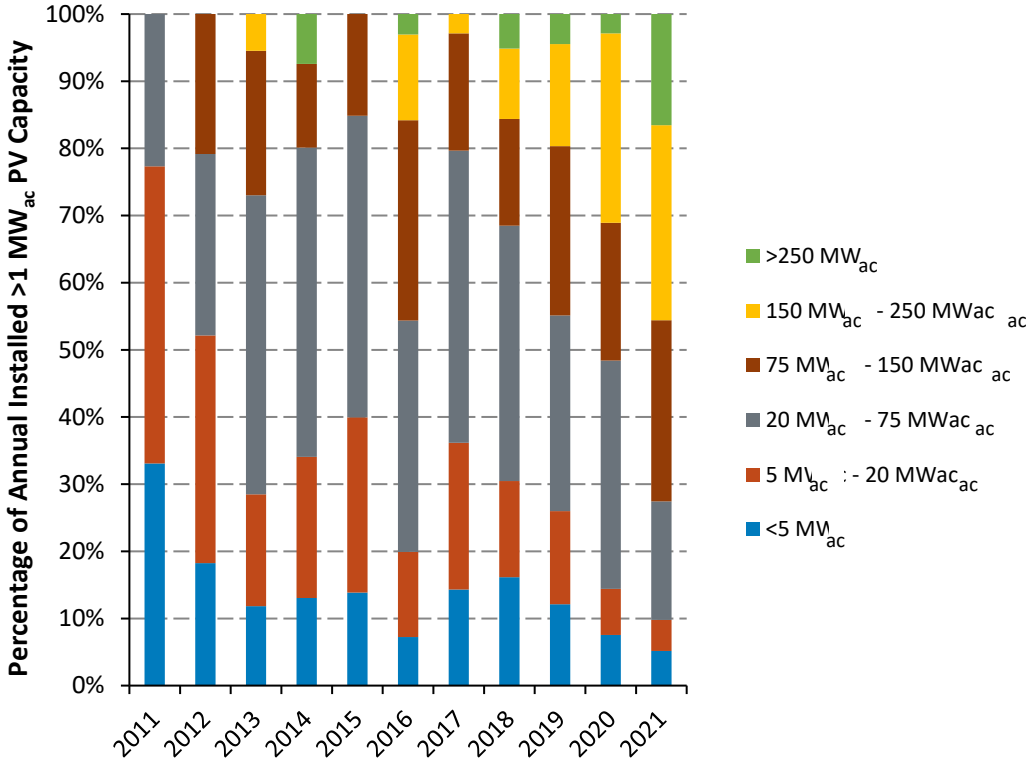



- The breakdown of residential system costs reported by respondents was similar in 2020 and 2021 with a few exceptions:
  - Customer acquisition accounted for a larger percentage in 2021.
  - Equipment accounted for a smaller percentage in 2021.
- Most respondents reported customer acquisition costs increased (38%) or remained unchanged (38%) in 2021.
  - Customer acquisition cost was surveyed for the first time. It averaged $792 per residential customer, or $0.11/W for a 7-kW system.
  - The difficultly of customer acquisition was lower in 2021 for 36% of respondents, unchanged for 37%, and higher for 27%.

PII = permitting, inspection, and interconnection

**Source:** EnergySage Solar Installer Survey: 2021 Results, May 2022

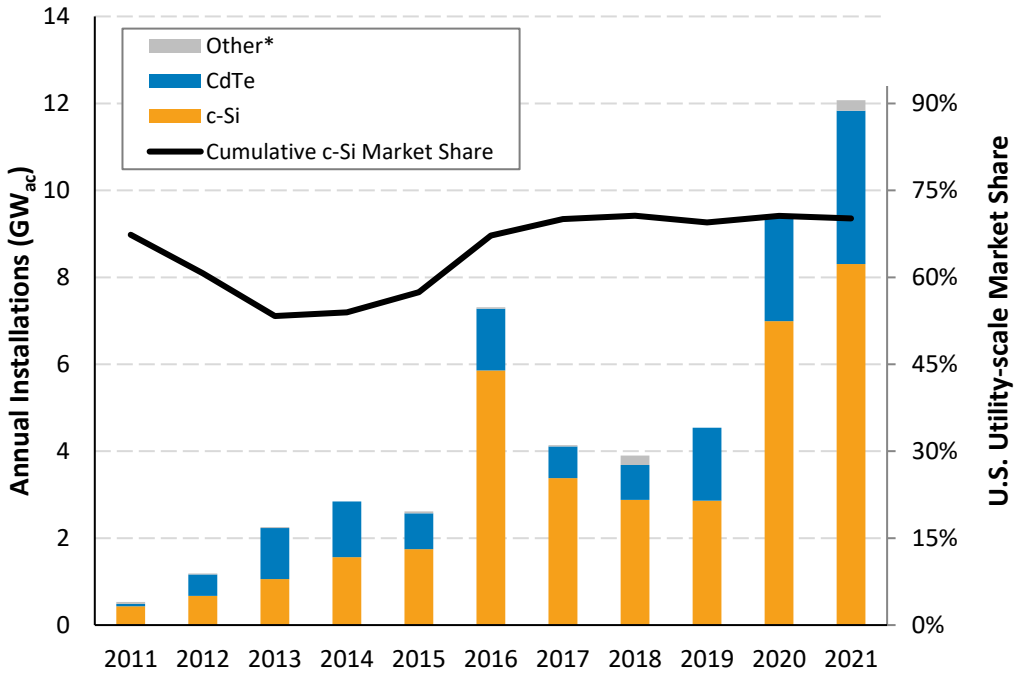
# >1 $MW_{ac}$ U.S. PV System Size Distribution by Year




- In 2011, only 23% of the U.S. PV systems (greater than 1 MWac installed) were above 20 MWac. The largest system was 35 MWac.
- In 2021, 90% of U.S. PV systems (above 1 MWac installed) came from systems above 20 Mwac. The largest system was 420 MWac.
- 2021 also marked the first year more than one system larger than 250 MWac was installed.

**Source:** U.S. EIA, Form EIA-860 2021ER. Corrections were made to the Nameplate Capacity of the 2021 Lily Solar Hybrid facility based on news reports.

# U.S. Utility-Scale PV Technology Distribution by Year

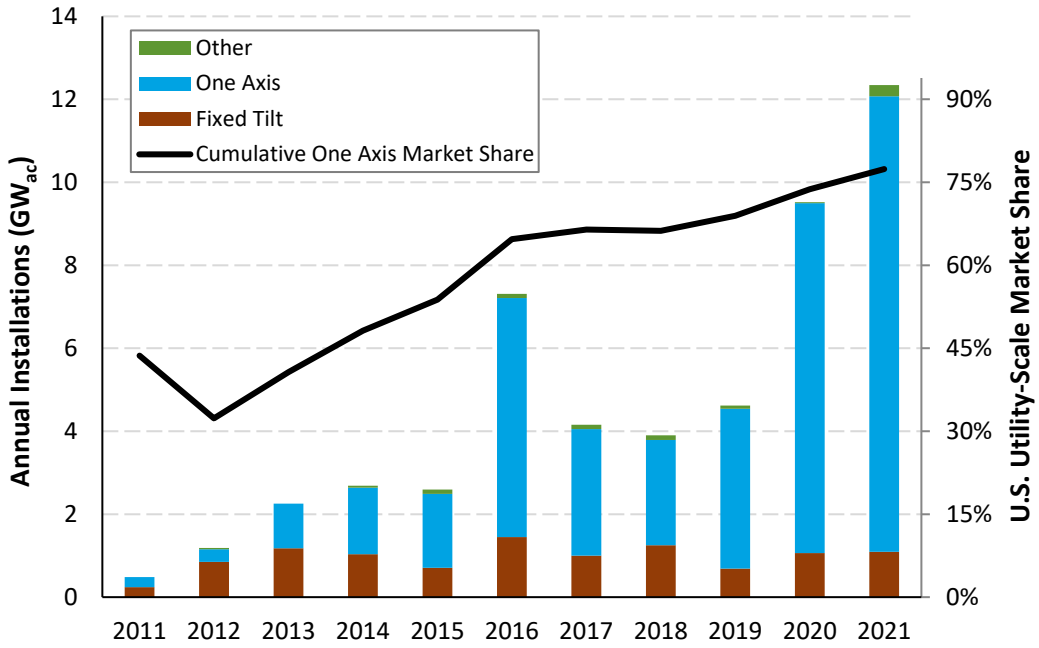



- Though thin-film PV represented less than 5% of global PV deployed from 2011 through 2021, it accounted for 30% of U.S. utility-scale PV deployments during this period.
  - 29% of U.S. utility-scale PV and ~19% of all U.S. PV systems built in 2021 used CdTe panels.
- c-Si has held remarkably steady over the past years—a testament to both technology's ability to scale as annual installations have grown significantly in that time.

* "Other" includes CIGS and a-Si, but also could represent data entry errors.

**Source:** U.S. EIA, Form EIA-860 2021ER. Utility-scale was defined as >5 $MW_{ac}$ facilities. Corrections were made to the Nameplate Capacity of the 2021 Lily Solar Hybrid facility based on news reports.

# U.S. Utility-Scale PV Mounting Type by Year



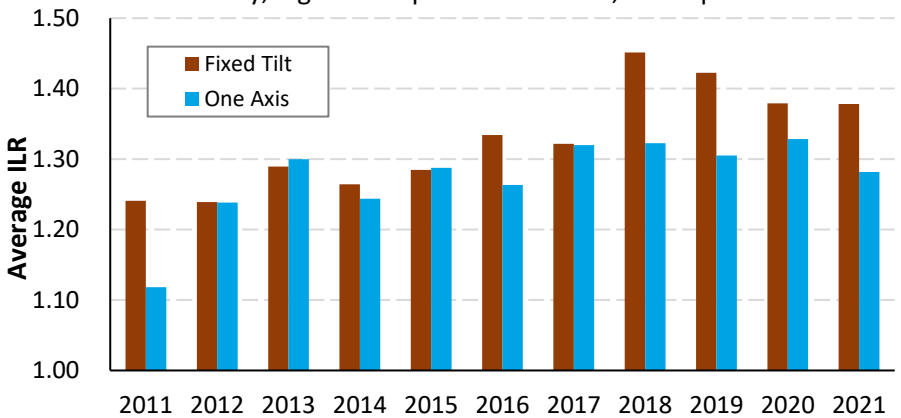

- The use of single-axis/one-axis tracking in the U.S. utility PV market has grown significantly over the past decade.
  - At the end of 2021, 77% of all U.S. utility-scale PV systems used single-axis tracking. And 89% of U.S. utility-scale PV systems installed in 2021 used single-axis tracking.
  - This growth can be attributed to the reduced cost and increased reliability of trackers, making them the economic choice in a broader distribution of PV systems (e.g., less irradiant climates).

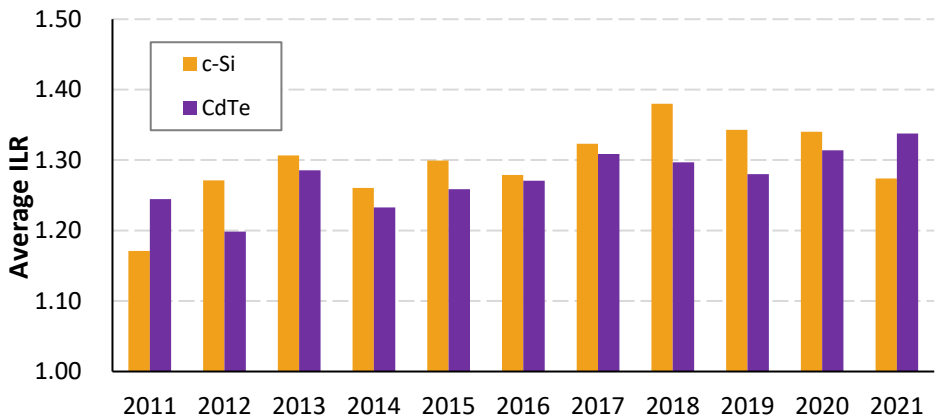
* "Other" includes two-axis tracking systems, but also could represent data entry errors.

**Source:** U.S. EIA, Form EIA-860 2021ER. Utility-scale was defined as >5 $MW_{ac}$ facilities. Corrections were made to the Nameplate Capacity of the 2021 Lily Solar Hybrid facility based on news reports.

# U.S. Utility-Scale PV Average Inverter Loading Ratio (ILR) by Year

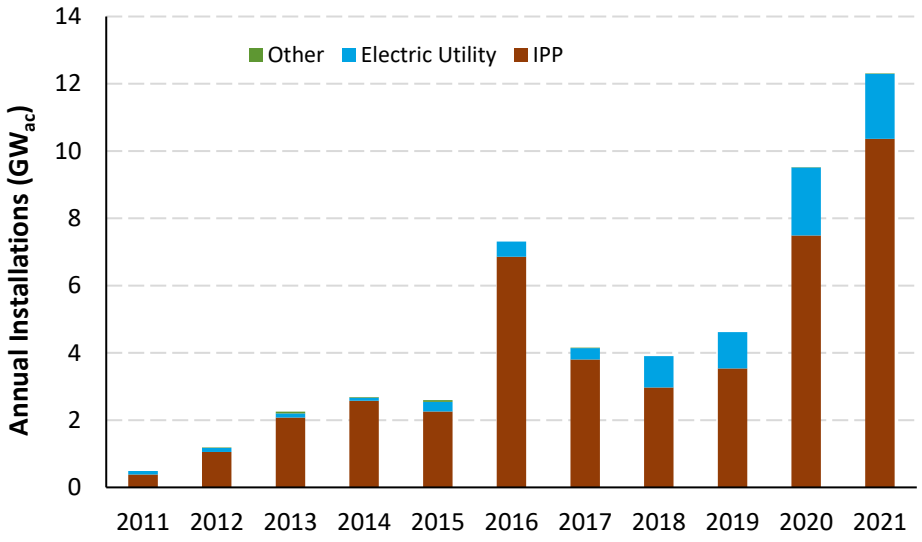
- Since 2011, the average ILR has increased for both fixed-tilt and one-axis tracking UPV systems in the United States. The average ILRs for fixed-tilt and one-axis tracking systems installed in 2021 were 1.38 and 1.28 respectively.
- For c-Si and CdTe systems, the average ILRs in 2021 were 1.27 and 1.34 respectively. ILRs for both technology types have increased since 2011, although 2021 does mark the first year since 2011 that c-Si systems have a lower ILR than CdTe.
  - Additionally, c-Si ILR has declined steadily from 1.38 in 2018 to 1.27 in 2021. This is likely due to the growth in the use of bifacial c-Si modules whose systems are typically designed with a lower ILR, due to a higher output per module.
- As panel prices have dropped, it makes more economic sense for developers to oversize their PV arrays relative to their inverters. Additionally, higher ILRs produce a flatter, wider production curve, which may be attractive from a load management perspective.




**Source:** U.S. EIA, Form EIA-860 2021ER. Utility-scale was defined as >5 $MW_{ac}$ facilities. Corrections were made to the nameplate capacity of the 2021 Lily Solar Hybrid facility based on news reports and to the DC Net Capacity of the 2021 Titan Solar Project, SE Athos II, Townsite Solar Project Hybrid, Aragorn Solar Project, and both Juno Solar Projects based on news reports from pv magazine and prnewswire.

# U.S. Utility-Scale PV Asset Ownership by Year




- Most U.S. utility-scale PV systems—84% of installations in 2021, 85% cumulative—are owned by independent power producers, which sell their electricity under long-term contracts.
- However, from 2011 to 2021, 7.5 GW of PV installed was owned by electric utilities—1.9 GW was installed in 2021 alone.
- Utilities own PV in 21 states, but 59% of installed capacity is in Florida and another 11% is in Virginia.
  - The Florida PSC and Virginia General Assembly established rules that would encourage direct utility ownership of solar assets.

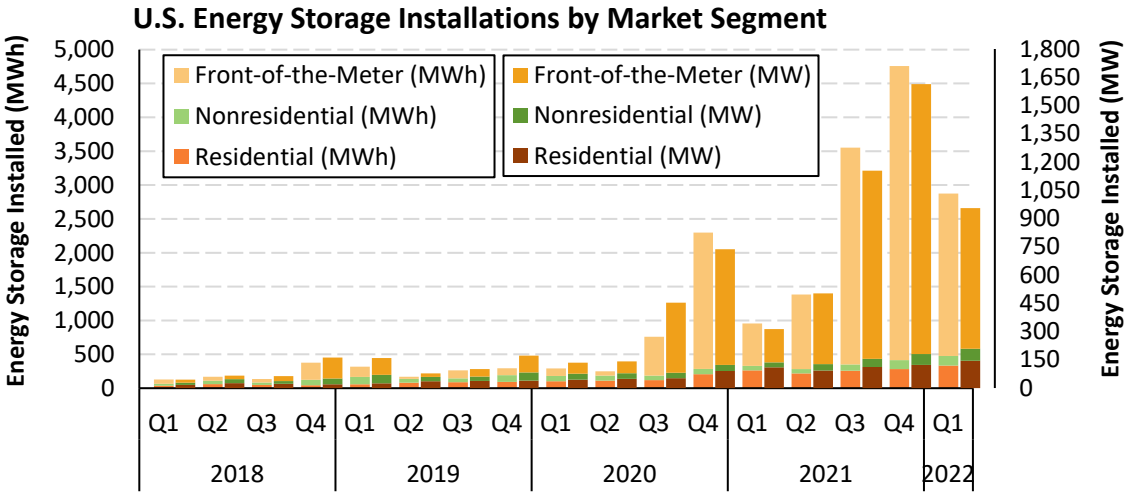
* "Other" includes commercial and industrial projects, but also could represent data entry errors.

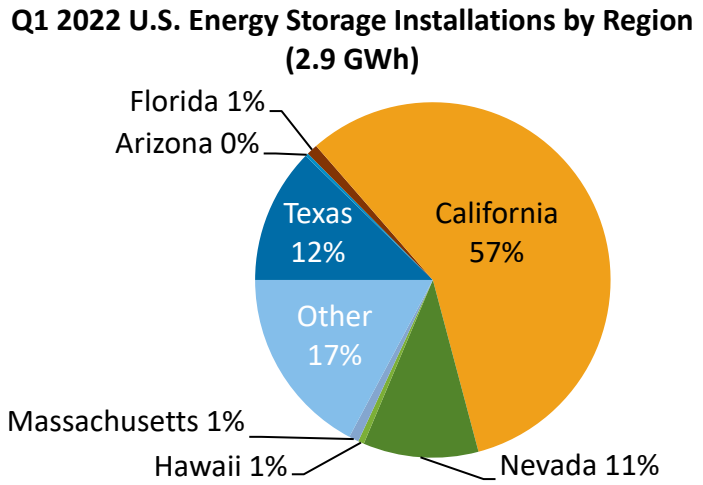
**Source:** U.S. EIA, Form EIA-860 2021ER. Utility-scale was defined as >5 $MW_{ac}$ facilities. Corrections were made to the Nameplate Capacity of the 2021 Lily Solar Hybrid facility based on news reports.

# U.S. Energy Storage Installations by Market Segment

- The United States installed approximately 2.9 GWh (0.955 $GW_{ac}$) of energy storage onto the electric grid in Q1 2022, +205% (+201%) y/y, as a result of record levels of residential and non-residential deployment.
  - Grid-scale, nonresidential, and residential were up 322%, 140%, and 32% in Q1 2021 y/y, respectively.

- California continues to dominate front-of-the meter and residential installations, however Texas and Nevada also had significant installations in Q1 2022.
  - A growing diversity of states are installing storage, with 24 states installing >1 $MW_{ac}$ of residential storage and 10 with >5 $MW_{ac}$.
- New York continues to lead in the nonresidential sector as a result of community solar-plus-storage projects.
- 1.2 GW of grid-scale storage originally scheduled to come online during Q1 was delayed or cancelled, with about three-quarters still slated to come online in 2022.

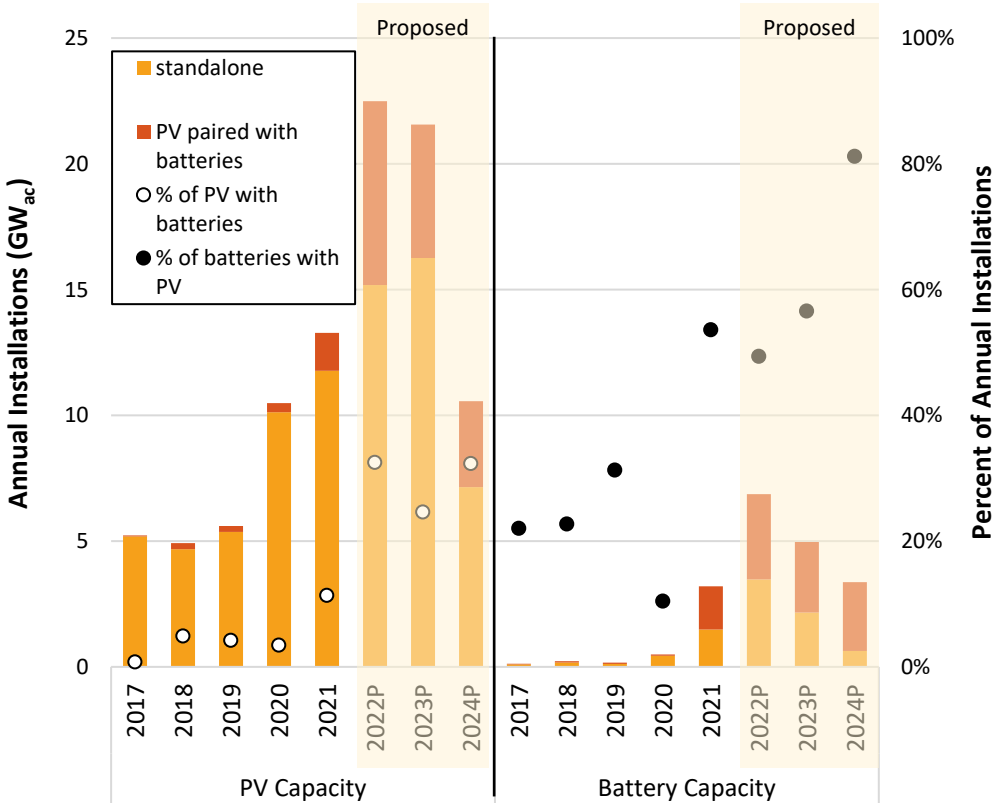



**Note:** "Front-of-the-meter" refers to all projects deployed on the utility side of the meter, regardless of size or ownership.

**Source:** Wood Mackenzie Power & Renewables and Energy Storage Association, U.S. Energy Storage Monitor: Q2 2022.

# U.S. Utility-Scale PV and Batteries




**Source:** U.S. EIA, Form EIA-860 2021ER.

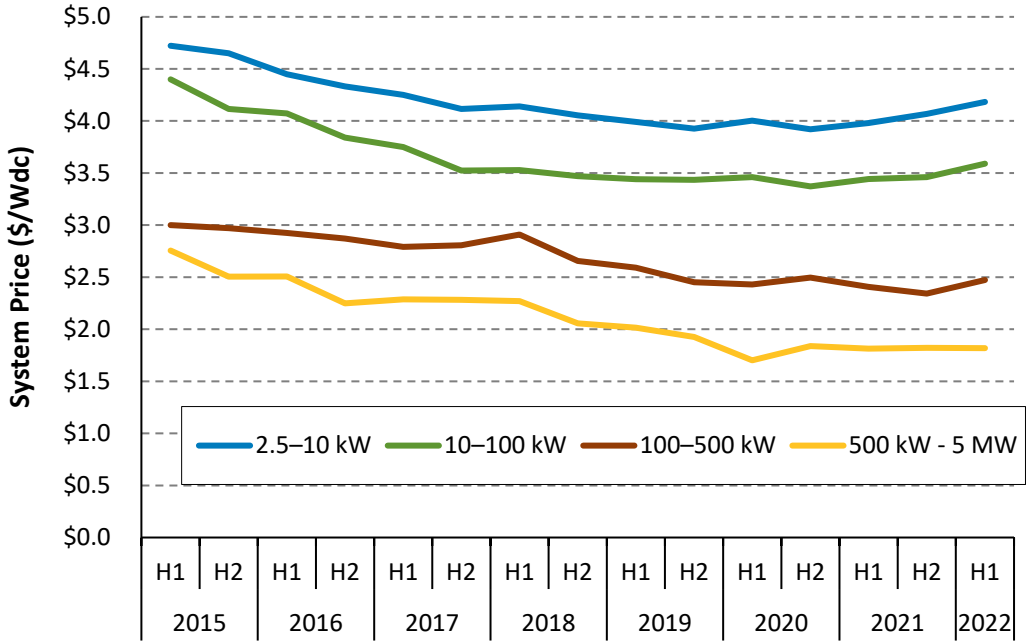
- From 2017 through 2021, ~2.4 GW of U.S. utility-scale PV systems were built and paired with 1.9 GW of storage (6 GWh), and 2021 alone accounted for about 90% of that battery capacity and 63% of that PV capacity.
  - This represents ~6% of U.S. utility-scale PV system capacity and 45% of utility-scale battery system capacity in MW installed during that time, or 59% in MWh.
- EIA reports another 16.0 GW of utility-scale PV are proposed to be built and paired with 8.9 GW of battery storage from 2022 through 2024.
  - The percentage of utility-scale PV systems paired with batteries is expected to increase to 32% of new additions in 2022, 25% in 2023, and 32% in 2024.

# Agenda

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

- **Reported PV system prices from select states increased between H1 2021 and H1 2022, resulting in the first time that consistent price increases have been observed in conjunction with the PV supply chain challenges that accelerated beginning in Q2 2021.**
  - An increase in price was also observed in the distributed PV+storage sector.

# System Pricing from Select States



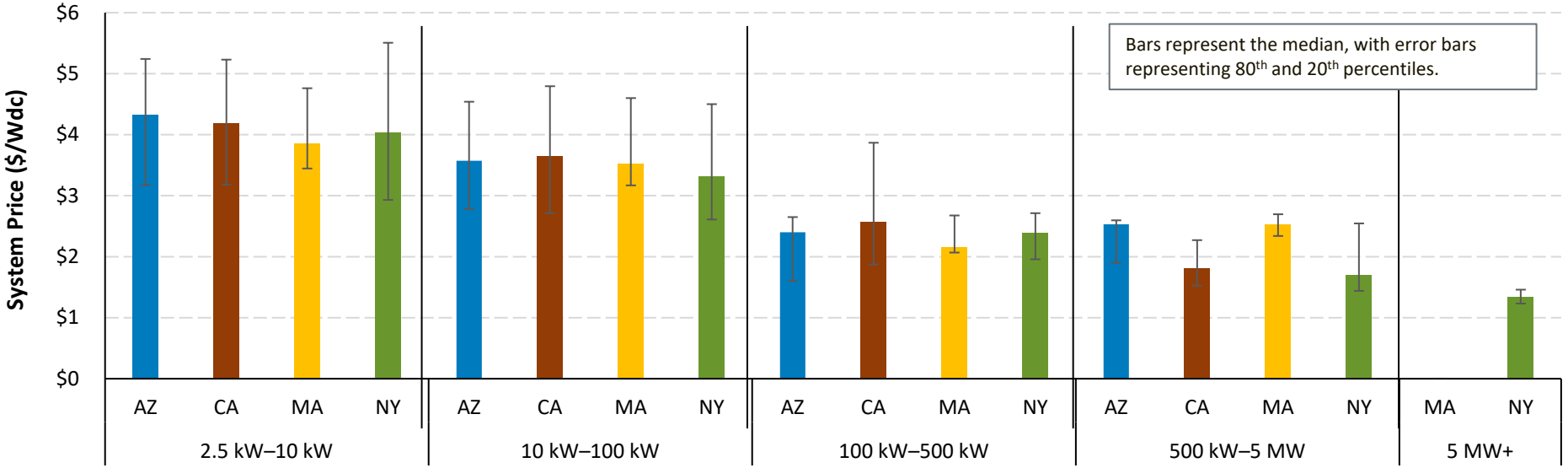

**2022 MW reported YTD**: Arizona (82), California (497), Connecticut (0*), Massachusetts (23), New York (288)
* Connecticut's Residential Solar Investment Program stopped accepting new applications in January 2022, and program data on installations ceased in 2021.
**Note:** System prices above $10/W and below $0.75/W were removed from the data set. There were not enough reported prices for systems above 5 MW in the data set to show a trend over time.
**Sources:** Arizona (date of data varies, as late as 6/22); California NEM database (5/31/22); Connecticut (1/13/22); Massachusetts SREC (1/21/22) and SMART (4/14/22) programs; NYSERDA (6/17/22).

- From H1 2021 to H1 2022 (partial), the median reported PV system price in Arizona, California, Connecticut, Massachusetts, and New York:
  - Increased 5% to $4.18/W for systems from 2.5 to 10 kW
  - Increased 4% to $3.59/W for systems from 10 to 100 kW
  - Increased 3% to $2.47/W for systems from 100 to 500 kW
  - Increased 0.3% to $1.82/W for systems from 500 kW to 5 MW.
- These data represent the first time that consistent price increases have been observed in conjunction with the PV supply chain challenges that accelerated beginning in Q2 2021.
- For systems < 100 kW, prices were as high in H1 2022 (partial) as they were 4–5 years ago.

# System Pricing from Select States, H1 2022 (partial)

- In addition to price differences based on system size, there is variation between states and within individual markets.
- Dollar-per-watt prices generally decrease as system size increases.

- For systems of less than 100 kW, California's median prices increased 8%–9% between H2 2021 and H1 2022 (partial), the largest increase among these states.
  - Increases were 0%–3% in Arizona, 2%–6% in Massachusetts, 4%–5% in New York.
- Arizona saw the largest price increases for systems of 100 kW to 5 MW (68%–140%); small sample sizes (42 in H2 2021, 19 in H1 2022) make median prices sensitive to change for these larger systems.

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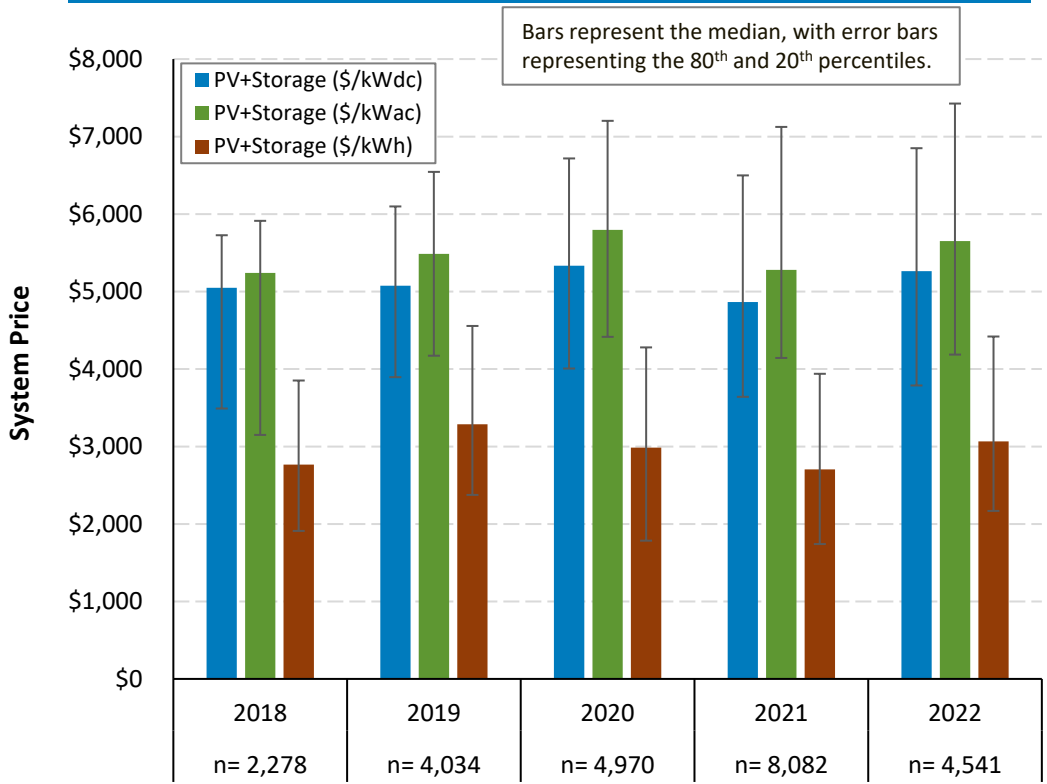
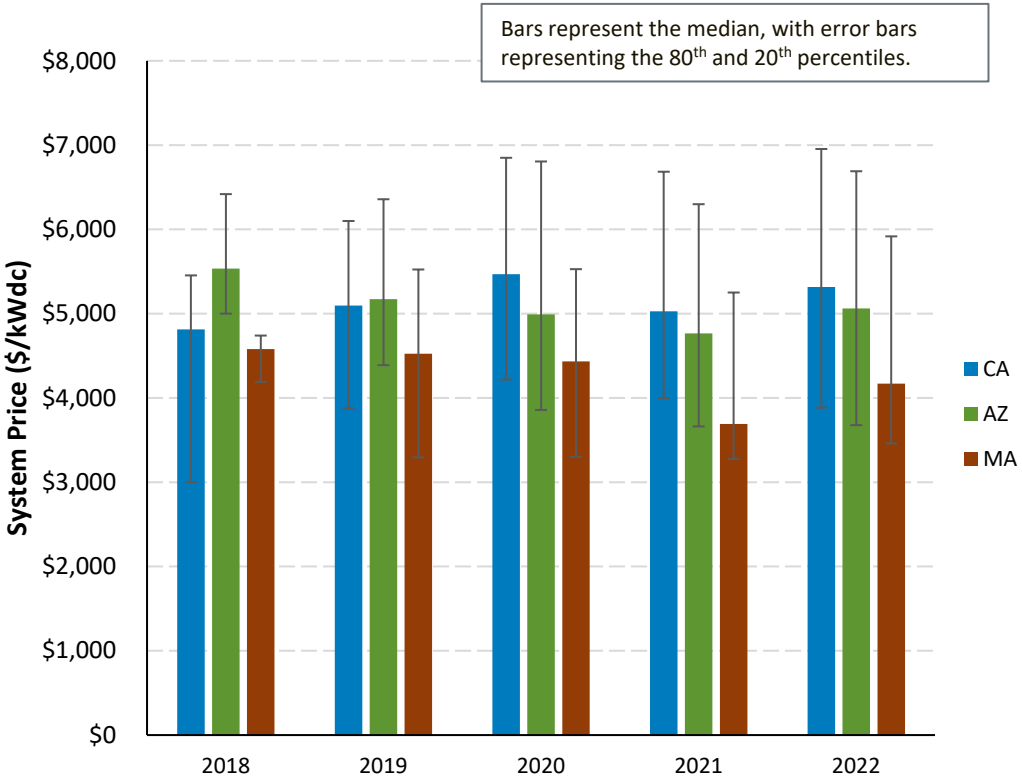
# Residential U.S. PV+Storage Pricing




- In 2022 YTD, residential PV+storage systems in Arizona, California, and Massachusetts had a median system price of $3,100/kWh, or $5,700/kWac ($5,300/kWdc)—an increase of 7%–13% compared with full 2021 median values.
  - Most of these systems offer 2–3 hours of storage.
  - Units represent total system price divided by the capacity of the battery (kWh) or the capacity of the PV system (kW).

**2022 YTD residential PV+storage sample, after data cleaning (MW)**: Arizona (6), California (32), Massachusetts (2)
**Most recent sources:** Arizona Goes Solar (6/18/22); California NEM database (5/31/22); Massachusetts SMART program (4/13/22)

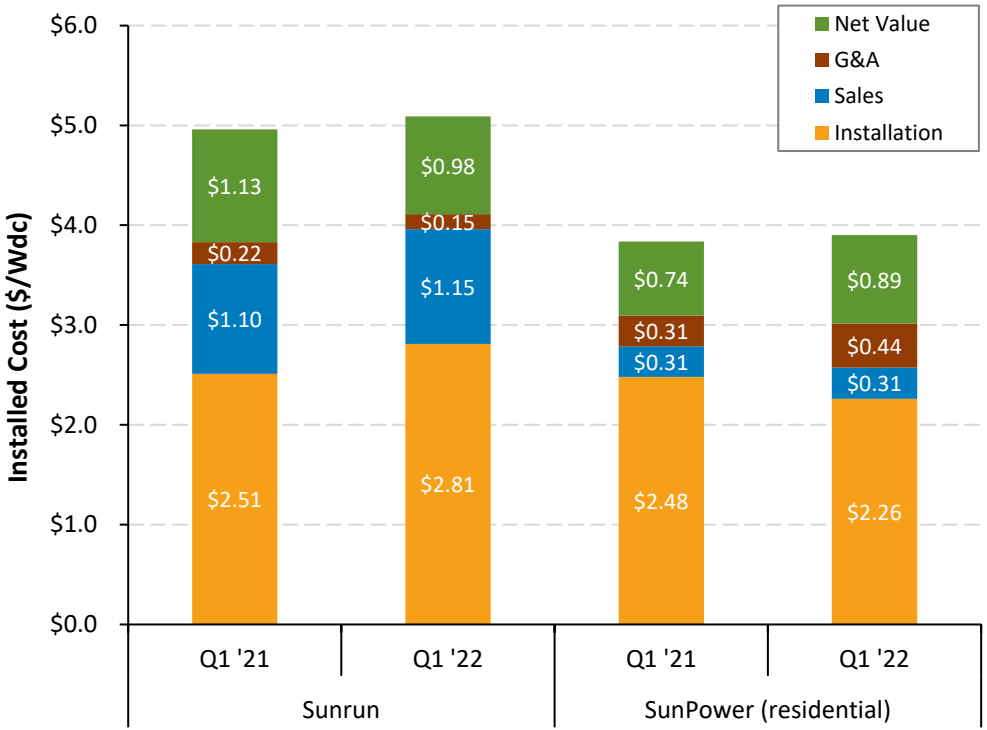
# Residential U.S. PV+Storage Pricing




- In 2022 YTD, residential PV+storage system prices in Arizona, California, and Massachusetts varied between states and internally.
  - Prices may vary due to differences in storage power and capacity, permitting and interconnection differences, local competitive factors, and installer experience.
- Compared with full median 2021 values, prices increased in 2022 YTD in Arizona (6%), California (6%), and Massachusetts (13%).

**2022 YTD residential PV+storage sample, after data cleaning (MW)**: Arizona (6), California (32), Massachusetts (2)
**Most recent sources:** Arizona Goes Solar (6/18/22); California NEM database (5/31/22); Massachusetts SMART program (4/13/22)

# Sunrun and SunPower Cost and Value, Q1 2022




- Residential installers reported strong demand for PV in Q1 2022, along with continuing supply-chain constraints and higher component, freight, and labor costs.
  - Demand was enhanced by rising utility costs.
  - Large customer backlogs were reported (e.g., 13,800 customers for SunPower), up 169% year-over-year.
  - Companies have responded using various strategies, including reducing margins, raising prices, and building component inventories.
  - New homes continue to be a key PV growth sector going forward.
- Costs include PV systems paired with batteries, which are increasing in popularity.
  - Sunrun's total PV + battery installations increased to 37,000 in Q1 2022; the company expects battery installations to increase by more than 50% in 2022, which is more than double the growth rate of overall solar installations in 2022.
  - The battery attachment rate was 24% for SunPower and 19% for Sunnova in Q1 2022.

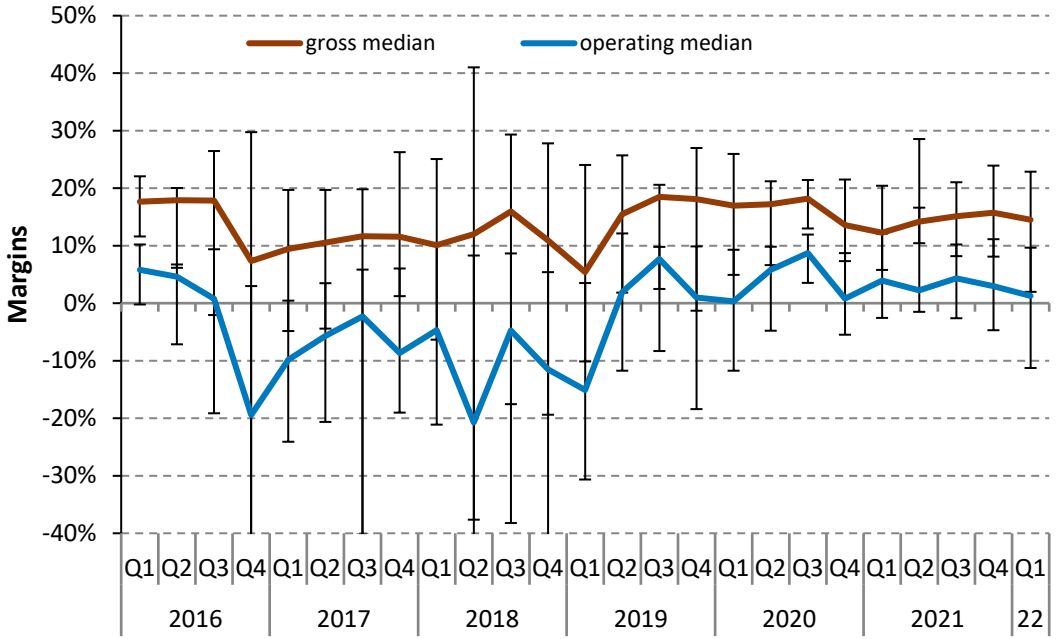
**Sources:** Corporate filings.

# Agenda

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

- **PV manufacturers, mostly Chinese companies, have generally been profitable since 2019.**
- **Historically, Chinese companies have invested a smaller percentage of their revenues in R&D than western companies, such as First Solar. This appears to be changing in recent years, likely due to Chinese government support tied to increased R&D spending.**
  - In 2021, 10 select Chinese companies spent over $7 billion in R&D, compared to $100 million each by First Solar and Maxeon, and about $1 billion from IEA governments.

# PV Manufacturers' Margins



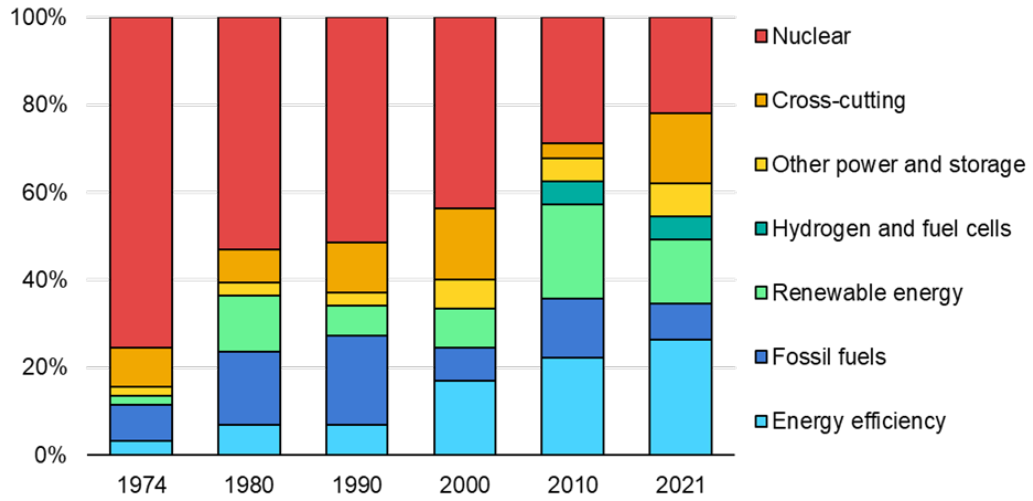

- PV manufacturers, mostly Chinese companies, have generally been profitable since 2019.
- The median gross margin of the publicly traded PV companies represented to the left was down 8%, q/q, but up 18%, y/y.
  - Q1 margins are generally lower than other quarters due to lower sales volumes.
- There continues to be significant variation by individual companies as individual factors come into play, although variation has been substantially less since 2019.

Lines represent the median, with error bars representing 80$^{th}$ and 20$^{th}$ percentiles for the following companies in Q1 2022: Canadian Solar, First Solar, JA Solar, Jinko Solar, LONGi, Maxeon, Motech Industries, REC Silicon, Renesola, Risen, Shanghai Aiko, Shanghai Aerospace, Tongwei, Trina Solar, and United Renewable Energy. Margin data from Hanwha Q Cells, Sunpower, and Yingli are also included from Q1 2010 to Q1 2021 where available.

**Note:** Gross margin = revenue – cost of goods sold (i.e. the money a company retains after incurring the direct costs associated with producing the goods or services it sells); operating margin = gross margin minus overhead and operating expenses (i.e. the money a company retains before taxes and financing expenses).

**Source:** Company figures based on public filings and finance.yahoo.com.

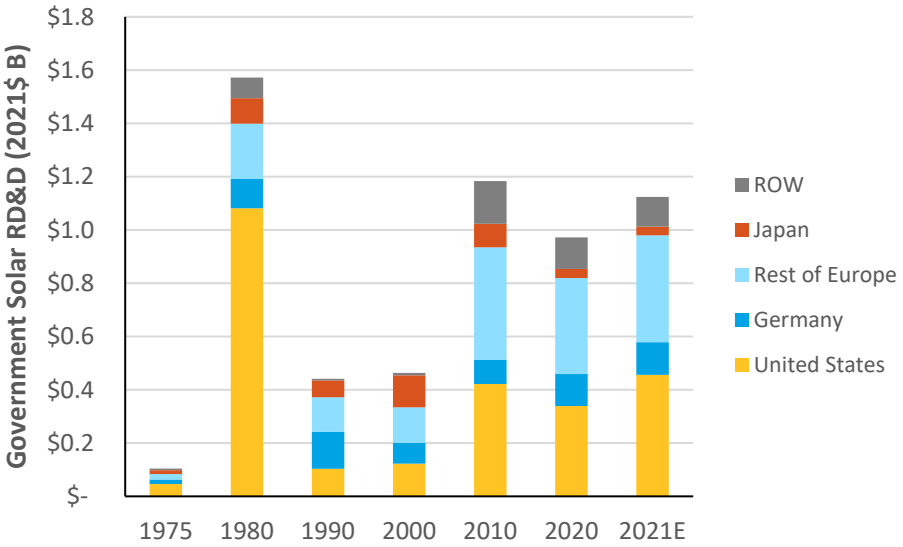
# Evolution of IEA Total Public Energy RD&D by Technology, 1974–2021




Since the 1970s, the energy RD&D priorities of IEA countries have changed from being heavily nuclear-focused to being more diverse with a clear increase in energy efficiency.

**Source:** IEA, 2022 Energy Technology RD&D Budgets data.

# Evolution of IEA Total *Solar* Public Energy RD&D by Technology, 1975–2020



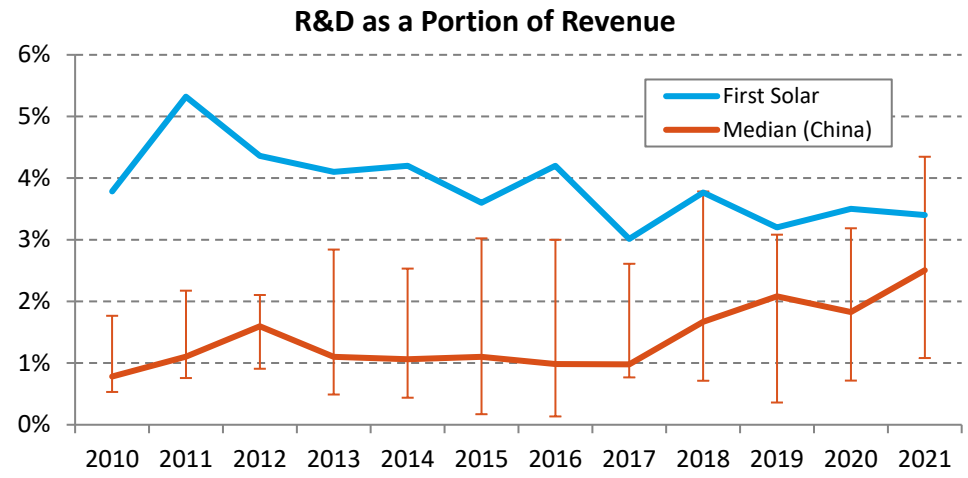

- Government-funded solar RD&D increased more than 20X from 1975 to 1980, in large part due to the United States and its allies looking for alternative sources of energy in response to the 1973 Arab oil embargo.
- Government cuts in the 1980s, mostly from the United States, significantly cut global solar RD&D spending and took 30 years to again become a priority.
- Over the past 10 years, RD&D spending has decreased, in real dollars, but it appears to be again on the upswing.
  - IEA reports the U.S. government solar RD&D expenditures were $456 million in 2021.
- This data also does not include China, which hosts most PV manufacturing facilities and companies.
  - While we could not find an estimate of Chinese government solar R&D expenditures, ~25% of global solar patents came from China in 2019—up from 10% in 2015.

**Note:** Includes only IEA-participating countries; notable country exceptions for solar include China and India. "E" = estimate. Not all countries reported 2021 RD&D expenditures; 2020 data were used in place of any country that did not report 2021 values.

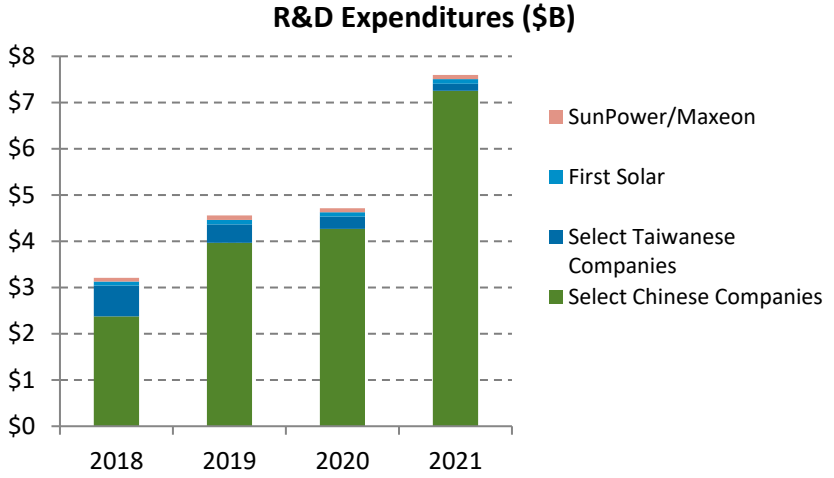
**Sources:** IEA, 2022 Energy Technology RD&D Budgets data; Tracking Clean Energy Innovation: Focus on China.

# Private R&D Expenditures

- Historically Chinese companies have invested a smaller percentage of their revenues in R&D than western companies, such as First Solar.
- This appears to be changing in recent years, likely due to Chinese government support tied to increased R&D spending.
  - In 2021, some companies, such as Aiko Solar, spent a higher percentage of revenues on R&D than First Solar.



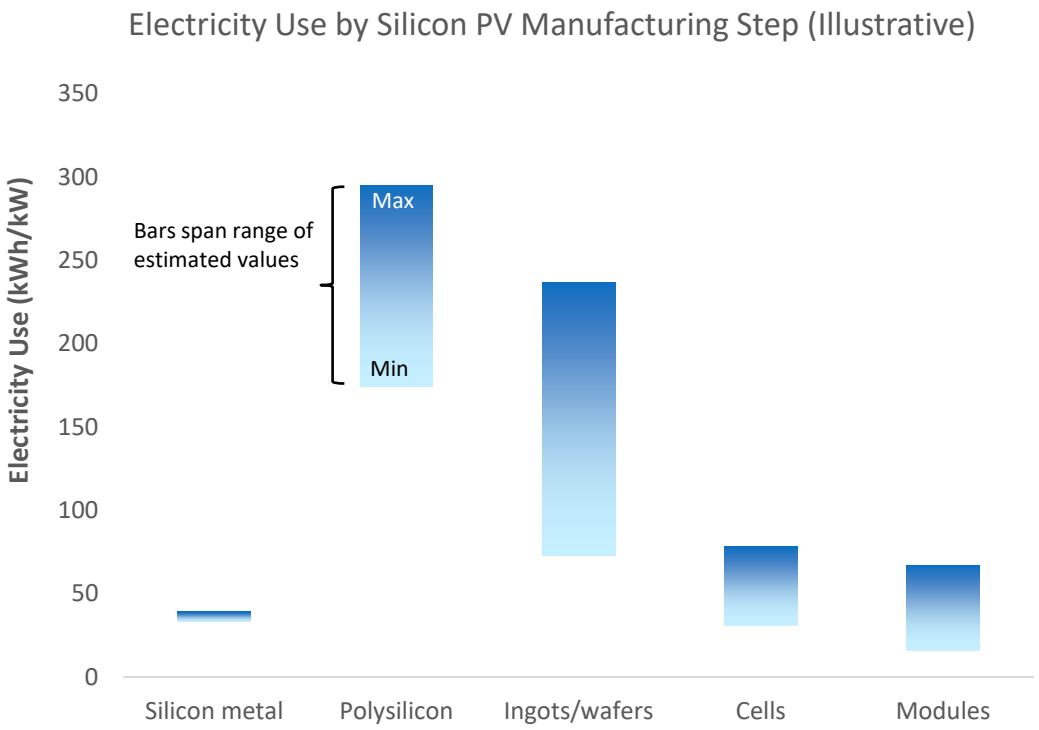

- In absolute terms, however, Chinese solar companies far outspend their foreign competitors.
  - In 2021, 10 select Chinese companies spent over $7 billion in R&D, compared to $100 million each by First Solar and Maxeon, and about $1 billion from IEA governments.




**Note:** Chinese companies include Aiko (post 2017), Canadian Solar, GCL-Poly (post 2017), JA Solar, Jinko Solar, Longi (post 2017), SAAE (post 2017), Risen (post 2017), Suntech (through 2012), Tongwei (post 2017), Trina Solar, Yingli. Taiwanese companies include Motech industries and United Renewable Energy.

**Sources:** Corporate public filings and yahoo.finance.com.

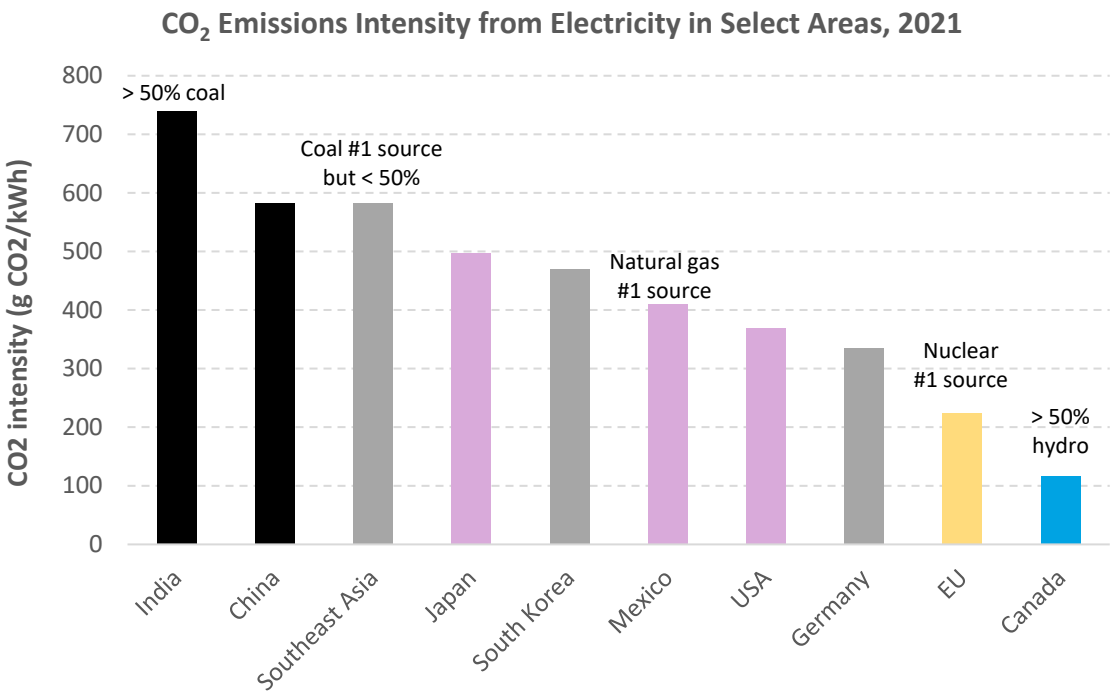
# Electricity $CO_2$ Emissions Intensities: Electricity for PV Manufacturing




- Crystalline-silicon PV manufacturing requires electricity at each step.
  - Purifying polysilicon from silicon metal uses the most electricity per unit of PV capacity, followed by ingot/wafer production.
  - Silicon metal production, cell processing, and module assembly use less electricity per unit of capacity.
- Production of additional subcomponents not considered here (e.g., glass module covers and encapsulant) also consumes electricity.
- The PV manufacturing supply chain also requires heat energy from natural gas (e.g., for glass and polysilicon production) and includes non-energy processes that emit greenhouse gases (e.g., reducing silica to silicon metal).

**Source**: NREL module manufacturing model; Chen et al. (2017); Frischknecht et al. (2020); Muller et al. (2021); Fan et al. (2021); Fthenakis and E. Leccisi (2021).

# Electricity $CO_2$ Emissions Intensities: National Variations

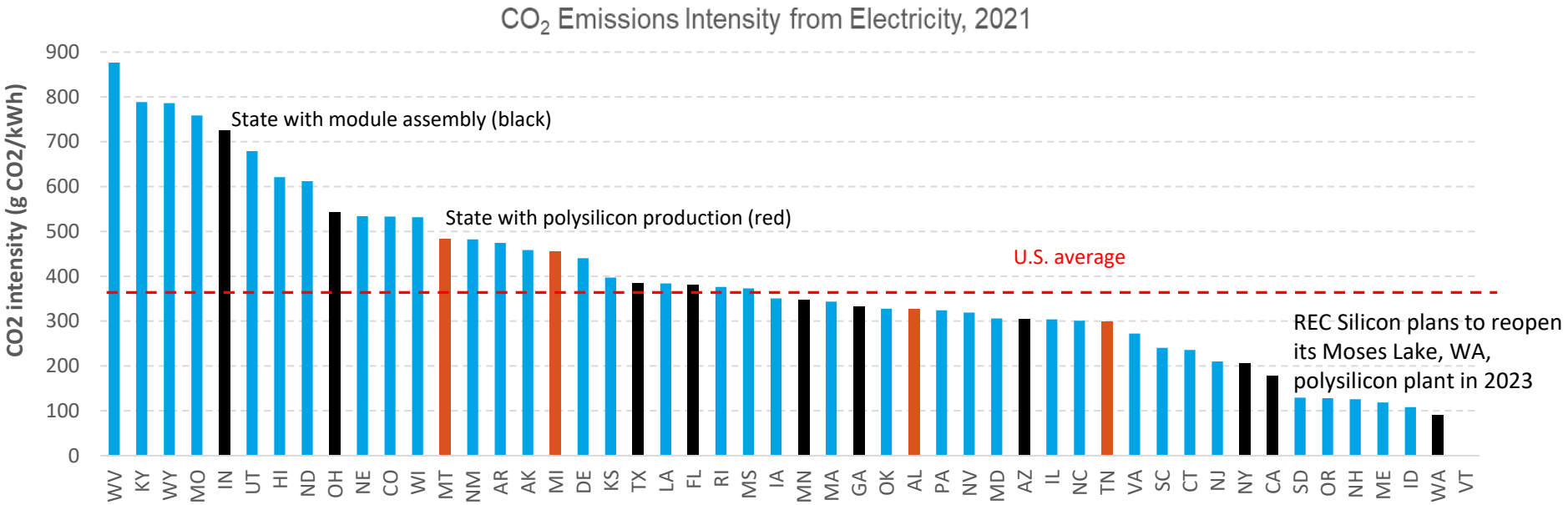



- Electricity $CO_2$ emissions intensities vary by grid mix.
  - Highest with high coal (India, China, Southeast Asia)
  - Lower from greater use of natural gas, nuclear, and/or renewables (Japan, South Korea, Mexico, United States, and Germany)
  - Lowest where nuclear or hydropower dominate (EU and Canada)
- Emissions intensity has generally been declining, for example, 2015–2021:
  - ↓ 5% in India
  - ↓ 10% in China
  - ↓ 20% in the United States.

**Source:** IEA, Electricity Market Report, 2022; IEA, Regions, accessed July 2022.

# Electricity $CO_2$ Emissions Intensities: Variation within the United States

- Emissions intensities vary across the United States, including for example:
  - 880 g $CO_2$/kWh in West Virginia (mostly coal)
  - 180 in California (gas, renewables, and nuclear)
  - 90 in Washington (mostly hydroelectric).
- PV components are produced in multiple states.

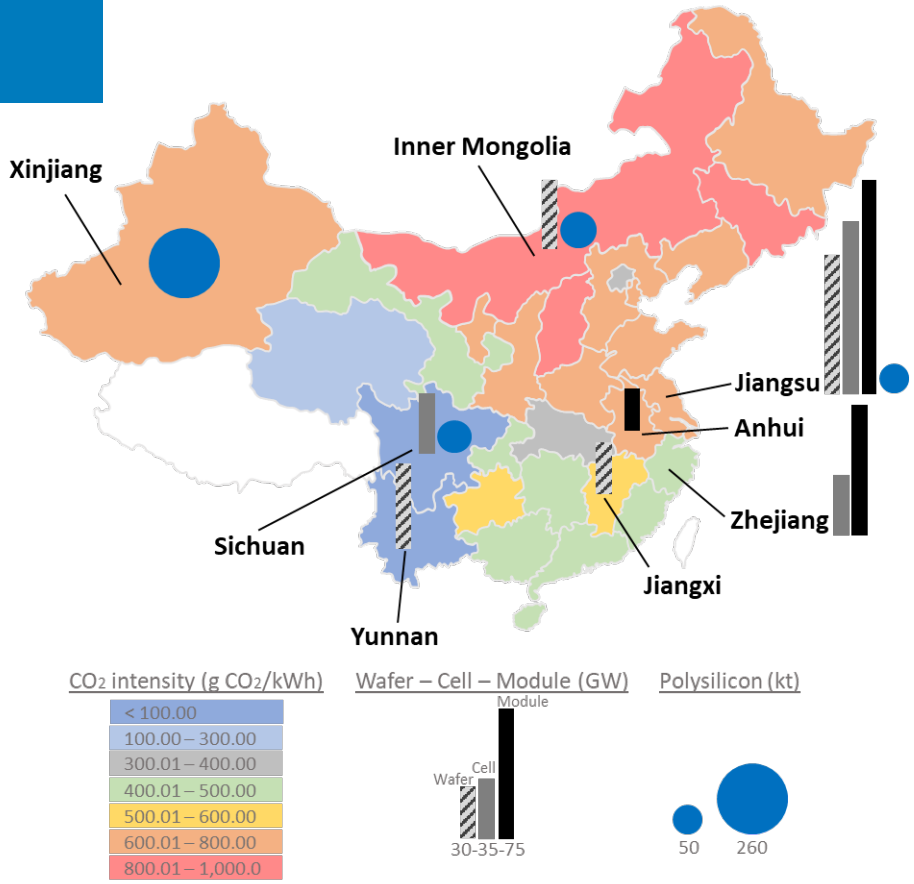



**Sources:** Carnegie Mellon University, Power Sector Carbon Index, accessed 2022; DOE, Solar Photovoltaics Supply Chain Deep Dive Assessment, 2022; IEA, Electricity Market Report, 2022; Solar Power World, U.S. Solar Panel Manufacturers, accessed 2022.

# Electricity $CO_2$ Emissions Intensities: Variation within China

- China is the world's largest producer of polysilicon, ingots, wafers, and cells.
- Components are manufactured in various regions, which vary in emissions intensity, largely based on the proportion of coal use.
  - Most polysilicon is produced in the Northwest (high intensity).
  - Most wafers, cells, and modules are produced in the East (moderate to high intensity).
  - Only select, major producing provinces are displayed on the map.
- New capacity is under construction or announced (e.g., polysilicon in North and Central, wafers in North, cells in East and Central, modules in East).

**Electricity $CO_2$ Intensity and Major Chinese PV Production Provinces, circa 2019–2021**



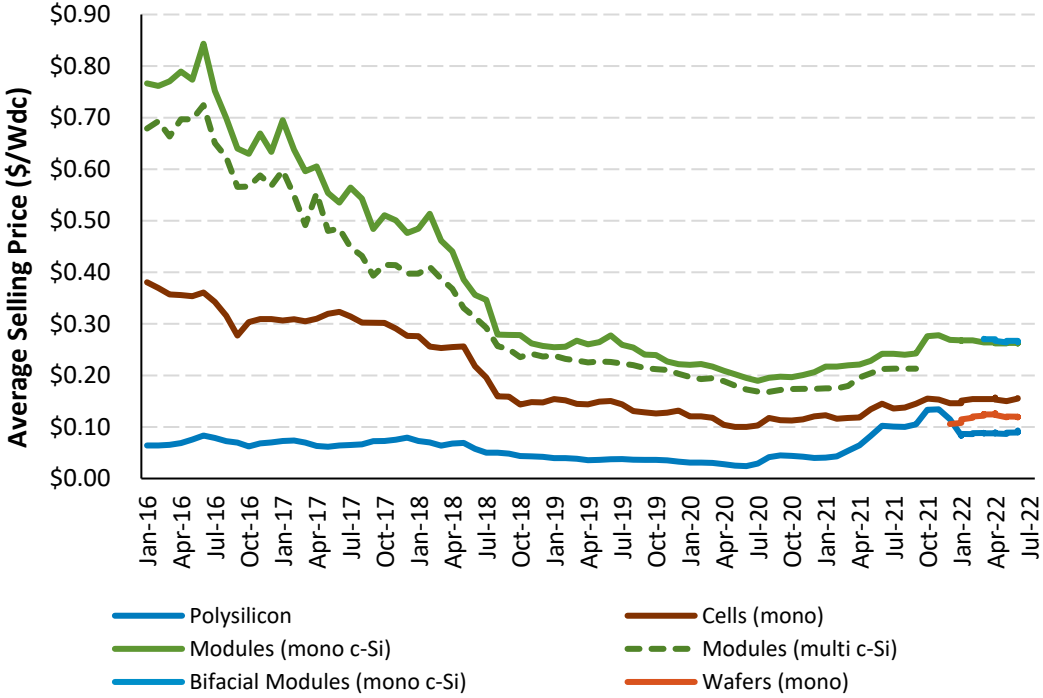

**Sources:** DOE, Solar Photovoltaics Supply Chain Deep Dive Assessment, 2022. Ma et al. (2022).

# Agenda

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

- **Prices in dollars were flat at relatively high levels for polysilicon ($33–$36/kg or about $0.09/W), wafers (~$0.12/W), cells (~$0.16/W), and modules (~$0.26/W) in Q2 2022.**
  - **Although polysilicon supply from China has been increasing, high demand has continued to support high prices.**
  - **Price increases in Chinese yuan were offset by yuan depreciation against the U.S. dollar.**
- **In Q1 2022, U.S. utility-scale monofacial mono c-Si module prices rose $0.03/W (y/y) and $0.02/W (q/q), trading at a 54% premium over global ASP.**

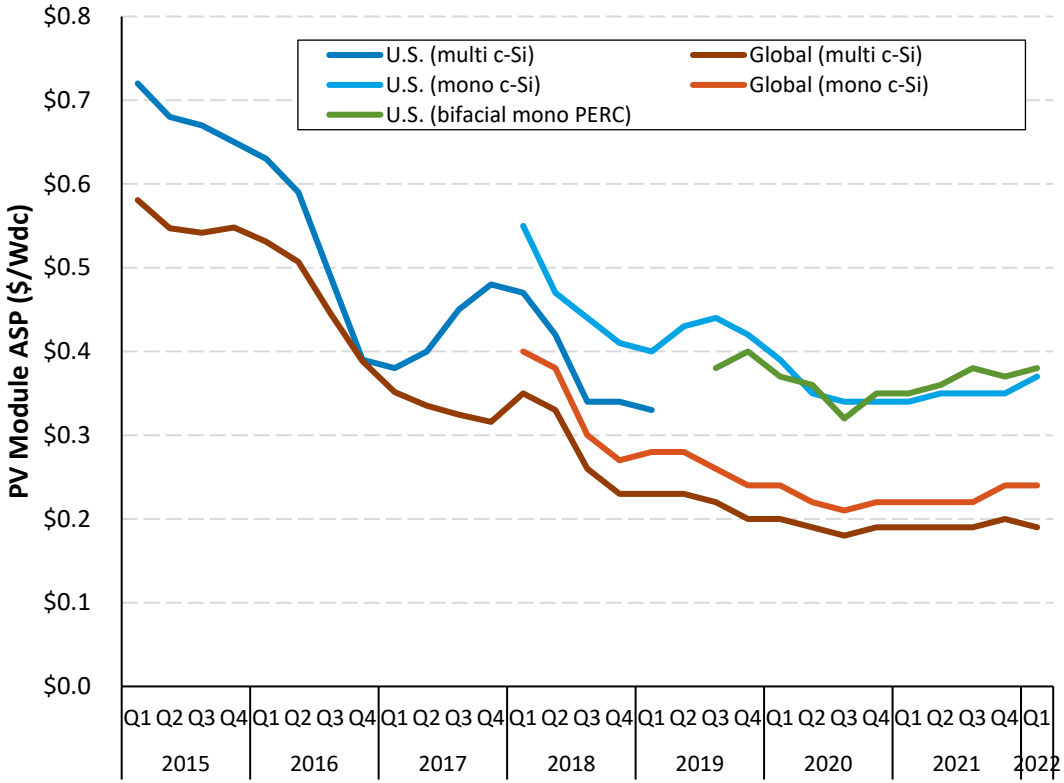
# PV Value Chain Spot Pricing




**Source:** BloombergNEF Solar Spot Price Index (7/1/22); BloombergNEF Bimonthly PV Index (5/23/22); PV Tech (6/27/22, 6/30/22, 7/4/22).
**Kilogram to watt conversion for polysilicon:** 4.78 grams per watt (2016), 4.73 (2017), from Cowen & Co. (05/11/17) and Deutsche Bank (07/19/17); 4.35 (2019), 4.10 (2019), 3.85 (2020), 3.60 (2021), from Bernreuter; 2.60 (2022), from NREL module manufacturing cost model.

- Polysilicon spot prices were fairly constant across Q2 2022 at $33–$36/kg or about $0.09/W.
  - Although polysilicon supply from China has been increasing, high demand has continued to support high prices.
  - Price increases in Chinese yuan were offset by yuan depreciation against the U.S. dollar.
- Prices in dollars were also flat at relatively high levels for wafers (~$0.12/W), cells (~$0.16/W), and modules (~$0.26/W) in Q2 2022.
- Signs in early July suggest prices may be rising.
  - Rising polysilicon prices and an ingot-manufacturing bottleneck contributed to a 6% wafer price increase by LONGi.
  - Tongwei and Aiko raised cell prices to around $0.18–$0.19/W (15%–20% higher than the June 29 spot price reported by BNEF).
  - Polysilicon capacity coming online by the end of the year is expected to reduce prices.

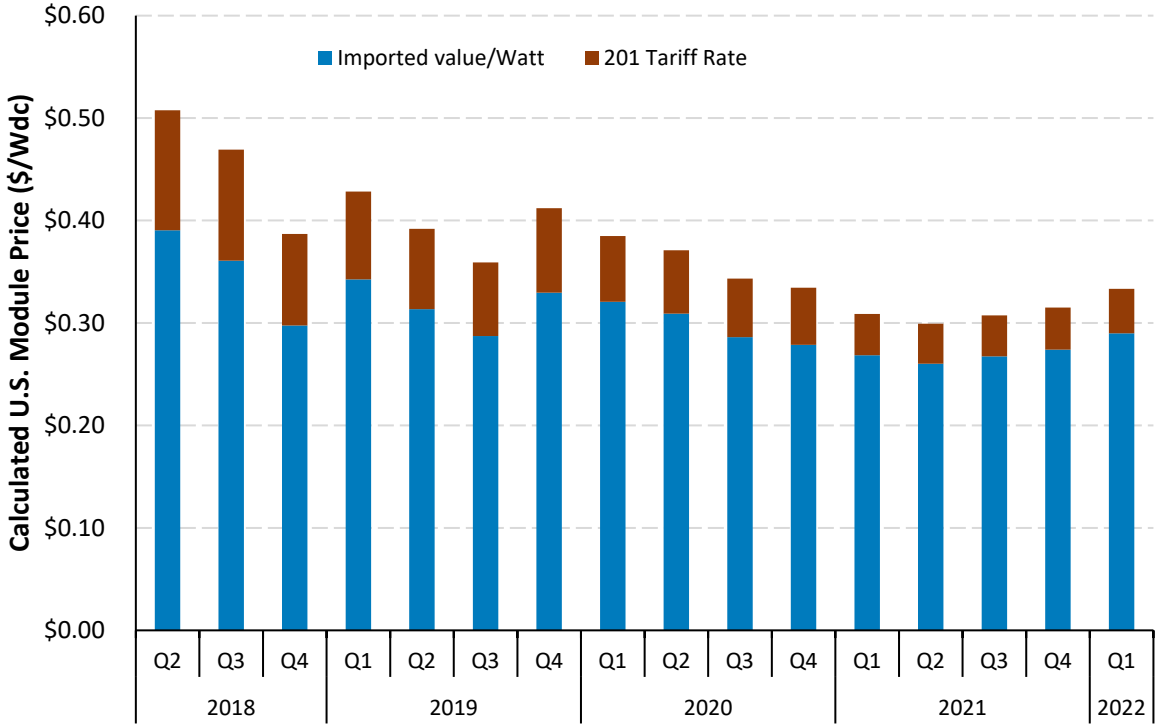
# Module Average Selling Price: Global versus United States




- In Q1 2022, U.S. utility-scale monofacial mono c-Si module prices rose $0.03/W (y/y) and $0.02/W (q/q), and they were trading at a 54% premium over global ASP.
- The price premium of U.S. bifacial mono c-Si modules over monofacial counterparts narrowed further to $0.01/W.
  - The bifacial exemption to the Section 201 tariffs—which was removed in Q4 2020—was reinstated in Q4 (late November) 2021.
  - In February 2022, the Section 201 tariffs were extended by 4 years, and the bifacial exemption was continued.
- Global c-Si module prices were flat (mono) or fell $0.01/W (multi) from Q4 2021 to Q1 2022.
- Q1 2022 modules prices do not include impacts of the anti-circumvention investigation announced by the U.S. Department of Commerce in late March 2022.

**Source:** Wood Mackenzie & SEIA, US Solar Market Insight: Q2 2022, June 2022.

# Calculated U.S. Module Pricing




- Based on the reported value and capacity of imported PV modules, the average price of a PV module in the United States before tariffs has risen steadily from Q2 2021 ($0.26/W) to Q1 2022 ($0.29/W).
  - While this price increase is minor in comparison to historical prices, it does appear to be a persistent trend.
- As a result of the underlying price reduction since 2018 and the step-down of the Section 201 tariff, these duties have been cut by 67% on a per-watt basis (from approximately $0.12/W to $0.04/W).

**Note:** Manual corrections were made to the following values due to suspected data entry errors for HTS code 8541430010: Cambodia February 2022, Malaysia June 2020, Vietnam July 2019.

**Sources:** Imports by HTS code: 8541460015(2018-2021)/8541430010(2022-), Customs Value and Second Quantity (watts) from the U.S. International Trade Commission DataWeb, the U.S. Census Bureau USA Trade Online tool and corrections page.

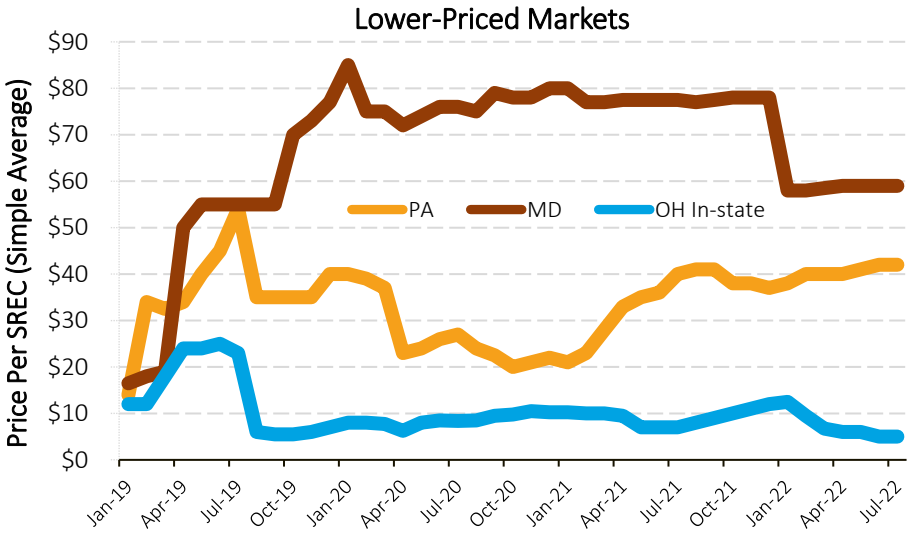
# Agenda

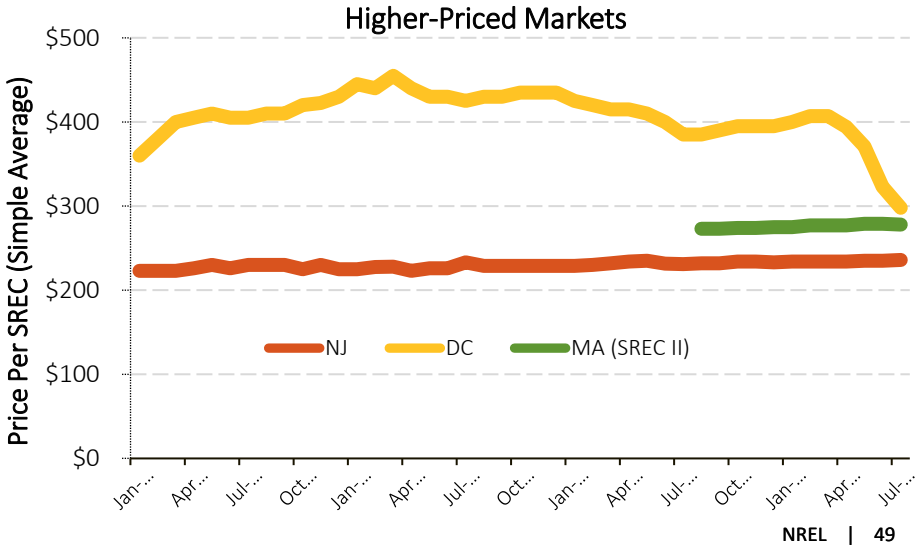
1. Global Solar Deployment
2. U.S. PV Deployment
3. PV System Pricing
4. Global Manufacturing
5. Component Pricing
6. **Market Activity**
7. U.S. PV Imports

- **Solar stocks represented by the Invesco Solar ETF dropped 24% early in Q1 2022, more steeply than the decline in the broader market, before rebounding to finish the quarter with only a 6% loss—compared with a quarterly loss of 17%–18% in the broader market.**
- **SREC bid prices declined 27% in Washington, D.C., between March and July 2022.**
  - **The price decline may indicate an oversupply of SRECs, as more than half of DC's solar capacity has been installed in the past two years.**

# SREC Pricing

- SREC bid prices declined 27% in Washington, D.C., between March and July 2022.
  - The price decline may indicate an oversupply of SRECs, as more than half of D.C.'s solar capacity has been installed in the past 2 years.
- Other SREC prices stayed relatively flat during this period.
- Active SREC programs have closed in New Jersey, Massachusetts, and Ohio.

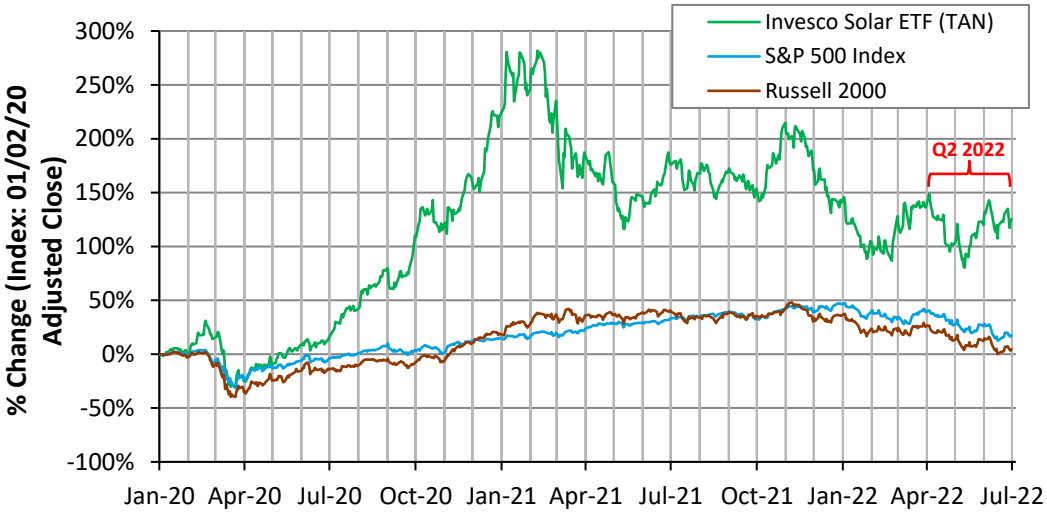


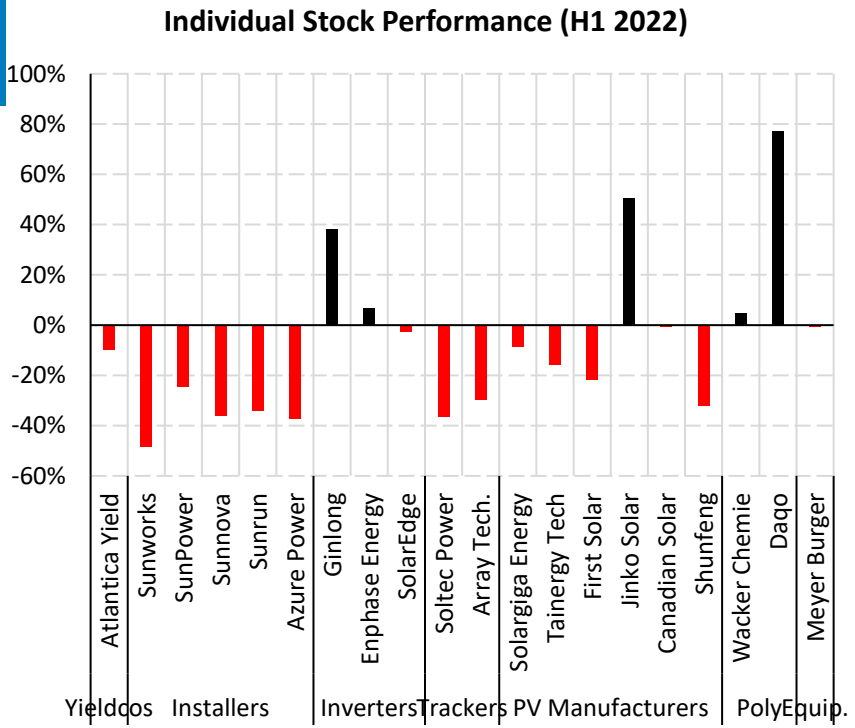




**Source:** SRECTrade, https://www.srectrade.com/, accessed 8/3/22.

# Stock Market Activity

- Solar stocks represented by the Invesco Solar ETF dropped 24% early in Q1 2022, more steeply than the decline in the broader market, before rebounding to finish the quarter with only a 6% loss—compared with a quarterly loss of 17%–18% in the broader market.
- Rising interest rates contributed to the steep early decline in solar stocks. The 2-year waiver of new tariffs on solar imports from Southeast Asia in June helped boost some solar stocks.




**Note:** The TAN index is weighted toward particular countries and sectors. As of 7/1/22, 42% of its funds were in U.S. companies and 28% were in Chinese companies. Its top 10 holdings, representing 57% of its value, were Enphase Energy, SolarEdge Technologies, GCL Technology Holdings, First Solar, Xinyi Solar Holdings, Sunrun, Daqo New Energy, JinkoSolar, Encavis, and Atlantica Sustainable Infrastructure.

**Sources:** NASDAQ (4/28/22). Markets Insider (6/9/22). Stock market: Yahoo Finance (7/5/22).

# Agenda

1 Global Solar Deployment

2 U.S. PV Deployment

3 PV System Pricing

4 Global Manufacturing

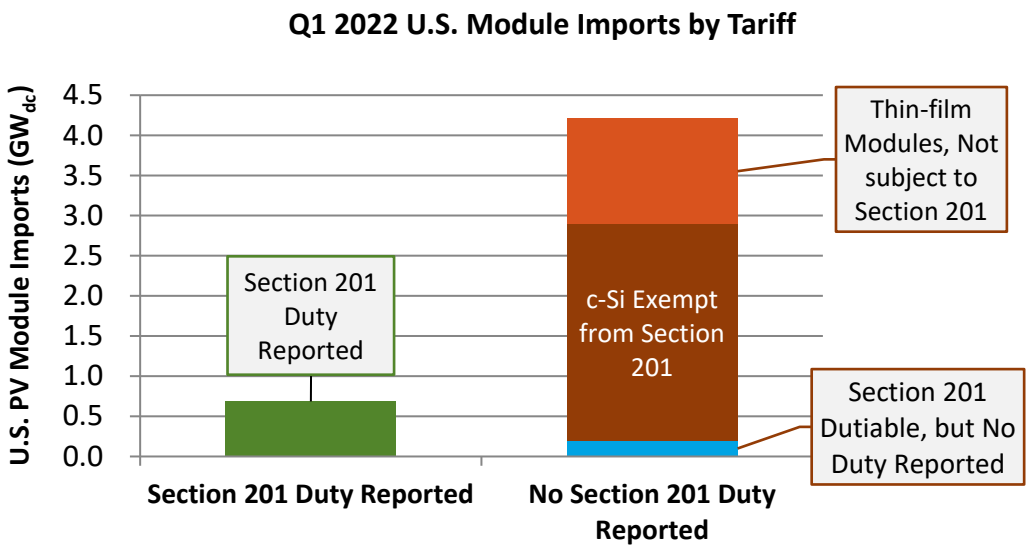
5 Component Pricing

6 Market Activity

7 **U.S. PV Imports**

- **4.9 GWdc of PV modules were imported into the United States in Q1 2022, down y/y.**
  - As of May, imported modules and cells from the four countries under investigation for AD/CVD circumvention were significantly below where they were a year ago (-32%, -597 MW y/y), mainly as a result of decreased imports from Malaysia.
- **265 MWdc of cells were imported in Q1 2022, down y/y.**
  - Despite the renewal of the Section 201 tariffs in February raising of the quota exemption from 2.5 $GW_{dc}$ to 5.0 $GW_{dc}$ , there has not been a significant uptick in the import of solar cells. Imports are on track to match those of 2021.

# Q1 2022 U.S. Module Imports by Tariff

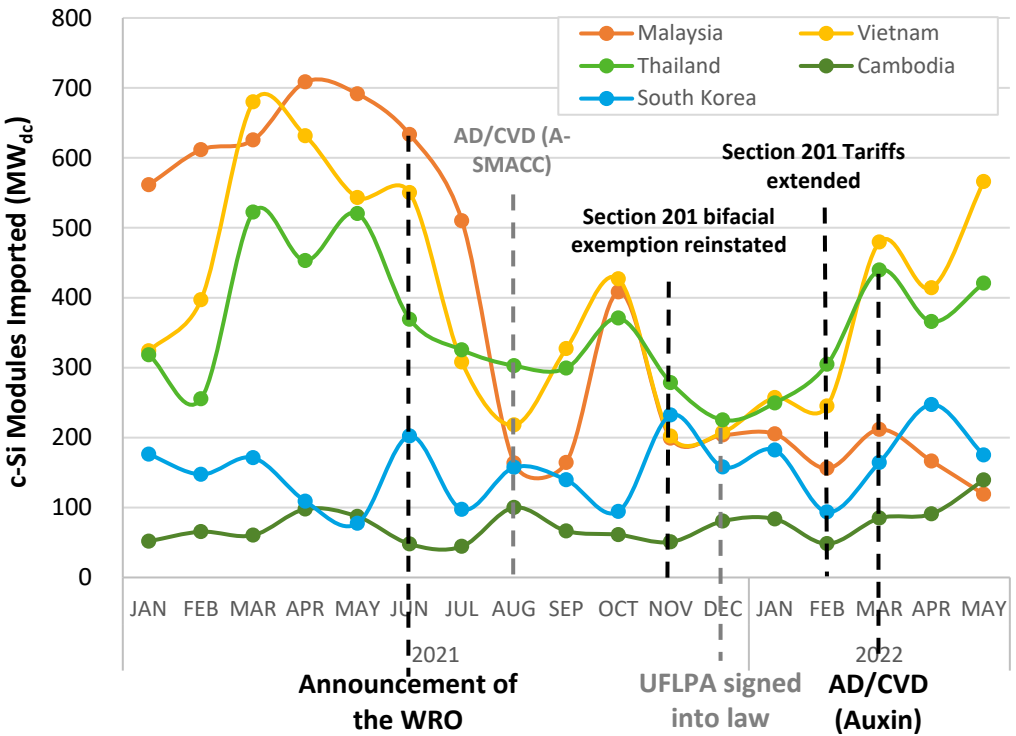



- In Q1 2022, only 685 $MW_{dc}$ (14%) reported a tariff.
- Most of the modules that did not were thin-film and not subject to tariffs (1.3 $GW_{dc}$, 27%) or c-Si technology panels exempt from Section 201 tariffs (2.7 $GW_{dc}$, 55%).
  - Imports of thin-film modules were up 35% (342 MW) over Q1 of 2021.
- In Q1 2022, imports of c-Si panels exempt from Section 201 tariffs more than doubled that of the previous quarter (+2.7 $GW_{dc}$ vs. +1.2 $GW_{dc}$), which was already nearly double previous quarters.
  - The c-Si imports were likely bifacial panels, which the Biden administration exempted from Section 201 duties in February 2022.
  - CdTe panels are not subject to the various duties c-Si modules are and do not have a supply chain in locations currently scrutinized over the use of forced labor.
- In addition to imports, First Solar produced ~450 $MW_{dc}$ of CdTe PV modules in the United States in Q1 2022.

**Notes:** We assumed all modules not subject to Section 201 tariffs are reported under "Free under HS Chapters 1-98" or "Entered into U.S. Virgin Islands," with exemptions coming from HTS code 8541406015/8541430010, and technologies not applicable reported under HTS code 854140603. We assumed all panels subject to Section 201 duties are reported under "Dutiable- HS chapter 99." Manual corrections were made to the following value due to suspected data entry errors for HTS code 8541430010: Cambodia February 2022.

**Sources:** Imports by HTS code: 8541460015(2018-2021)/8541430010(2022-) and 8541460035(2018-2021)/8541430080(2022-), Second Quantity (watts), and Rate Provision Code from the U.S. International Trade Commission DataWeb as well as the U.S. Census Bureau USA Trade Online tool and corrections page as of 7/15/22, and Wood Mackenzie/SEIA: U.S. Solar Market Insight: Q2 2022.

# Impact of the WRO, AD/CVD Petitions, UFLPA, and 201 Tariff Changes on c-Si Module Imports

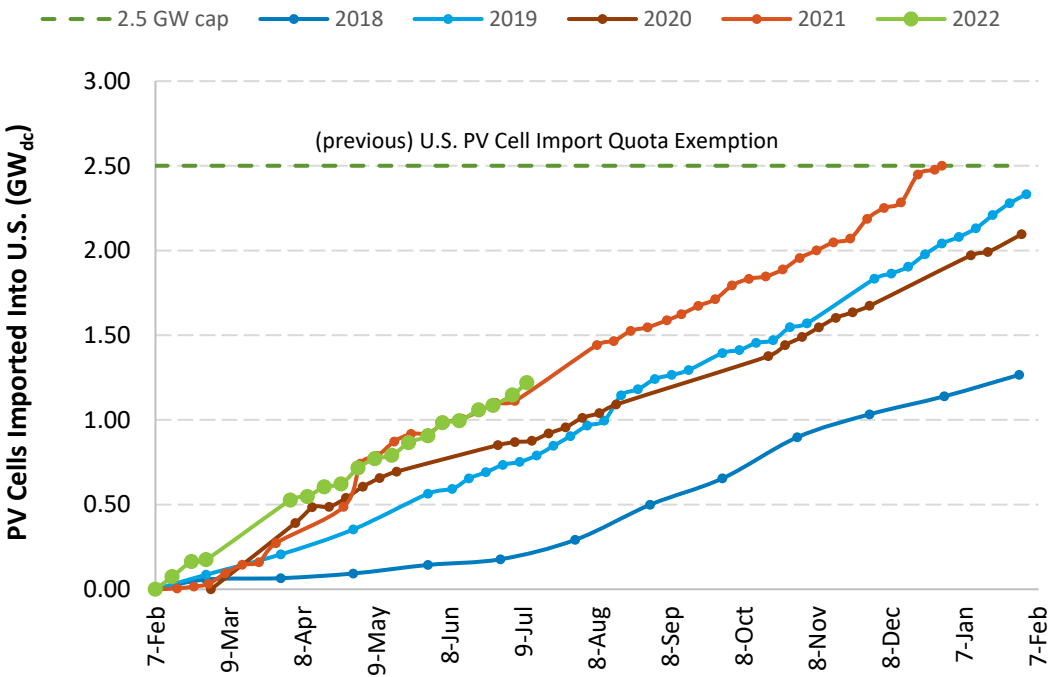



- The U.S. solar import ecosystem has had an eventful 12 months, including:
  - Actions related to ensuring the absence of forced labor from the supply chain through a withhold release order (WRO) and the passage of the Uyghur Forced Labor Protection Act (UFLPA)
  - Actions relating the Section 201 Tariffs including their 4-year extension in February
  - Two anti-dumping and countervailing duty (AD/CVD) circumvention petitions against imports from Malaysia, Vietnam, Thailand, and Cambodia, one of which recently resulted in an ongoing investigation.
- Though there has not been a precipitous drop in imports since the announcement of the AD/CVD investigation, many of these imports were likely already in transit or under contract before the announcement.
  - Imports across the four countries in May were still significantly below where they were a year ago (-32%, -597 MW y/y), mainly as a result of decreased imports from Malaysia.

**Note:** Manual corrections were made to the following value due to suspected data entry errors for HTS code 8541430010: Cambodia February 2022.

**Sources:** Imports by HTS code: 8541460015(2018-2021)/8541430010(2022-), Second Quantity (watts) from the U.S. International Trade Commission DataWeb as well as the U.S. Census Bureau USA Trade Online tool and corrections page as of 7/7/22.

# Cell Import Data by Tariff




Despite the renewal of the Section 201 tariffs in February raising of the quota exemption from 2.5 GWdc to 5.0 GWdc, there has not been a significant uptick in the import of solar cells. Imports are on track to match those of 2021.

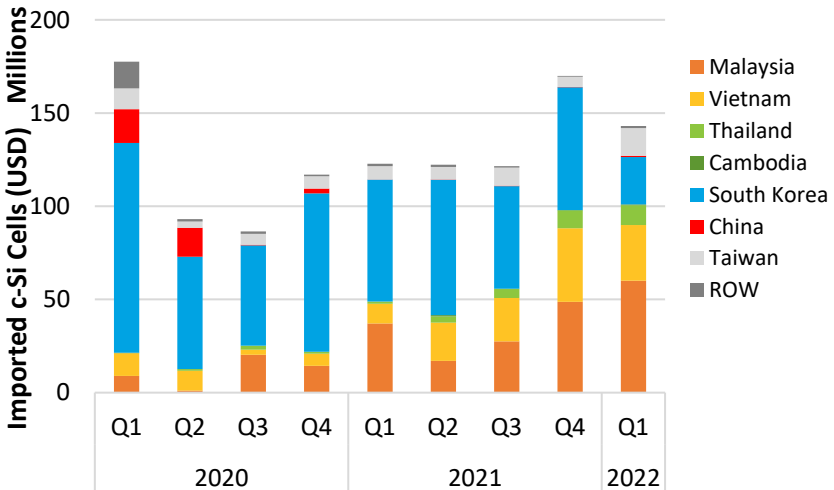
**Sources:** Imports by HTS code: 8541460025(2018-2021), Second Quantity (watts) from the U.S. International Trade Commission DataWeb ; U.S. Customs and Protection Commodity Status Reports February 2019–July 2022.

# Module and Cell Imports by Region

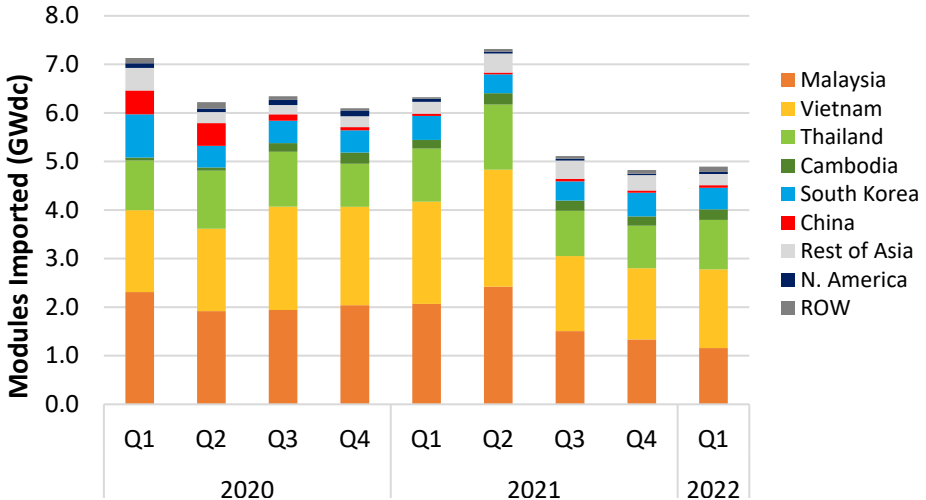
- U.S. PV cell imports* were down 16% q/q, although still up 16% y/y.
  - The drop in imports in Q1 2022 was mainly due to decreased imports from South Korea (-61%) and Vietnam (-24%), presumably as a result of uncertainty regarding the Section 201 cell TRQ extension.

- After hitting a peak in Q2 of 2021, module imports into the United States fell in Q3 of 2021 and have remained steady since then.
  - 4.9 GWdc of PV modules were imported into the United States in Q1 2022, down 23% y/y.
  - Total module imports have been > 1GWdc below the same quarter of the previous year for the last three quarters.
  - Imports from Malaysia fell the most, with a >80% y/y increase in thin-film imports in those three quarters unable to compensate for c-Si import decreases.

**U.S. Cell Imports by Region**




**U.S. Module (c-Si + CdTe) Imports by Region**




**Note:** *cell imports are reported in USD and not $GW_{dc}$ because of suspected data entry errors from Malaysia and South Korea over Q4 2021 and Q1 2022.

**Sources:** Imports by HTS code: 8541460015(2018-2021)/8541430010(2022-), 8541460025(2018-2021)/8541420010(2022-), and 8541460035(2018-2021)/8541430080(2022-), Second Quantity (watts) from the U.S. International Trade Commission DataWeb as well as the U.S. Census Bureau USA Trade Online tool and corrections page as of 7/7/22.

# Recent News on U.S. Imports

- On June 6, 2022, President Biden declared an emergency and authorized the temporary extension of time and *duty (and deposit)-free importation* of solar cells and modules from Southeast Asia for *up to 24 months* over concerns the lack of panel supply would cause electric grid reliability issues.
  - This does not halt the ongoing AD/CVD investigation or the collection of tariffs (e.g., Section 201, 232, or 301 tariffs).
  - This is a novel implementation of this provision, which is typically used for more traditional emergencies and thus could be subject to legal challenge on procedural grounds.
- On June 6, 2022, the President also took executive actions to accelerate U.S. PV manufacturing during the two-year window, invoking the *Defense Production Act* to provide loans and grants to PV manufacturers, directing the development of *master supply agreements* for domestic manufacturers, and establishing "*super preferences*" to apply domestic content standards for federally procured solar systems.
  - The Defense Production Act has a limited budget and so would likely do very little to directly build domestic manufacturing, without more Congressional approvals.
  - Recent invocations of the Defense Production Act include batteries for electric vehicles and energy storage facilities (2022–), COVID-19 mitigation (2020–), and advanced drop-in biofuel production (2012–2016).
- Enforcement of the Uyghur Forced Labor Protection Act (UFLPA) began on June 21, and CBP's guidance to importers and the Forced Labor Enforcement Task Force's report were finalized on June 13.
  - The EU recently called on the European Commission "to propose an import ban on all products produced by forced labour and on products produced by all Chinese companies listed as exploiting forced labour."
- The United States has agreed to lift tariffs on Canadian solar products, as instructed in President Biden's extension of the 201 tariffs, so long as a surge does not take place. Canada had previously argued the tariffs violated the terms of the U.S.-Mexico-Canada Agreement. A surge in imports is defined as:
  - >1 GW between February 2022 and February 2023,
  - >1.15 GW between February 2023 and February 2024,
  - >1.3 GW between February 2024 and February 2025, and
  - >1.45 between February 2025 and February 2026.

**Sources:** duty free sources: White House June 6th, 2022, Commerce June 6th, 2022, pv-tech duty-free article; Defense Production Act sources: GAO 2021, CRS 2022, CRS 2020, DOE 2015, and DON/DOE/USDA 2011; CBP guidance, pv-tech EU Parliament article; Canada MOU.

# Thank You

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# List of Acronyms and Abbreviations

**AD:** antidumping
**ac:** alternating current
**a-Si:** amorphous silicon
**ASP:** average selling price
**BNEF:** Bloomberg New Energy Finance
**C&I:** commercial and industrial
**CBP:** U.S. Customs and Border Protection
**CdTe:** cadmium telluride
**CIGS:** Copper indium gallium selenide
**CO2:** carbon dioxide
**c-Si:** crystalline silicon
**CSP:** concentrating solar power
**CVD:** countervailing
**dc:** direct current
**DOE:** U.S. Department of Energy
**DPV:** distributed PV
**EIA:** U.S. Energy Information Administration
**EPC:** engineering, procurement and construction
**ETF:** exchange traded fund
**EU:** European Union
**G&A:** general and administrative expenses
**GW:** gigawatt
**GWh:** gigawatt-hour
**GWth:** gigawatt-thermal
**H1:** first half of year
**H2:** second half of year
**HTS:** harmonized tariff schedule
**ICA:** integration capacity analysis
**IEA:** International Energy Agency
**ILR:** inverter loading ratio
**ITC:** investment tax credit
**kW:** kilowatt
**kWh:** kilowatt-hour
**mono c-Si:** monocrystalline
**multi c-Si:** multicrystalline
**MW:** megawatt
**MWh:** megawatt-hour
**NEM:** net energy metering
**NREL:** National Renewable Energy Laboratory
**ORAU:** Oak Ridge Associated Universities
**ORISE:** Oak Ridge Institute for Science and Education
**PII:** permitting, inspection, and interconnection
**PPA:** power purchase agreement
**PSC:** public service commission
**PTC:** production tax credit
**PV:** photovoltaics
**Q:** quarter
**R&D:** research and development
**RD&D:** research, design, and development
**SEGS:** Solar Energy Generating Systems
**SEIA:** Solar Energy Industries Association
**SMART:** Solar Massachusetts Renewable Target
**SREC:** solar renewable energy certificate
**TAN:** Invesco Solar ETF
**TRQ:** tariff-rate quota
**UFLPA:** Uyghur Forced Labor Prevention Act
**UPV:** utility-scale PV
**USD:** U.S. dollars
**W:** watt
**WRO:** withhold release order
**y/y:** year over year
**YTD:** year to date