NREL
NATIONAL RENEWABLE ENERGY LABORATORY

H1 2021
Solar Industry Update

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Executive Summary

Global Solar Deployment

- From 2010 to 2020, global PV capacity additions grew from 17 GW_{DC} to 139 GW_{DC}.
  - At the end of 2020, global PV installations reached 760 GW_{DC}.
  - Analysts project increased annual global PV installations over the next 2 years, with continued growth in China, the United States, Europe, and India.
- In 2020, approximately 100 MW of CSP was added in China and another 1.4 GW was under construction at the end of the year.

U.S. PV Deployment

- The United States installed 4.0 GW_{AC} (4.9 GW_{DC}) of PV in Q1 2021—its largest Q1 total ever.
- At the end of 2020, there were approximately 2.7 million residential PV systems in the United States.
- SEIA reported that in 2020 the U.S. community solar market installed 826 MW_{DC} of community solar installations—a 30% increase y/y—bringing cumulative capacity to 3 GW_{DC}.
- Based on EIA's Short-Term Energy Outlook, annual PV and wind deployment will grow 34% and 8% respectively in 2021 from the record-setting levels achieved in 2020.

PV System and Component Pricing

- Median reported price by EnergySage for residential PV systems decreased 4.8% between H2 2019 and H2 2020—the largest decrease since 2017.
- In a select data set of utility-scale PV systems owned by 25 regulated utilities, the median system price in 2020 was \$1.34/W_{AC}(\$0.85/W_{DC})—flat y/y in $Watts_{AC}$ but an 8% decrease in $Watts_{DC}$ that was due to increased ILR.
- Mono c-Si PV module prices rose 17% in the first half of 2021, to \$0.24/W—a price not seen since 2019. A large reason for this is because polysilicon, the key feedstock to most PV modules, was up 169% in H1 2021 and 352% y/y, to \$28.5/kg at the end of June; prices were as low as \$6.3/kg in May and June of 2020.
- In Q1 2021, U.S. mono c-Si module prices were still 55% above global ASP.

Global Manufacturing

- In 2020, global PV shipments were approximately 132 GW—an increase of 7% from 2019.
- In 2020, 88% of PV shipments were mono c-Si technology, compared to 35% in 2015 (when multi peaked at 58%).
- In 2020, average module efficiency of modules installed in the United States was approximately 19.7% for mono c-Si, 17.5% for multi c-Si, and 17.7% for CdTe.
- Module and cell imports into the United States picked up significantly in March and April 2021; the first 4 months of the 2021 had a flat level of PV imports, y/y (9.8 GW).

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

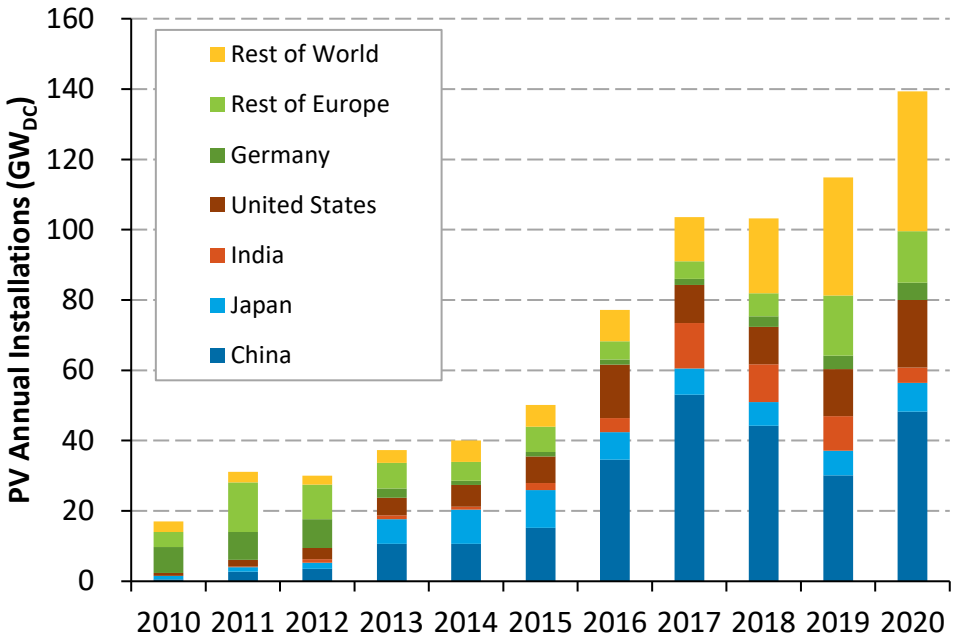
Agenda

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

PV Price Increases

- **From 2010 to 2020, global PV capacity additions grew from 17 GW_{DC} to 139 GW_{DC}.**
  - At the end of 2020, global PV installations reached 760 GWDC.
- **Q1 2021 PV installations increased significantly, y/y, for many leading markets.**
  - From Q1 2020 to Q1 2021, installs in China, the United States, and Germany increased 35%–45%, and installs in India increased 89%.
- **Analysts project increased annual global PV installations over the next 2 years, with continued growth in China, the United States, Europe, and India.**
- **In 2020, approximately 100 MW of CSP was added in China.**

Global Annual PV Capacity Additions by Country



- From 2010 to 2020, global PV capacity additions grew from 17 GW$_{DC}$ to 139 GW$_{DC}$.
  - The COVID-19 pandemic did not significantly impact solar deployment in 2020, with countries installing more in H2 after lockdowns were lifted.
- European markets led in the beginning of the decade, but PV growth transitioned to Asia.
  - At the end of 2020, 57% of cumulative PV installations were in Asia, 22% were in Europe, and 15% were in the Americas.
  - The United States is the country with the second-largest cumulative installed PV capacity.
    - Brazil (3.1 GW$_{DC}$) and Mexico (1.5 GW$_{DC}$) joined the United States as the only countries in the Western Hemisphere to install more than 1 GW of PV in 2020.
  - A recent surge of ROW installations indicates the "globalization" of PV.

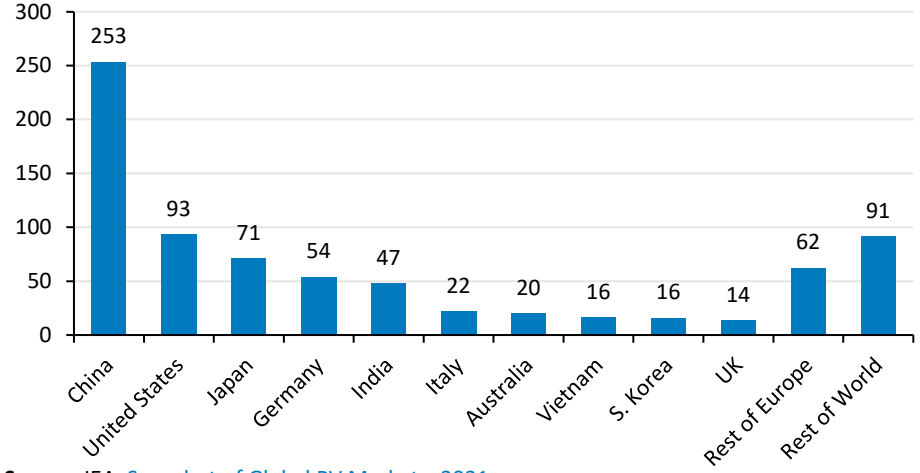
Sources: IEA, Snapshot of Global PV Markets: 2021; PVPS Snapshot 2020; Trends in Photovoltaic Applications 2019.

Top PV Markets

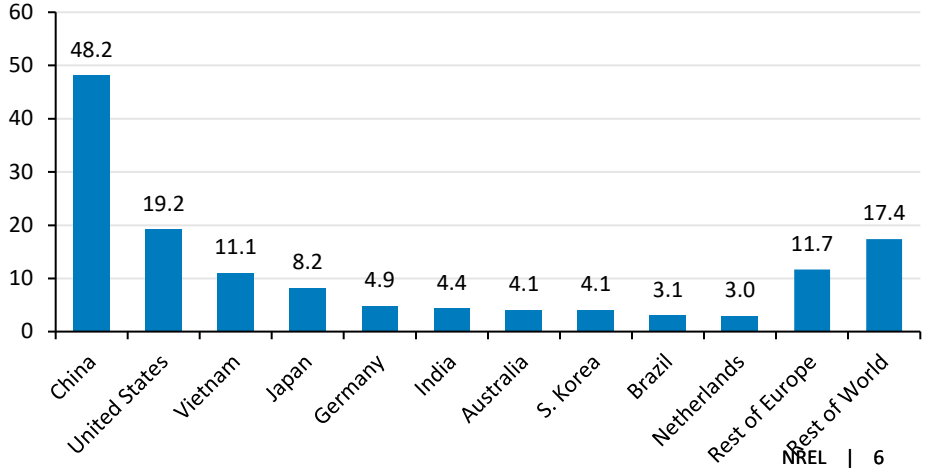
- At the end of 2020, global PV installations reached 760 GW_{DC}, an annual increase of 139 GW_{DC} from 2019.
- The leading five markets in cumulative PV installations at the end of 2020 were China, the United States, Japan, Germany, and India.
  - Vietnam, with more than 11 GW of installations in 2020, bumped India out of the top five for annual deployment.

- China's annual PV installations grew 60% y/y in 2020, representing more than one-third of annual global deployment.
- In 2020, the United States was the country with the second-largest PV market in terms of both cumulative and annual installations.
- 20 countries installed more than 1 GW of PV in 2020, and 14 countries now have more than 10 GW of cumulative capacity.

Cumulative PV Deployment, 2020 (760 GW_{DC})



Annual PV Deployment, 2020 (139 GW_{DC})

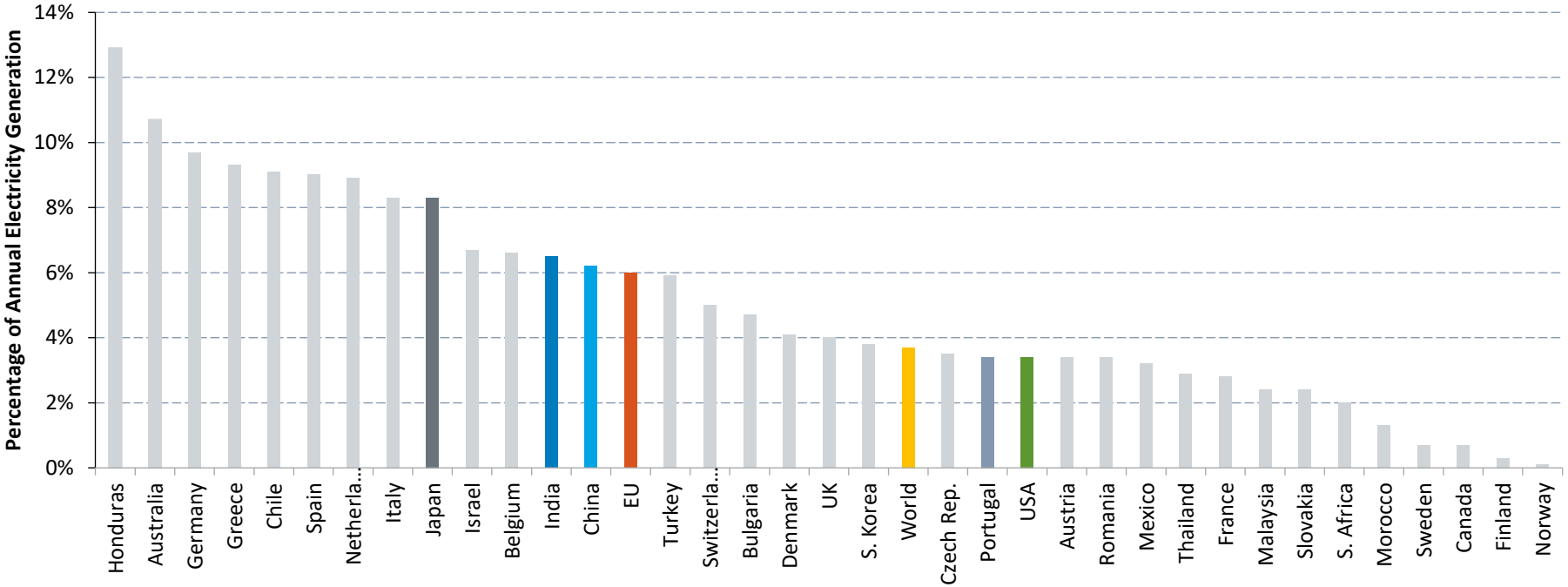


Source: IEA, Snapshot of Global PV Markets: 2021.

Global PV Penetration

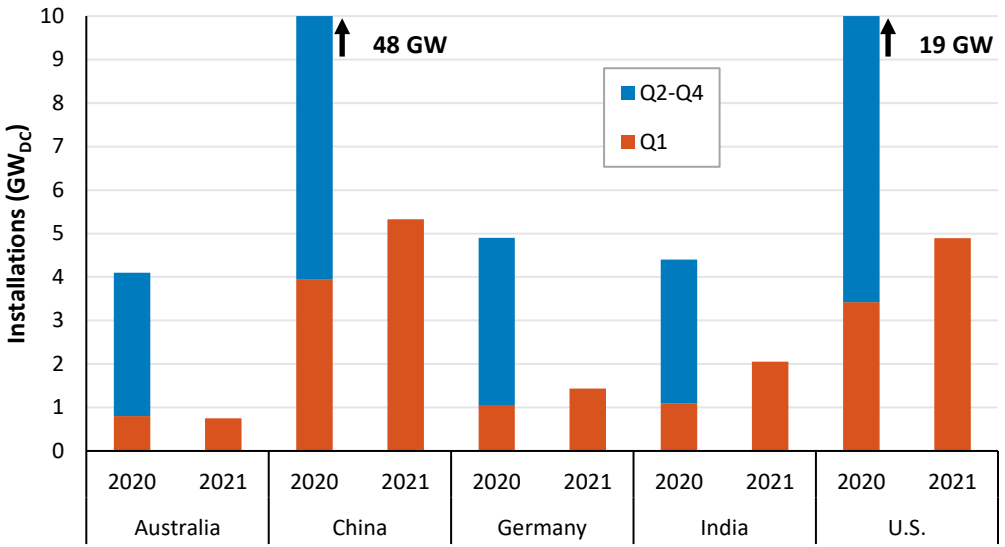
- IEA estimates that in 2020, 3.7% of global electricity generation came from PV.

- The United States, despite being a leading PV market, is below this average and other leading markets in terms of PV generation as a percent of total country electricity generation, with 3.4%.
  - If California were a country, its PV contribution (22.7%) would be the highest.



Sources: IEA, Snapshot of Global PV Markets: 2021; U.S. Energy Information Administration (EIA), "Electricity Data Browser." Accessed March 10, 2021.

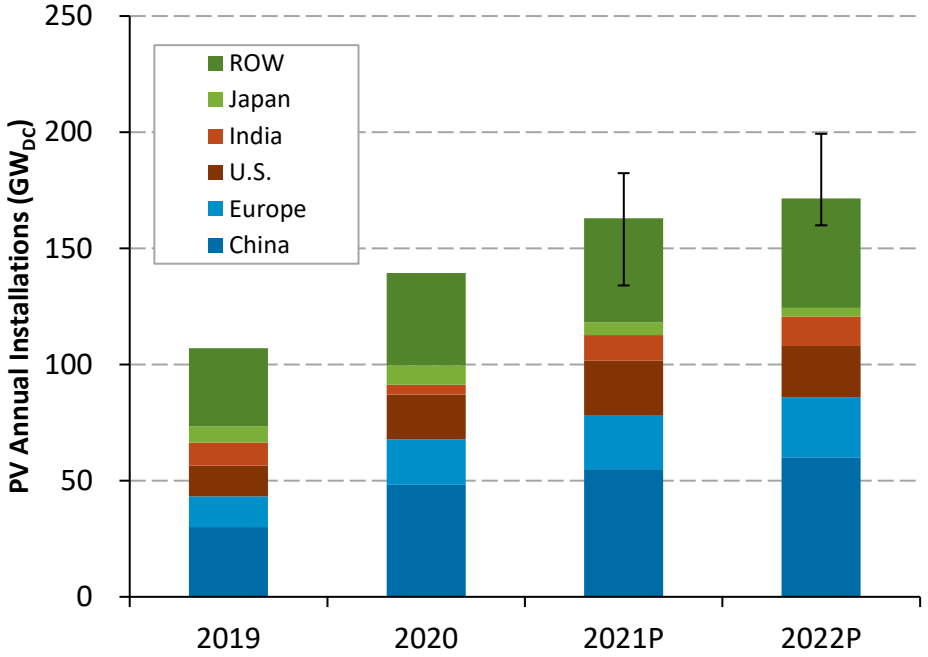
International Q1 2021 Installations



- Q1 2021 PV installations increased significantly, y/y, for many leading markets.
  - From Q1 2020 to Q1 2021, installs in China, the United States, and Germany installs increased 35%–45%, and installs in India increased 89%.
  - Analysts attributed India's large increase to developers finishing delayed 2020 projects.
- Despite the growth in installations, it is not necessarily indicative of 2021 as a whole.
  - A significant portion of deployment often comes toward the end of the year.
  - Significant supply constraints, increased costs, and resurgent waves of the pandemic (particularly in India) might suppress installations.

Sources: Australian Photovoltaic Institute. IEA, Snapshot of Global PV Markets: 2021. Mercom (05/03/21 05/31/21). Wood Mackenzie/SEIA: U.S. Solar Market Insight: Q2 2021.

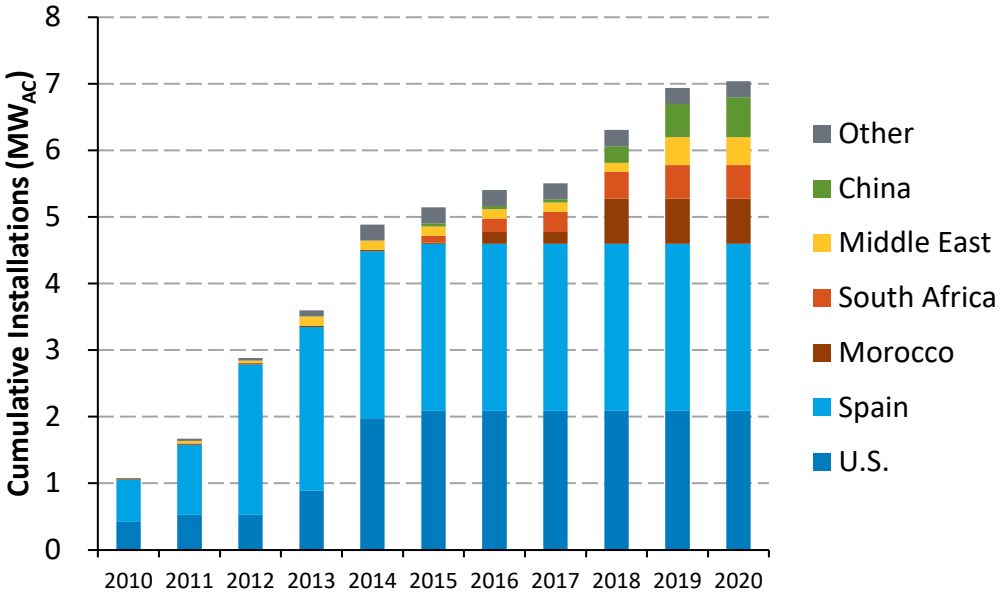
Annual Global PV Demand



- Analysts project increased annual global PV installations over the next 2 years, with continued growth in China, the United States, Europe, and India.
  - The median estimate of 2021 global PV system deployment projects a 17% y/y increase to approximately 163 GW_{DC}.
  - The median estimate of 2022 global PV system deployment projects another 5% y/y increase to approximately 172 GW_{DC}.

Notes: P = projection. Bar represents median projection. Error bars represent high and low projections. Not all sources have data for all categories.
Sources: BNEF, "2Q 2021 Global PV Market Outlook," 05/21/21; IEA, Renewable Energy Market Update: Outlook for 2021 and 2022. Goldman Sachs Equity Research. Americas Clean Technology: Solar 2021 Outlook. 01/04/21. IHS Markit Research (03/31/21). IEA, Snapshot of Global PV Markets: 2021.

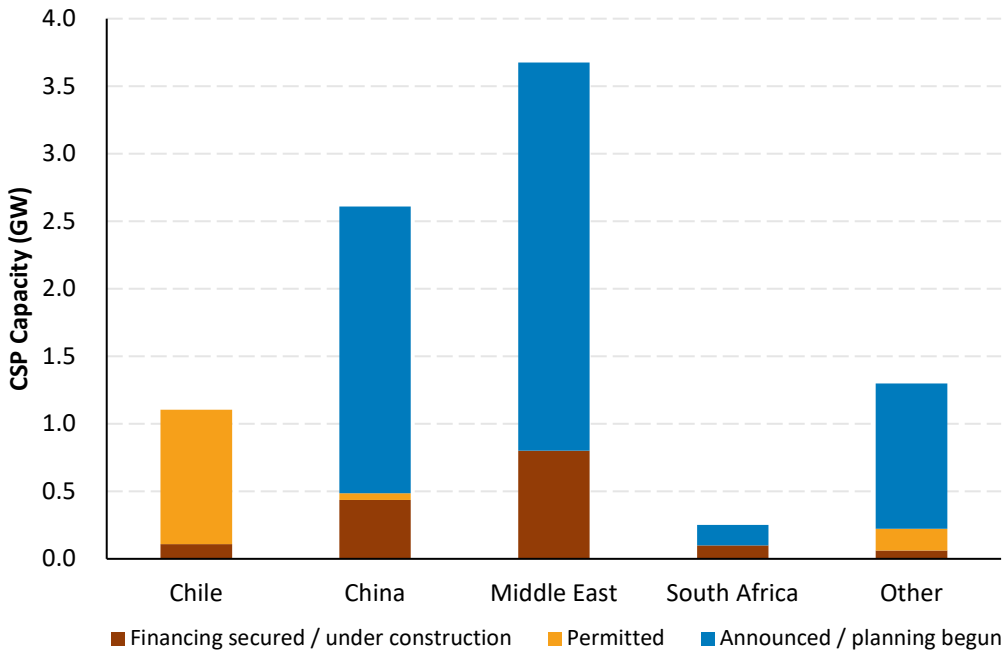
Global CSP Installed



- From 2010 to 2020, cumulative global CSP installations increased by almost 6X.
  - Initially most of the growth came from Spain and the United States.
- From 2015 to 2020, approximately 2 GW of CSP was installed in other parts of the world, particularly the Middle East, North Africa, and China.
  - There is also some development in other parts of the world, such as South America.
- In 2020, approximately 100 MW of CSP was added in China.

Sources: BNEF, "Capacity & Generation" data set. Accessed June 2, 2021.

Global CSP Pipeline

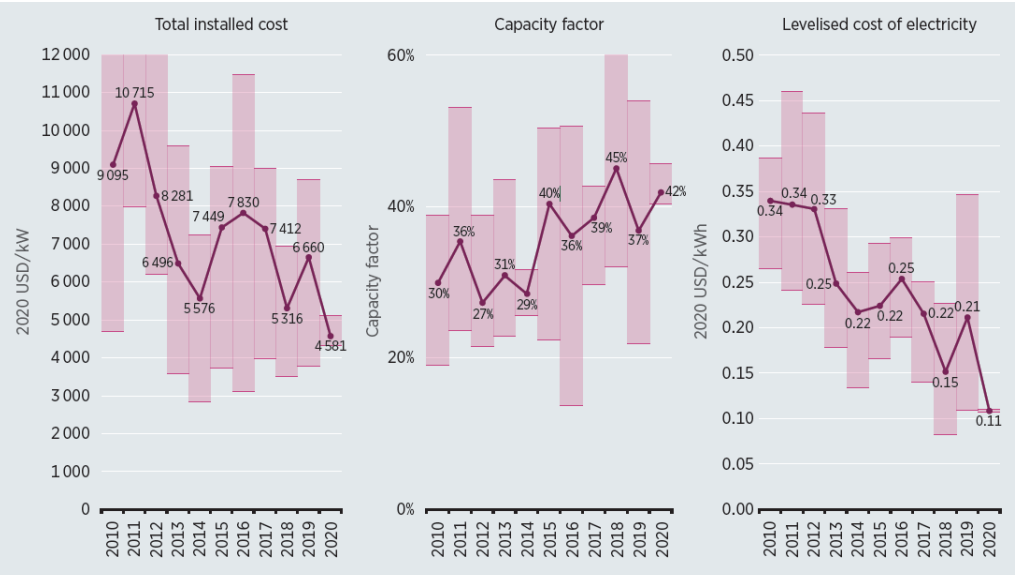


- BNEF reports a CSP pipeline of 8.8 GW:
  - 1.4 GW is under construction.
  - 1.2 GW is permitted.
  - 6.2 GW has been announced.
- In the near term, CSP projects are primarily expected to be built in Chile, China, and the Middle East.
- In the longer term, significantly more projects are planned in China and the Middle East.

Note: Pipeline is defined as active projects in BNEF's database that have: secured financing or are under construction; received permit(s) for construction; or been announced and planning has begun. Timelines vary by the circumstances of individual CSP projects, however each step can take two years, or six years in total.

Sources: BNEF, "Capacity & Generation" data set. Accessed June 2, 2021.

CSP Global Averages

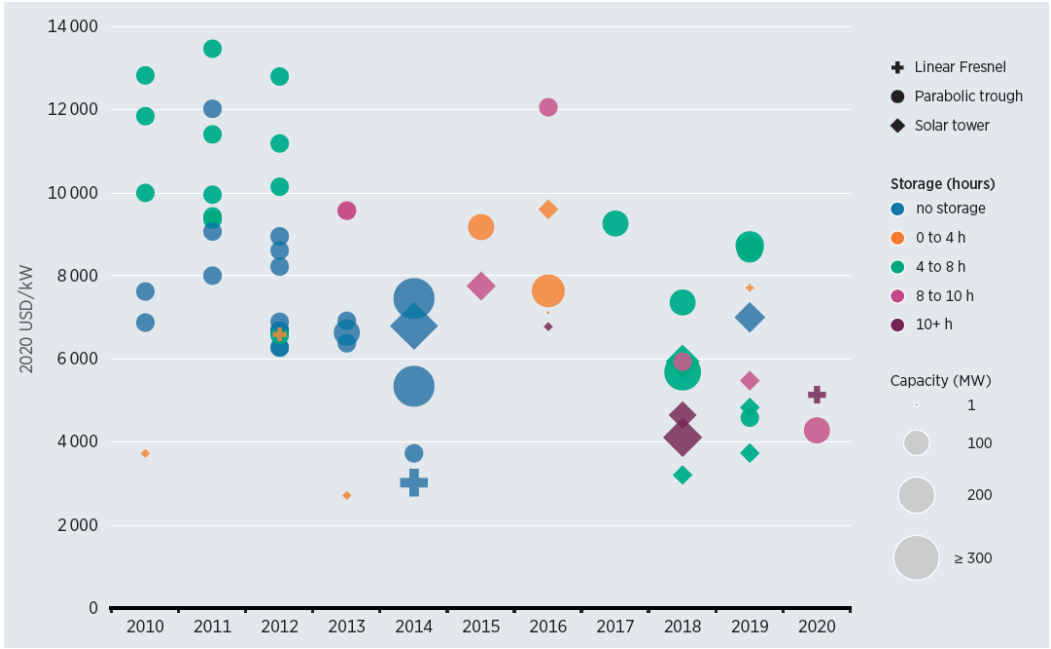


Source: IRENA Renewable Cost Database.

- IRENA reports that the weighted-average LCOE of CSP plants fell 68% from 2010 to 2020, to $0.108/kWh.
- In 2020, the global weighted-average total installed cost was $4,581/kW, which is 31% lower than in 2019.
- Average capacity factor of CSP plants increased from 30% in 2010 to 42% in 2020 as a result of technology improvements, deployment occurring in better solar resource areas, and increased use and levels of storage.

Source: IRENA, Renewable Power Generation Costs in 2020.

CSP Installed Cost by Project Size, Collector Type, and Amount of Storage, 2010–2020



- IRENA reports that CSP CAPEX declined from 2010 to 2020, despite adding more hours of energy storage on average.
- IRENA also reports system size has generally increased (which likely facilitates cost reduction opportunities) and the industry has deployed a more diverse set of collector types.

Source: IRENA, Renewable Power Generation Costs in 2020.

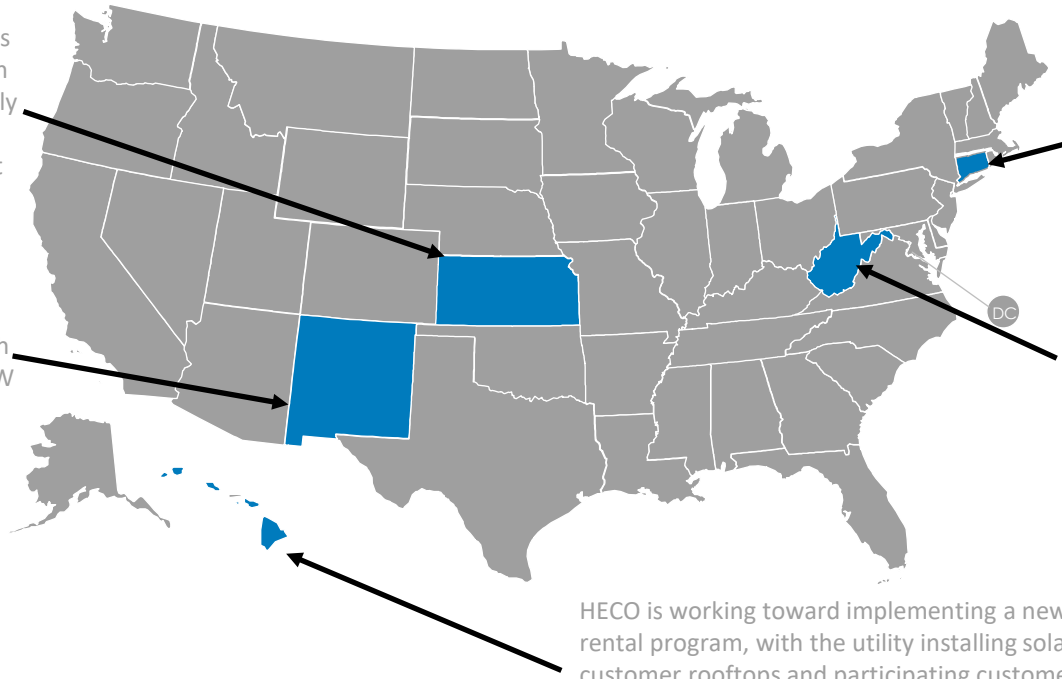
- **The United States installed 4.0 GW_{AC} (4.9 GW_{DC}) of PV in Q1 2021—its largest Q1 total ever.**
- **At the end of 2020, there were approximately 2.7 million residential PV systems in the United States.**
- **SEIA reported that in 2020 the U.S. community solar market installed 826 MW_{DC} of community solar installations—a 30% increase, y/y, bringing cumulative capacity to 3 GW_{DC}.**
- **Based on EIA's Short-Term Energy Outlook, annual PV and wind deployment will grow 34% and 8% respectively in 2021 from the record-setting levels achieved in 2020.**

Q1 2021 State Updates

- Many states are working on adopting unique net metering successor policies as they continue to increase size limits and aggregate caps; however, many utility proposals include minimum bills, higher fees, time-of-use rates, and lower export credit rates.
- Community solar continues to expand, but many states are facing challenges achieving LMI participation goals.

Kansas regulators reject Evergy's proposed distributed generation fees, saying they could negatively impact low-income customers. However, the commission is not against a grid access charge.

New Mexico lawmakers passed community solar legislation, with an initial program cap of 100 MW and a 30% capacity requirement for LMI customers.



Connecticut's PUC approved two NEM successor options: (1) a buy-all, sell-all fixed tariff and (2) a monthly netting option set at retail rates.

West Virginia passed legislation to allow third-party PPAs. It had been one of seven states that prohibited third-party PPAs.

HECO is working toward implementing a new rooftop rental program, with the utility installing solar on customer rooftops and participating customers receiving fixed monthly bill credits.

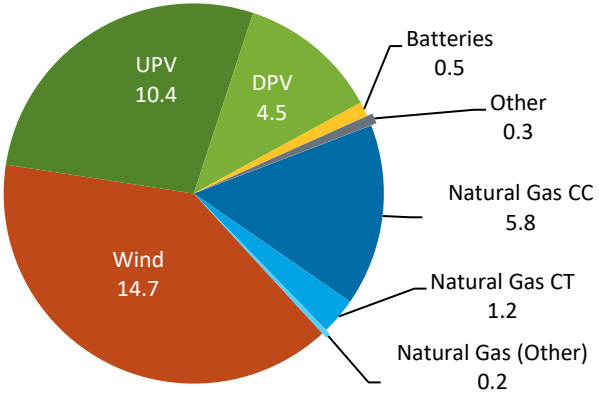
Source: Meister Consultants Group, *50 States of Solar: Net Metering Quarterly Update* (Q1 2021).

U.S. Generation Capacity Additions by Source: 2020 and *Planned* 2021

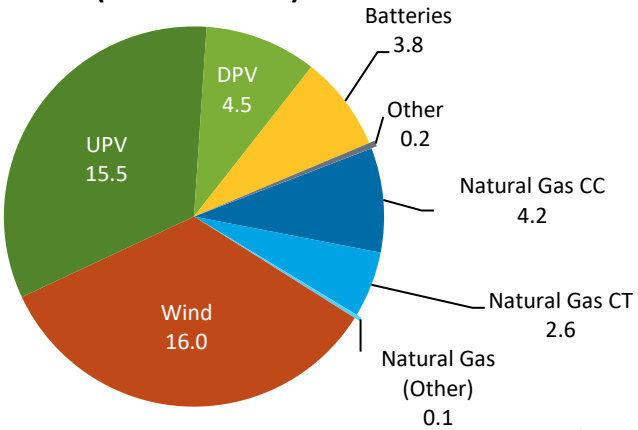
- EIA estimates the percentage of U.S. electric capacity additions from solar will grow from 40% in 2020 to 43% in 2021 (33% UPV and 10% DPV).
- It is estimated that wind and solar will represent 77% of all new electric generation capacity and battery storage will represent another 8%.

- Based on EIA's Short-term Energy Outlook, annual PV and wind deployment will grow 34% and 8%, respectively in 2021 from the record-setting levels achieved in 2020.
  - 2020 and planned 2021 total U.S. capacity additions represent a significant increase in total deployment from the previous 10-year average of 26 GW per year.
  - More than 30% of new capacity is projected to be installed in Texas, with over 3.2 GW of natural gas, 5.7 GW of wind, and more than 4.5 GW of solar.

2020 U.S. Generation Capacity Additions (Total 37.6 GW)

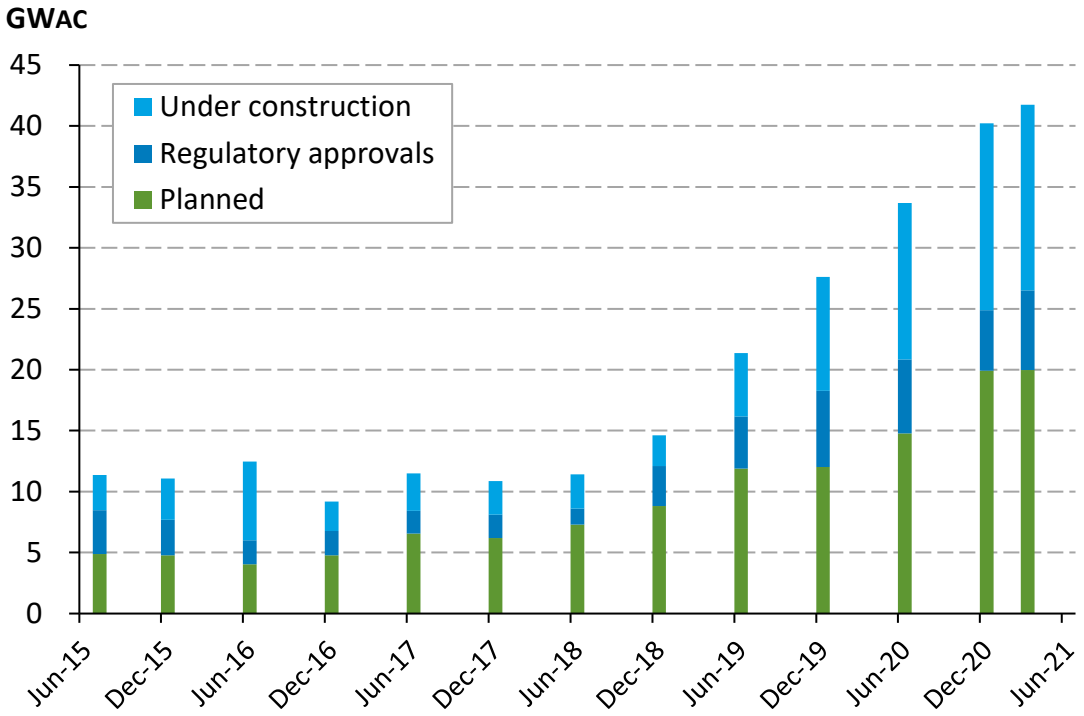


***Planned* 2021 U.S. Generation Capacity Additions (Total 46.9 GW)**



Sources: EIA "Preliminary Monthly Electric Generator Inventory. EIA "Electric Power Monthly" Table 6.1. EIA "Short-term Energy Outlook."

EIA PV Project Planned Pipeline



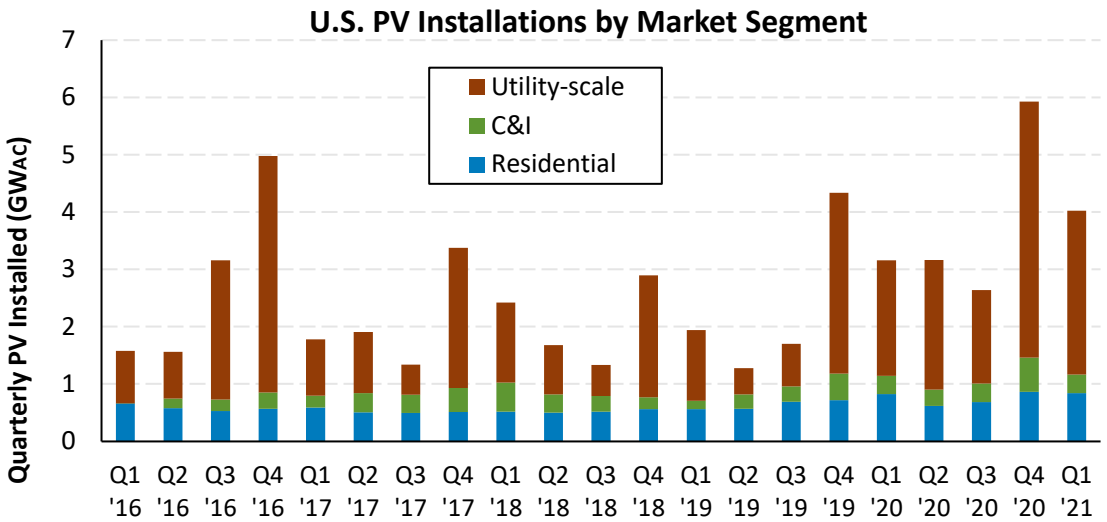
According to EIA data, the U.S. PV project pipeline of utility-scale PV projects continues to hit record highs, with 15 GW_{AC} of projects under construction, 7 GW_{AC} having received regulatory approval, and 20 GW_{AC} planned as of March 2021.

Note: Pipeline is defined as all planned PV projects which have been submitted in EIA's Form 860M. All projects have a scheduled placed-in-service date between 2021-2024.

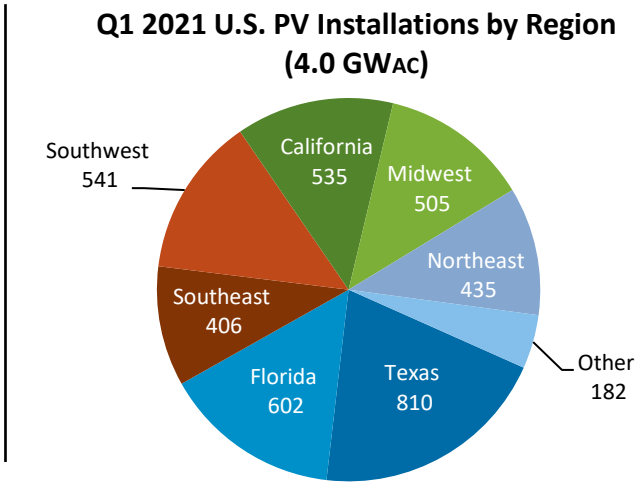
Source: EIA Form 860M (March 2021).

U.S. Installation Breakdown Annual: EIA (GW_{AC})

- The United States installed 4.0 GW_{AC} of PV in Q1 2021, its largest Q1 total ever—up 27% y/y.
  - Residential and C&I were up 2% and utility-scale PV was up 40% in Q1 2021.



- Texas, Florida, and California represented half of U.S. PV capacity installed in Q1 2021, which is similar to 2020 levels.
- Despite a concentration of PV installations in the top three markets, diversification of growth continues across the United States.
  - 15 states installed more than 50 MW_{AC} of PV in Q1 2021.

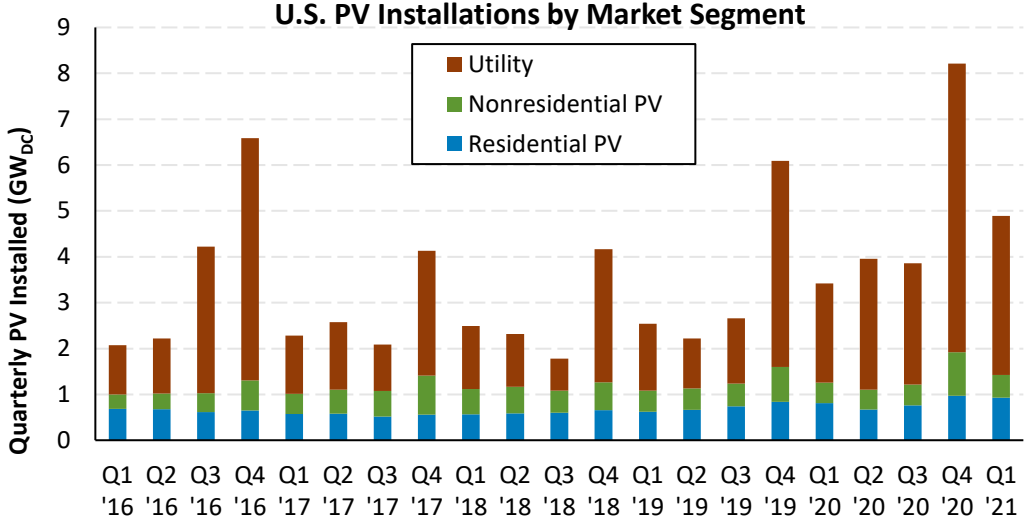


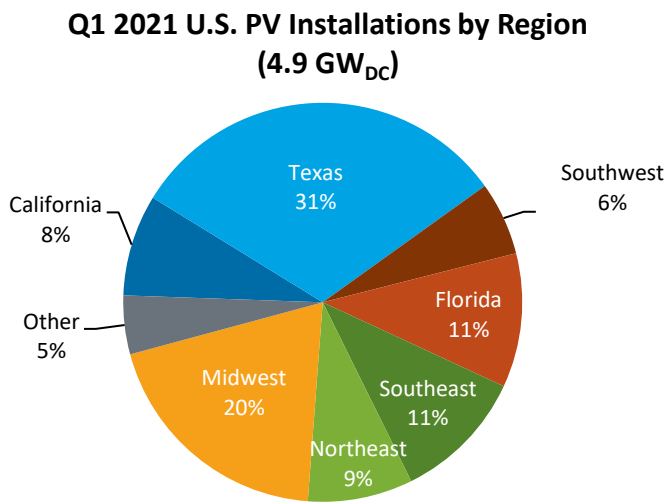
Note: EIA defines "utility-scale" as projects having a capacity greater than 1 MW. EIA reports values in W_{AC} which is standard for utilities. The Solar industry has traditionally reported in W_{DC}. See next slide for values reported in W_{DC}.
Sources: EIA, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861 (June 2021, February 2021, February 2019).

U.S. Installation Breakdown Annual: SEIA (GW_{DC})

Unlike the values on the previous slide, the values on this slide are in GWDC instead of GWAC.

- SEIA reports that the United States installed 4.9 GW_{DC} of PV in Q1 2021—up 43% y/y.
- At the end of Q1 2021, there were over 100 GW_{DC} of cumulative PV installations.
- Two Midwestern states (Indiana and Michigan) were top 5 PV markets in Q1 2021, with Indiana installing more PV than California.



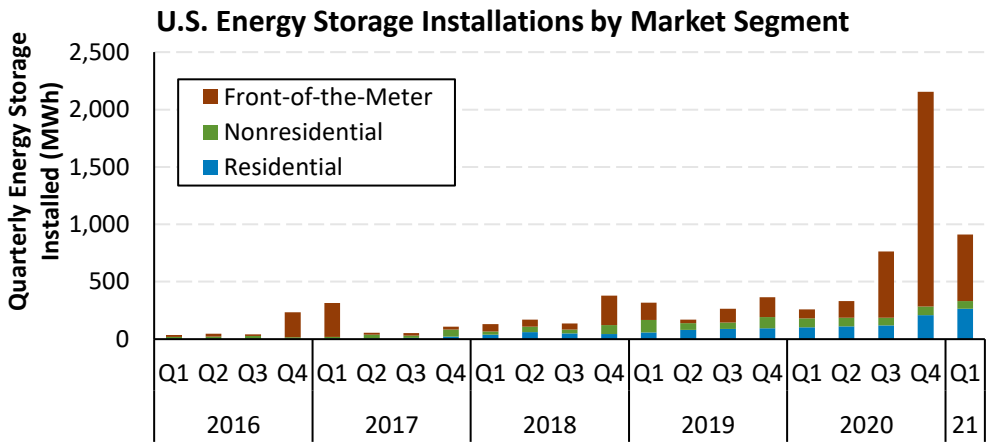


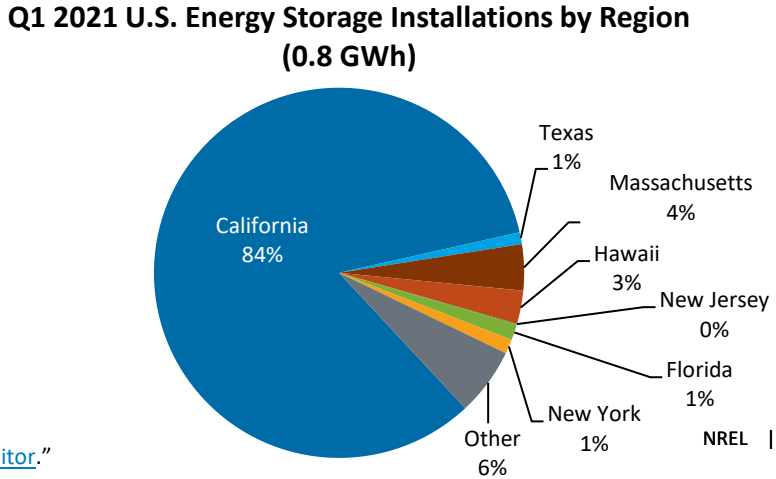
Sources: Wood Mackenzie/SEIA: U.S. Solar Market Insight: Q2 2021.

U.S. Energy Storage Installations by Market Segment

- The United States installed approximately 0.9 GWh/0.3 GW_{AC} of energy storage onto the electric grid in Q1 2021, up 252% y/y, as a result of record levels of residential deployment and the second highest quarterly level of front-of-the-meter deployment (though only two projects came in California online).
  - Q1 2021 was the first time residential storage surpassed 250 MWh (or 100 MW) of quarterly installs.
  - The nonresidential market has remained relatively flat for the past 3 years.

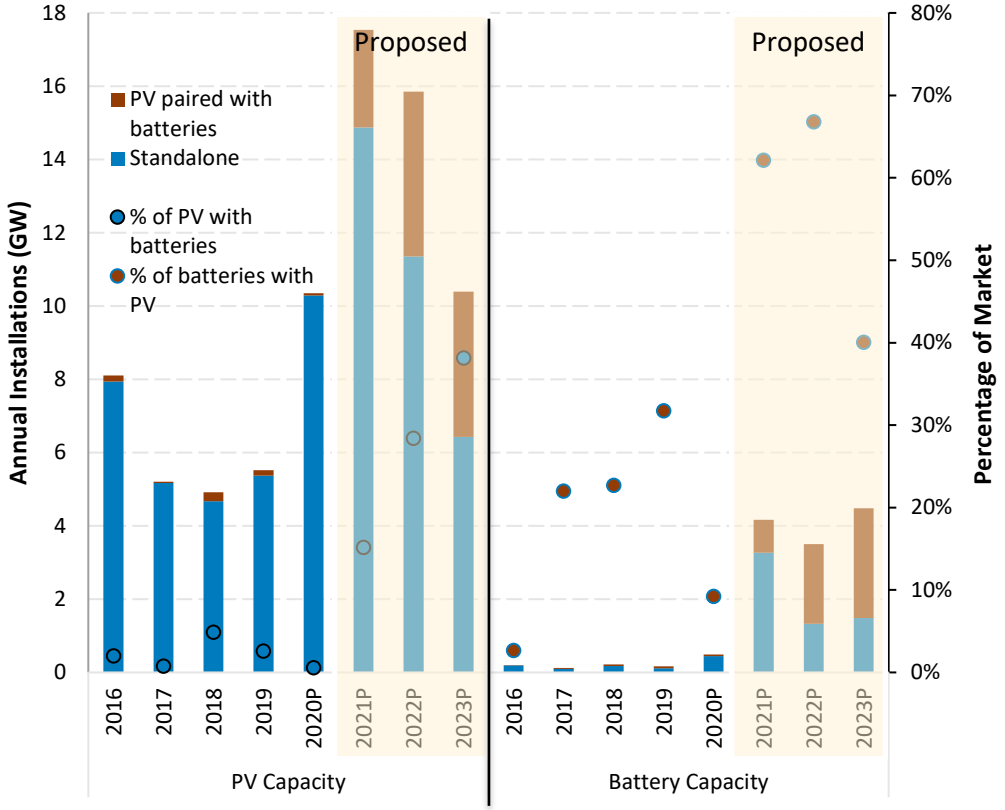
- Wood Mackenzie reports the nonresidential market has had troubles scaling because of the challenges of standardizing and scaling a commercial offering.
- California continued to be far and away the largest residential and utility-scale market in Q1 2021, with Massachusetts taking the top spot in the nonresidential sector.
- The Biden administration is proposing a standalone tax credit for energy storage, which has the possibility to increase storage deployment and decouple it from solar.





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

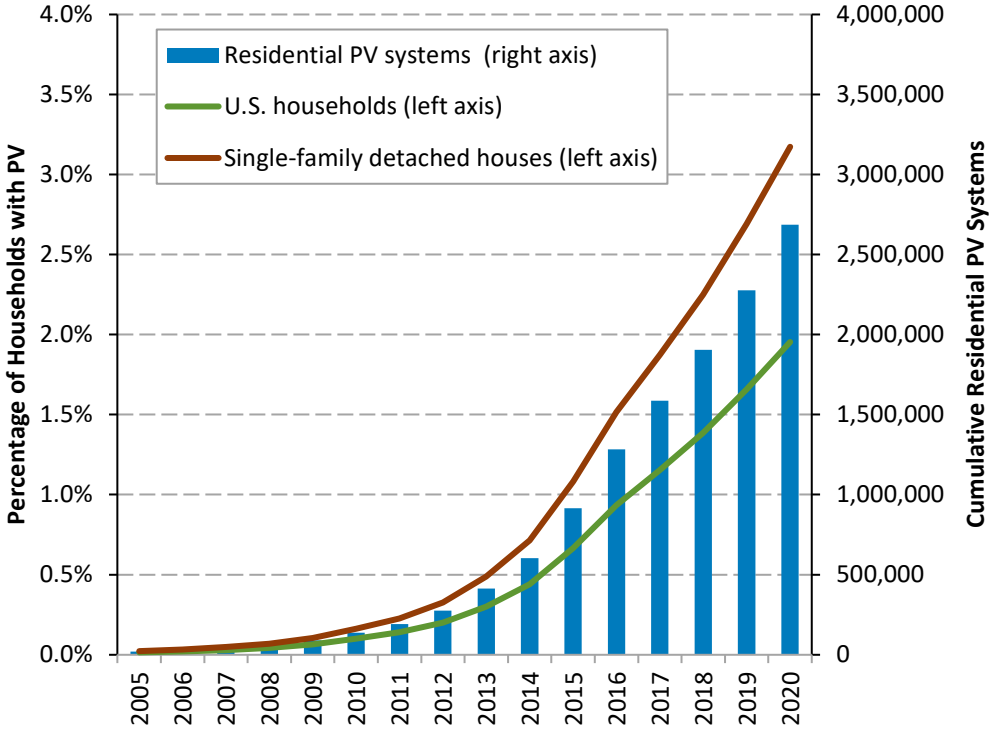
U.S. Utility-Scale PV and Batteries



- From 2016 through 2020, approximately 650 MW of U.S. utility-scale PV systems were built—and paired with 180 MW of storage (493 MWh)—representing approximately 2% of U.S. utility-scale PV system capacity and 15% of utility-scale battery system capacity (MW) installed during that time.
  - 41% of utility-scale battery capacity (in MWh capacity) installed between 2016 and 2020 was paired with PV.
- EIA reports another 11.1 GW of utility-scale PV are proposed to be built—and paired with 6.1 GW of battery storage—from 2021 through 2023.
  - The percentage of utility-scale PV systems paired with batteries is expected to increase 15% in 2021, 28% in 2022, and 38% in 2023.

Source: U.S. EIA, Form EIA-860 2020ER.

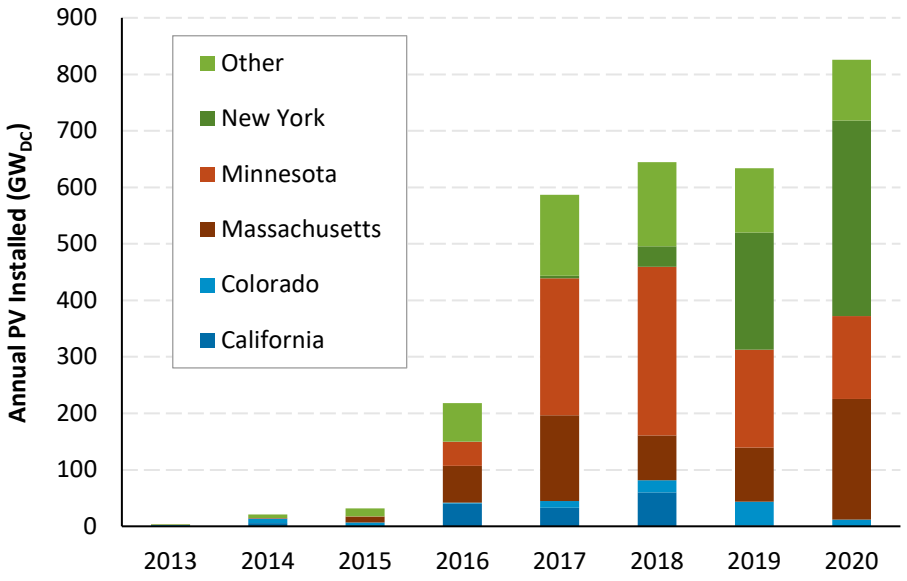
U.S. Residential PV Penetration



- Since 2005, when Congress passed the investment tax credit, the number of residential PV systems installed annually has grown by approximately 32% per year, or by about 60X.
- At the end of 2020, there were approximately 2.7 million residential PV systems in the United States.
  - Still, only 2.0% of households own or lease a PV system (or about 3.2% of households living in single-family detached structures).
  - However, solar contributions vary by location. Hawaii, California, and Arizona have residential systems on an estimated 32%, 15%, and 9% of single-family detached structures.
- At the end of 2020, Australia and Germany had approximately 2.7 million and 2.0 million PV systems, respectively, but with much smaller populations.

Sources: Res. PV Installations: 2000-2009, IREC 2010 Solar Market Trends Report; 2010-2020, Wood Mackenzie Power and Renewables/SEIA: U.S. Solar Market Insight 2020 Year-in-Review; U.S. Households U.S. Census Bureau, 2019 American Community Survey; German Solar Association (BSW-Solar); Australian Photovoltaic Institute.

Annual Community Solar Additions



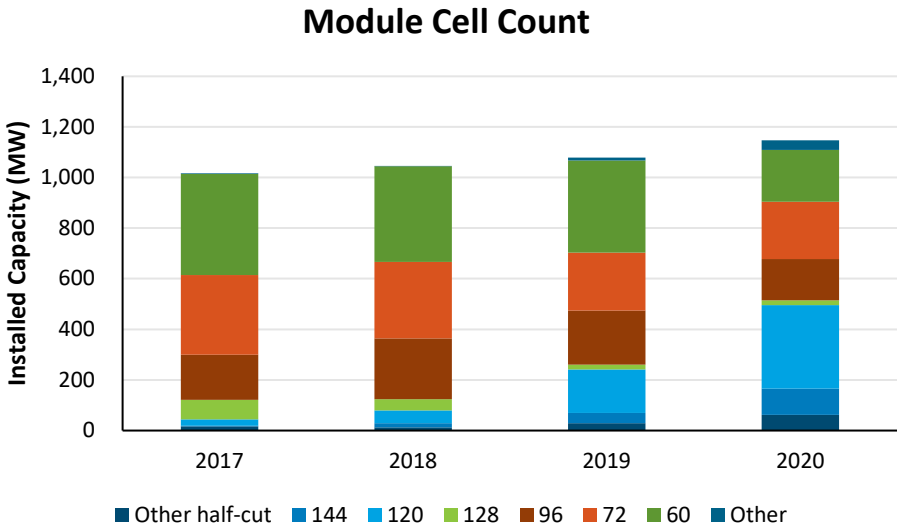
- SEIA reported that in 2020 the U.S. community solar market installed 826 MW_{DC} of community solar installations—a 30% increase, y/y—bringing cumulative capacity to 3 GW_{DC}.
- At the end of 2020, community solar projects were in 40 states, but 79% of the cumulative installed community solar capacity was in the leading 5 states.
  - Community solar growth has been driven by leading markets, first in Colorado, and then Minnesota and Massachusetts, and in 2019-20 in New York.
- Wood Mackenzie expects growth in 2021 that is due to delayed projects from previous years. Growth is also expected to come from newer community solar markets such as Illinois, Maine, and New Jersey.

Note: Wood Mackenzie Power and Renewables and SEIA define "Community Solar" as projects where multiple customers can subscribe to power offtake from a PV system installed in their community and receive credits on their utility bills.

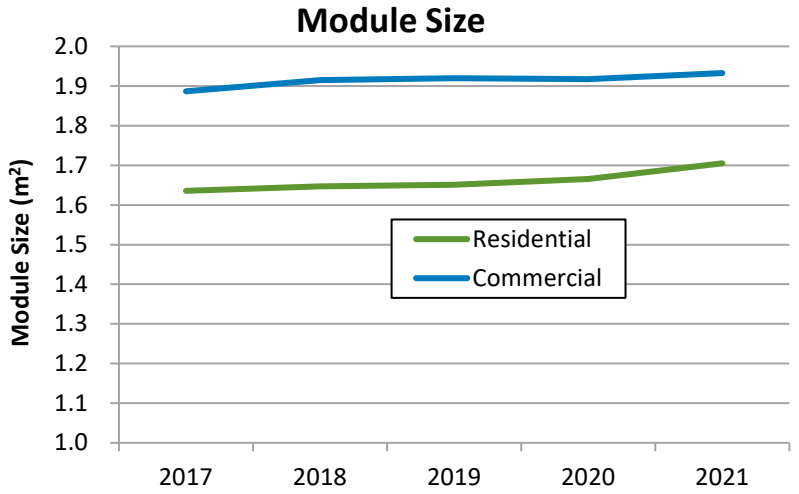
Sources: Wood Mackenzie Power and Renewables/SEIA: U.S. Solar Market Insight Q2 2021.

Module Characteristics of California NEM Data Set

- Historically, most California distributed PV capacity used modules with 60 or 72 PV cells, or SunPower's 96 or 128 count.
- From 2017 to 2020 PV modules with half-cut cells (e.g., 60 x 2 = 120; 72 x 2 = 144) grew from 4% to 43% of distributed capacity installed in California.

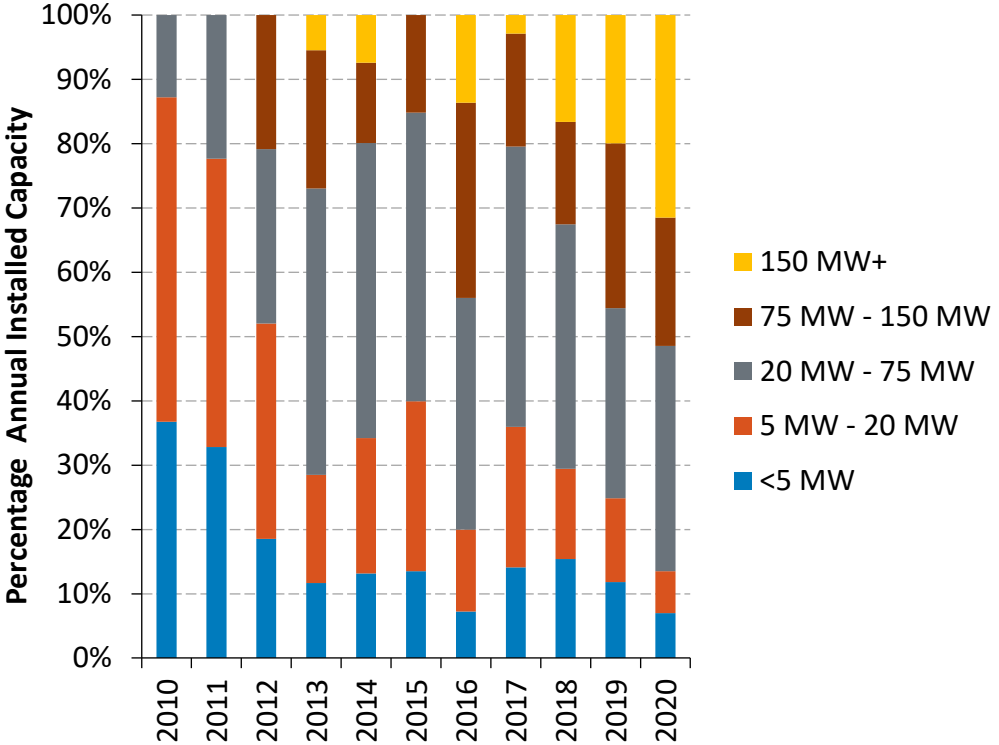


- Although bifacial panels have recently captured a significant market share in the United States, in 2020 they still represented a small percentages of California's commercial (5%) and distributed ground-mount (4%) capacity.
  - That level for commercial systems still represents a significant jump from 0.1% of installed capacity in 2018 and 0.4% in 2019.
- Module size in the commercial and residential sector increased only modestly from 2017 to 2020.



Source: CA NEM database (03/31/21).

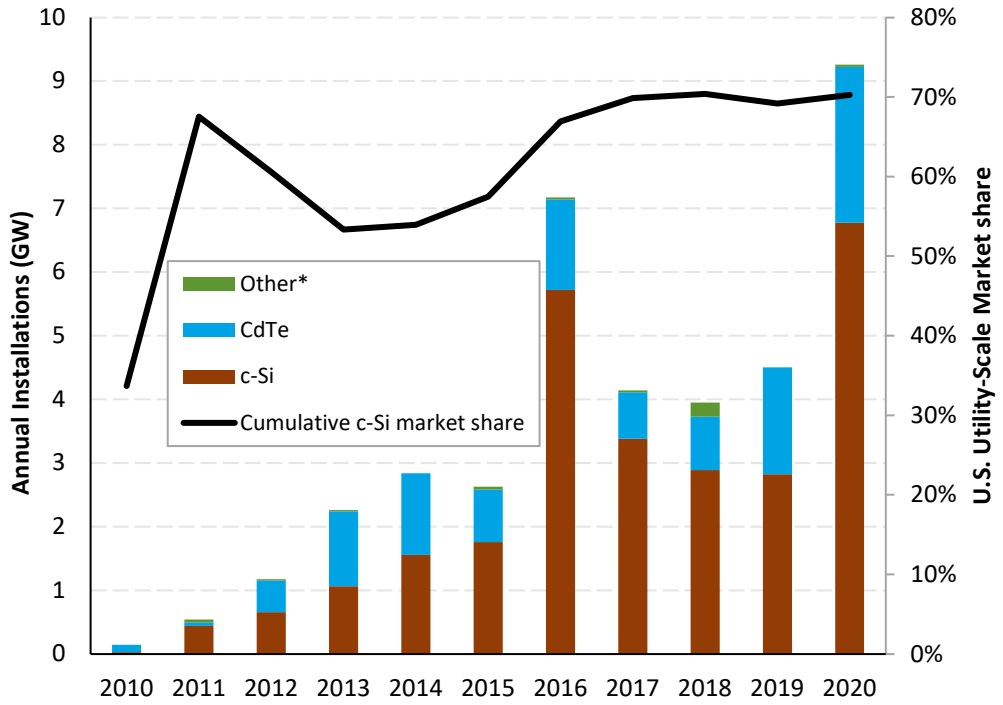
1 MW+ U.S. PV System Size Distribution by Year



- In 2010, only 13% of the U.S. PV systems greater than 1 MW installed were above 20 MW_{AC}, with the largest system being 30 MW_{AC}.
- In 2020, 86% of U.S. PV systems above 1 MW_{AC} installed came from systems above 20 MW_{AC}, with the largest system being 300 MW_{AC}.

* "Other" could represent data entry errors.
Source: U.S. EIA, Form EIA-860 2020ER.

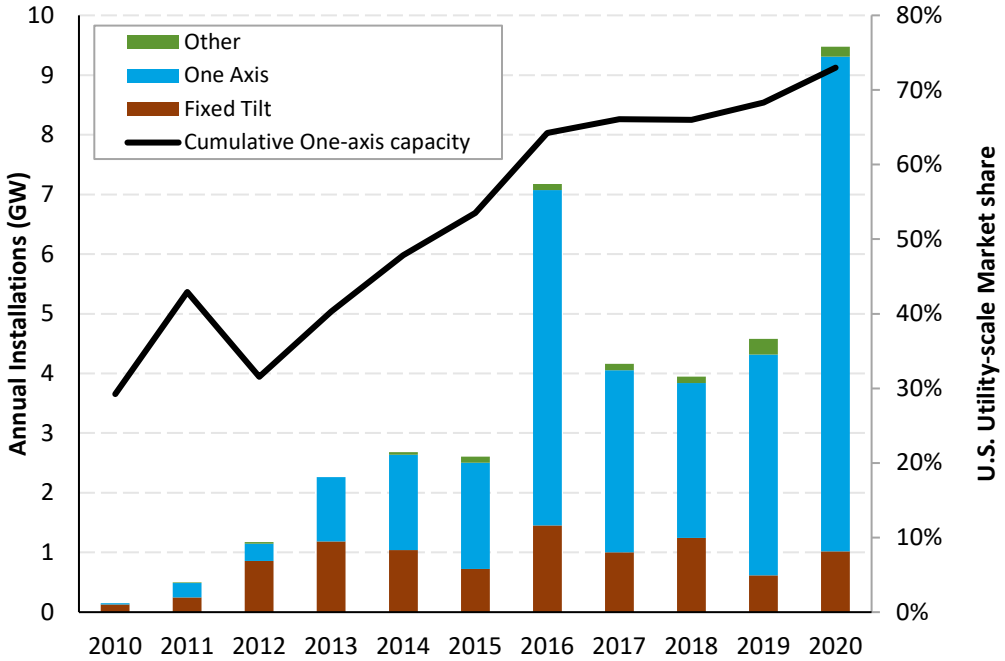
U.S. Utility-Scale PV Technology Distribution by Year



- Though thin-film PV represented less than 5% of global PV deployed from 2010 through 2020, it accounted for 29% of U.S. utility-scale PV deployments during this period.
  - In 2020, CdTe PV accounted for 26% of U.S. utility-scale PV.
  - For First Solar, the leading supplier of CdTe modules, the U.S. market has been critical, accounting for 77% of its revenue from 2016 through 2020.
- Most of the distributed U.S. PV market uses c-Si modules; therefore, CdTe market share for all U.S. PV systems is lower.
  - CdTe accounted for approximately 16% of all U.S. solar deployed in 2020 (cumulative and annual).

* "Other" includes CIGS, a-Si, but also could represent data entry errors.
Source: U.S. EIA, Form EIA-860 2020ER.

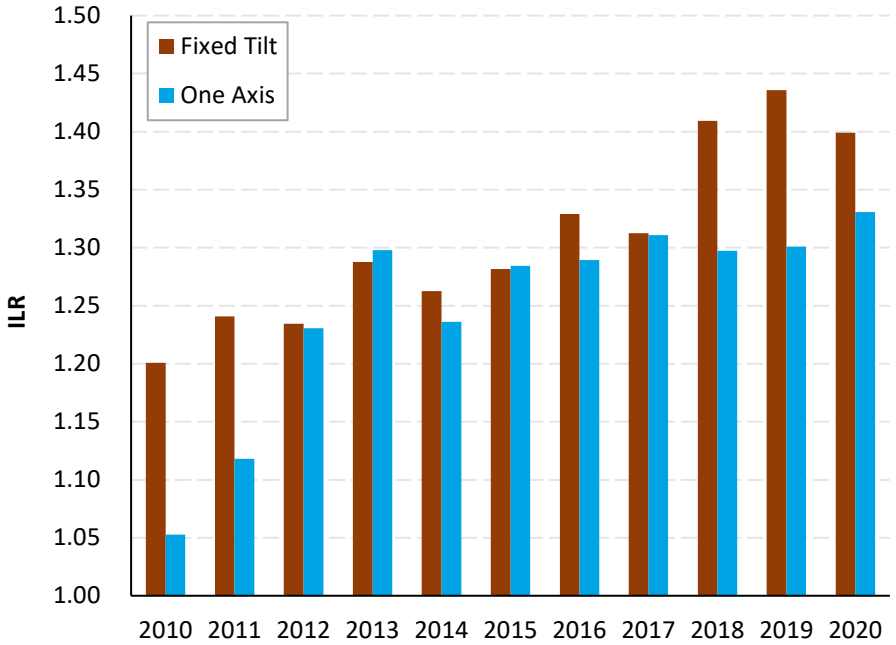
U.S. Utility-Scale PV Mounting Type by Year



- The use of single-axis tracking in the U.S. utility PV market has grown steadily over the past decade.
  - At the end of 2020, 73% of all U.S. utility-scale PV systems used single-axis tracking. And 87% of U.S. utility-scale PV systems installed in 2020 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 could represent data entry errors.
Source: U.S. EIA, Form EIA-860 2020ER.

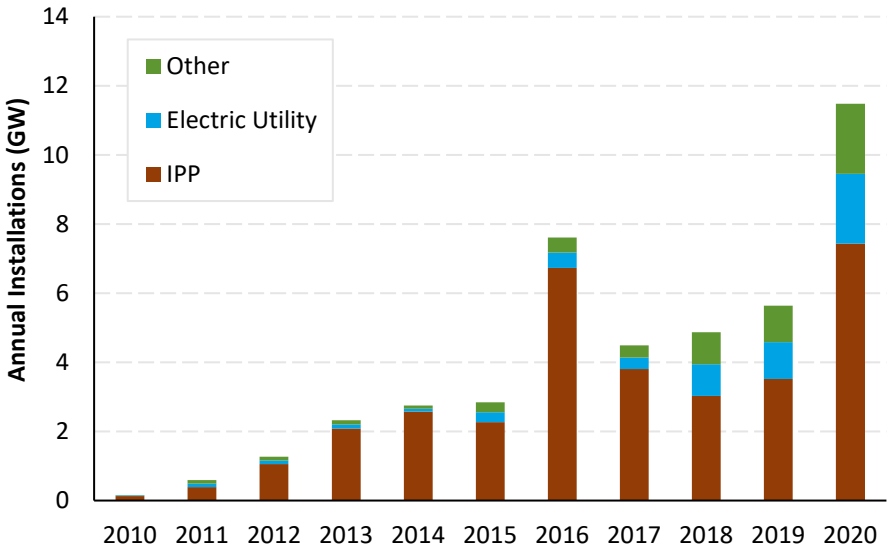
U.S. Utility-Scale PV Average Inverter Loading Ratio (ILR) by Year



- Over the past 10 years, the average ILR has increased for both fixed-tilt and one-axis tracking PV systems in the United States.
- The average ILRs for fixed-tilt and one-axis tracking systems installed in 2020 were 1.40 and 1.33 respectively.
- 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 2020ER.

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

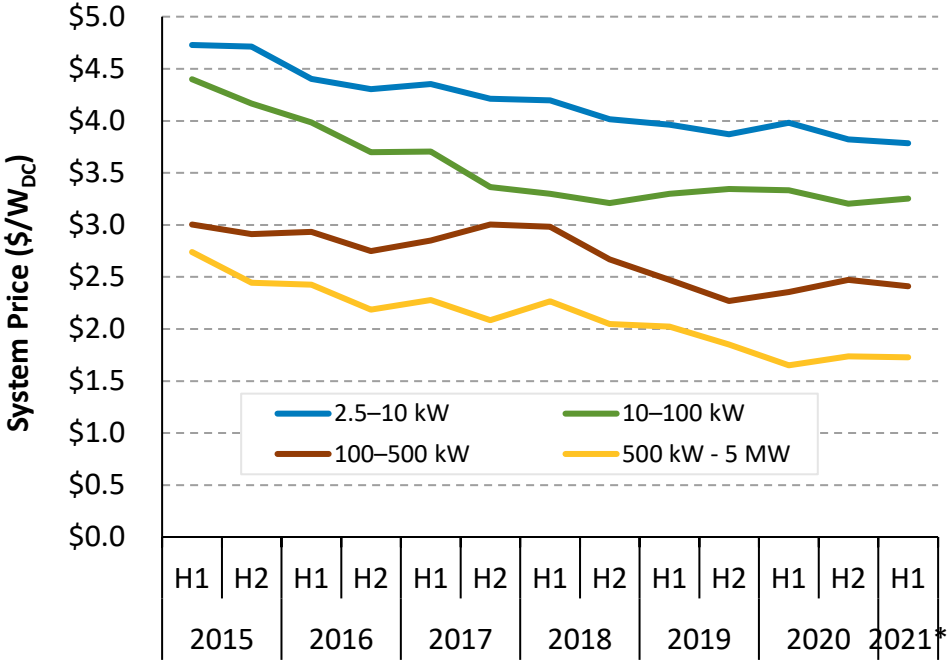


- Most U.S. utility-scale PV systems are owned by independent power producers (IPPs), which sell their electricity under long-term contracts.
- However, from 2010 to 2020, 5.5 GW of PV installed has been owned by electric utilities—2.0 GW was installed in 2020 alone.
- Utilities own PV in 19 states, but 59% 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 above 5 MW in size.
Source: U.S. EIA, Form EIA-860 2020ER.

- **The median reported price by EnergySage for residential PV systems decreased 4.8% between H2 2019 and H2 2020—the largest decrease since 2017.**
- **In a select data set of utility-scale PV systems owned by 25 regulated utilities (149 projects totaling 6.0 GW_{AC}), the median system price in 2020 was \$1.34/W_{AC} (\$0.85/W_{DC})—flat y/y in $Watts_{AC}$ but an 8% decrease in $Watts_{DC}$ that was due to increased ILR.**

System Pricing from Select States



- From H1 2020 to H1 2021, the median reported PV system price in Arizona, California, Connecticut, Massachusetts, and New York:
  - Fell 5% to $3.78/W for systems from 2.5 kW to 10 kW
  - Fell 2% to $3.25/W for systems from 10 kW to 100 kW
  - Increased 2% to $2.41/W for systems from 100 kW to 500 kW
  - Increased 5% to $1.73/W for systems from 500 kW to 5 MW.

2021 YTD MW: AZ (48), CA (72), CT (2), MA (70), NY (183)

- **YTD**

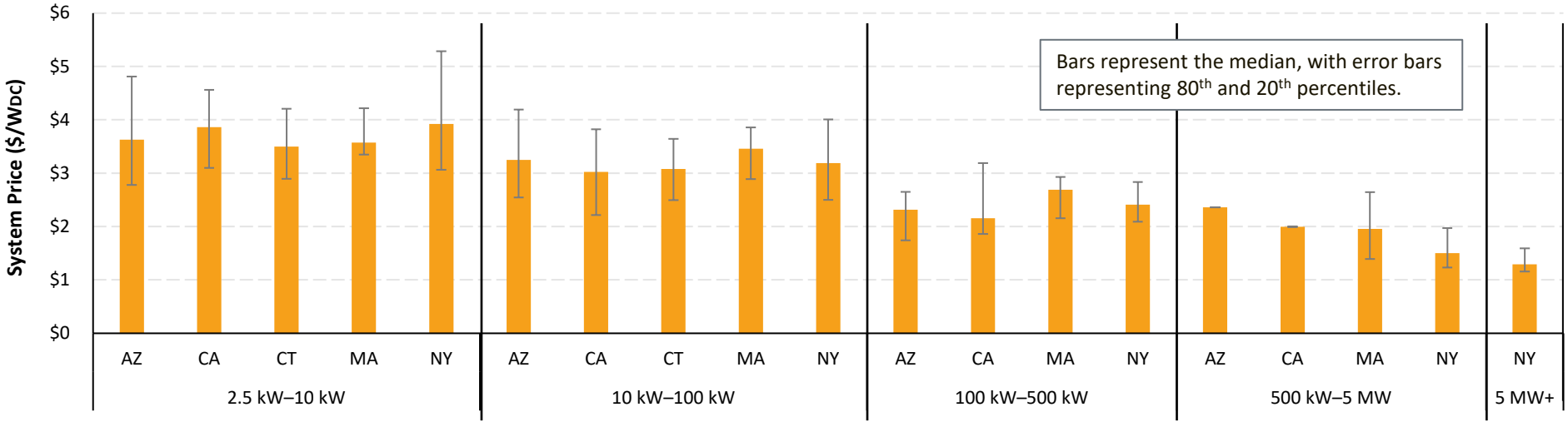
Note: System prices above $10/W and below $0.75/W were removed from the data set. There were not enough reported prices for systems above 5 MW in this data set to show a trend over time.

Sources: AZ (06/24/21), CA NEM database (04/31/21); CT (05/14/21), MA SREC (05/05/21) and SMART (06/01/21) programs; NYSERDA (06/24/21).

System Pricing from Select States, H1 2021*

- In addition to price differences based on system size, there is variation between states and within individual markets.

- The median price of a large system in New York was about 21% less than the median price in Massachusetts.
- In 2020, the 20th and 80th percentile prices in California for a small system were $3.23/W and $4.94/W respectively.



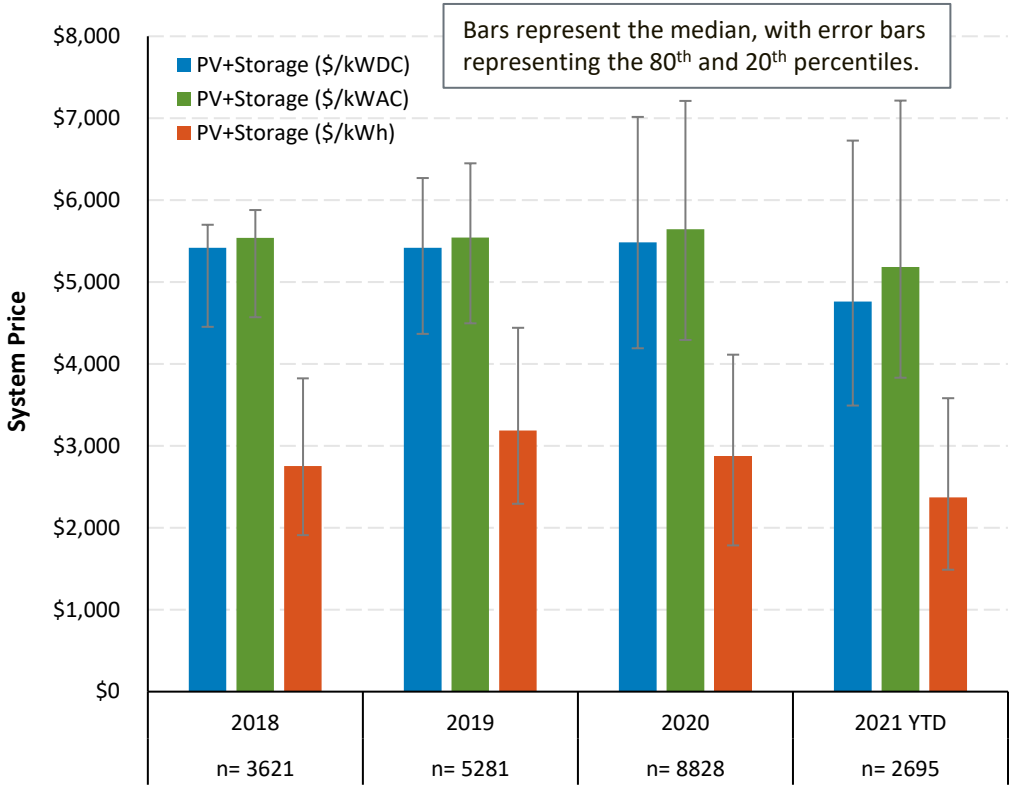
2021 YTD MW: AZ (48), CA (72), CT (2), MA (70), NY (183)

- **YTD**

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 this data set to show a trend over time.

Sources: AZ (06/24/21), CA NEM database (04/31/21); CT (05/14/21), MA SREC (05/05/21) and SMART (06/01/21) programs; NYSERDA (06/24/21).

Residential U.S. Storage Pricing



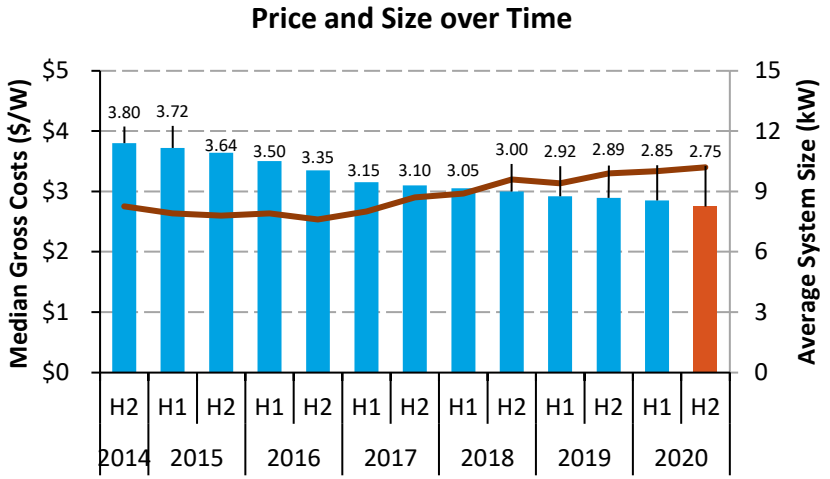
In 2021 YTD, residential PV+storage systems in Arizona, California, and Massachusetts had a median price of $2,400/kWh, or $5,200/$kW_{AC}$ ($4,800/$kW_{DC}$)—a reduction of 8%–16% compared to full 2020 median values.

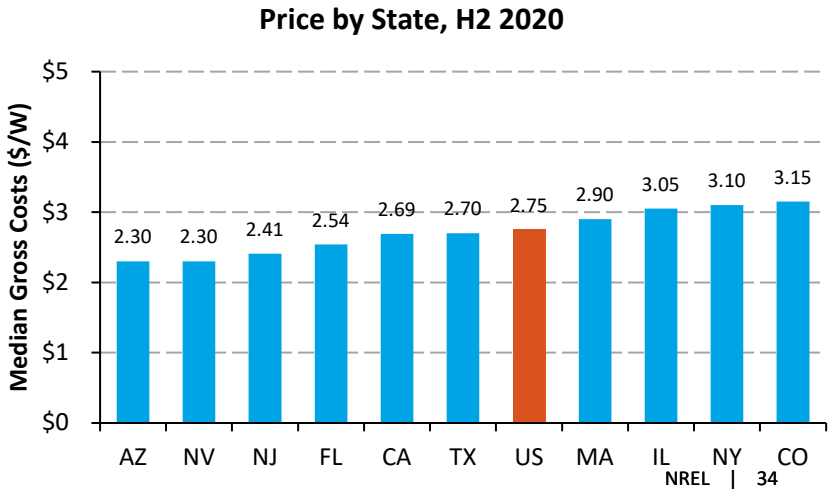
– Most of these systems offer 2–3 hours of storage.

Sources: Arizona Goes Solar (06/24/21); CA NEM database (04/31/21); Massachusetts SMART program (06/01/21)

Residential System Price Reported by EnergySage, H2 2020

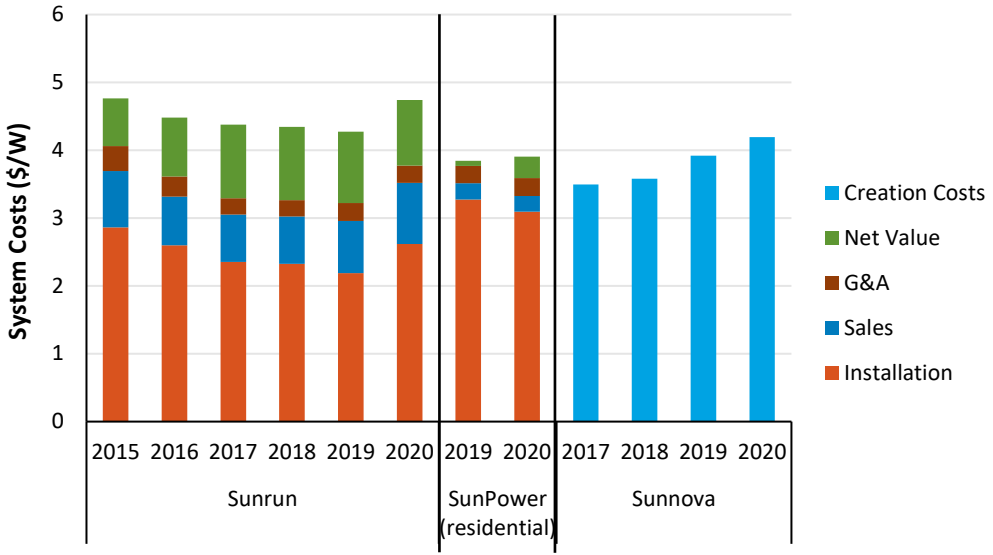
- The median reported price by EnergySage for residential PV systems decreased 4.8% between H2 2019 and H2 2020—the largest decrease since 2017.
  - Some of the decrease in price can be attributed to a 3.0% increase in system size, to 10.2 kW.
- Residential system price varied by state. In H2 2020, the median price of a residential system in Colorado was 37% higher than the median price of a residential system in the bordering state of Arizona.
  - Part of the price disparity between states is due to differences in average system size, though other factors, such as cost of living (e.g., California) also play a role.





Note: price based on winning quoted price.
Source: EnergySage, "Solar Market place Intel Report H1 2020 – H2 2020."

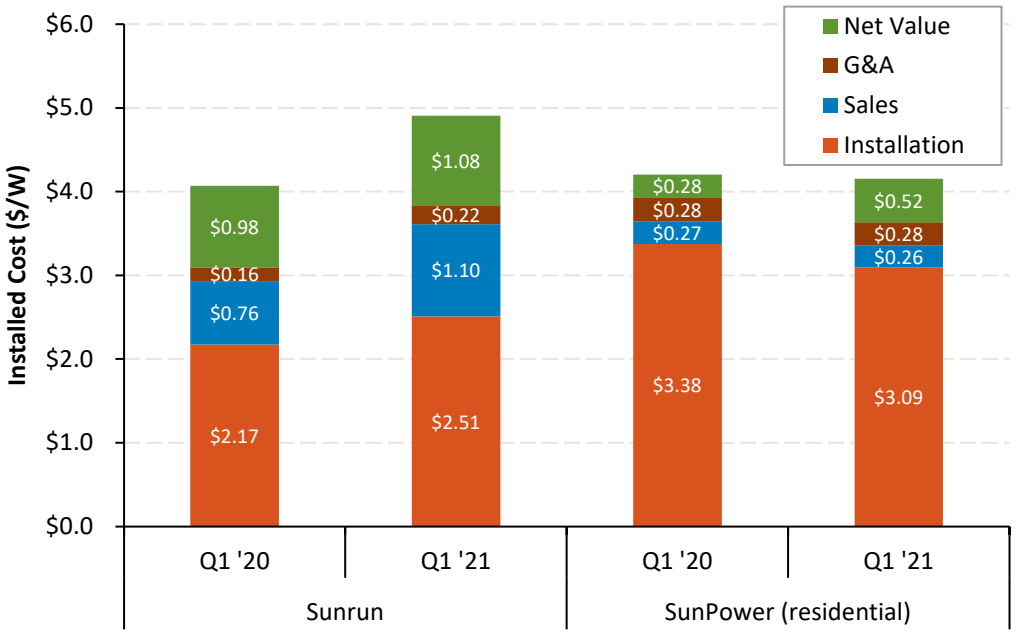
Sunnova, Sunrun, and SunPower Cost and Value, 2015–2021



- Total system costs increased in 2020 for many national residential installers, with reported cost increases in installation and SG&A.
  - The pandemic caused disruption in many parts of the solar supply chain, and traditional business practices. Many residential installers have historically relied on face-to-face sales, and they spent time and money transitioning to a more virtual approach.
    - This switch in sales is expected to result in cost savings going forward.

Sources: Corporate filings.

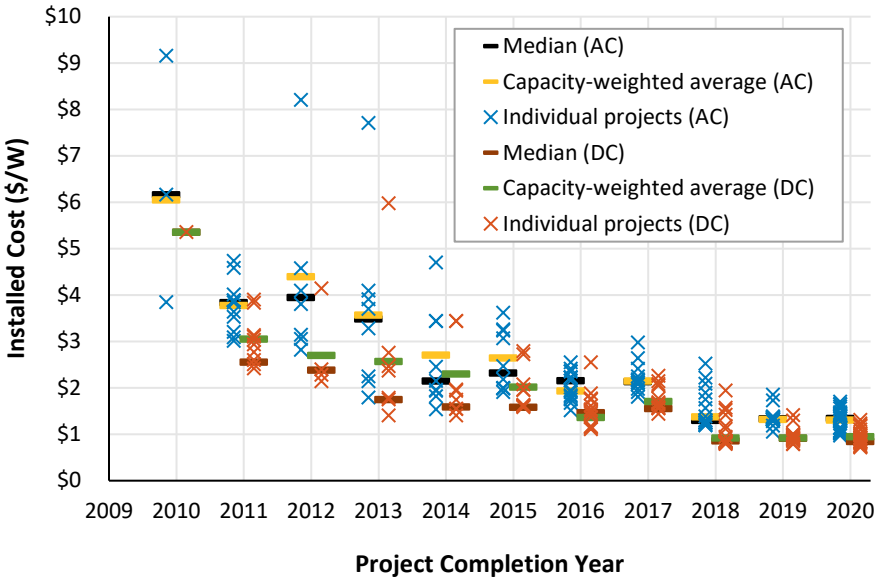
Sunrun and SunPower Cost and Value, Q1 2021



- Increased costs persisted in Q1 2021 for Sunrun, compared to Q1 2020. Sunrun's system costs were around $4/W and its total value creation was around $5/W.
- SunPower's residential installation costs decreased by about 8%, but it had relatively flat pricing due to increased net value.
  - Sunpower reports lower SG&A costs than Sunrun because it reports an aggregated SG&A for its residential and commercial sectors, while Sunrun focuses mostly on the residential sector.
    - Because of their smaller size, residential PV systems typically have higher SG&A-per-watt values.

Sources: Corporate filings.

Utility-Owned PV Pricing (>5 MW)

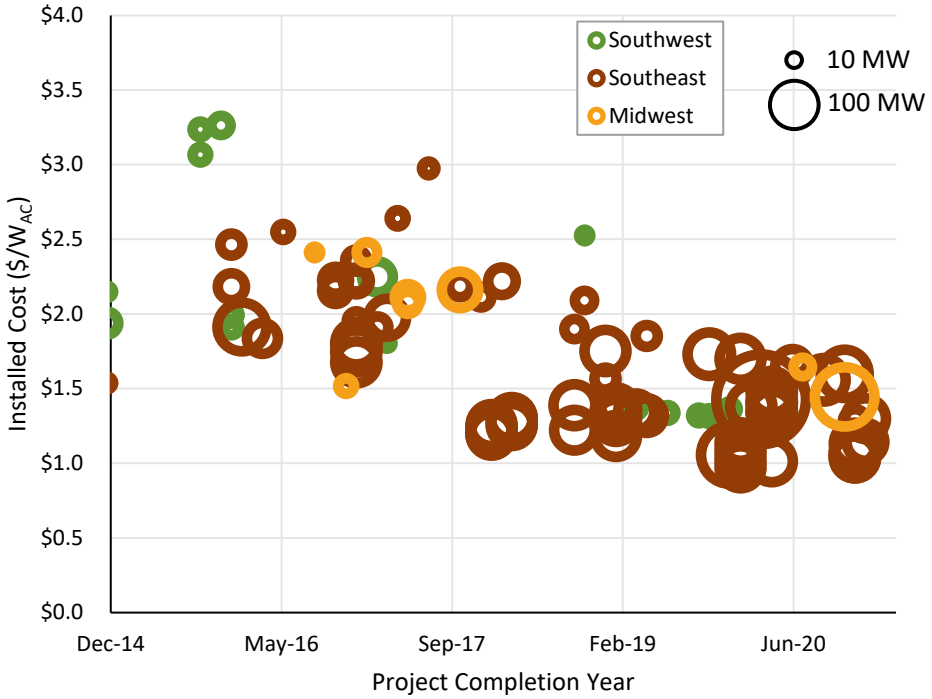


In a select data set of utility-scale PV systems owned by 25 regulated utilities (149 projects totaling 6.0 GW_{AC}), the median system price in 2020 was $\$1.34/W_{AC}$($\$0.85/W_{DC}$)—flat y/y in $Watts_{AC}$ but an 8% decrease in $Watts_{DC}$ that was due to increased ILR.

- The lowest and highest reported prices in 2020 were $\$0.97/W_{AC}$ and $\$1.70/W_{AC}$ ($\$0.72/W_{DC}$ and $\$1.31/W_{DC}$).
- From 2010 through 2020, system prices fell 14% per year on average per W_{AC} and 16% per year on average per W_{DC}.

Sources: FERC Form 1 filings from the from the following utilities: Alabama Power, Allete, Arizona Public Service, Avangrid, DTE, Duke Energy, El Paso Electric, Florida Power and Light, Georgia Power, Indiana Michigan Power, Kentucky Utilities, Nevada Power, Pacific Gas and Electric, Public Service of New Mexico, Southern California Edison, Tampa Electric, Tucson Electric, United Illuminating, UNS Electric, Virginia Electric.

Utility-Owned PV Pricing (>5 MW)

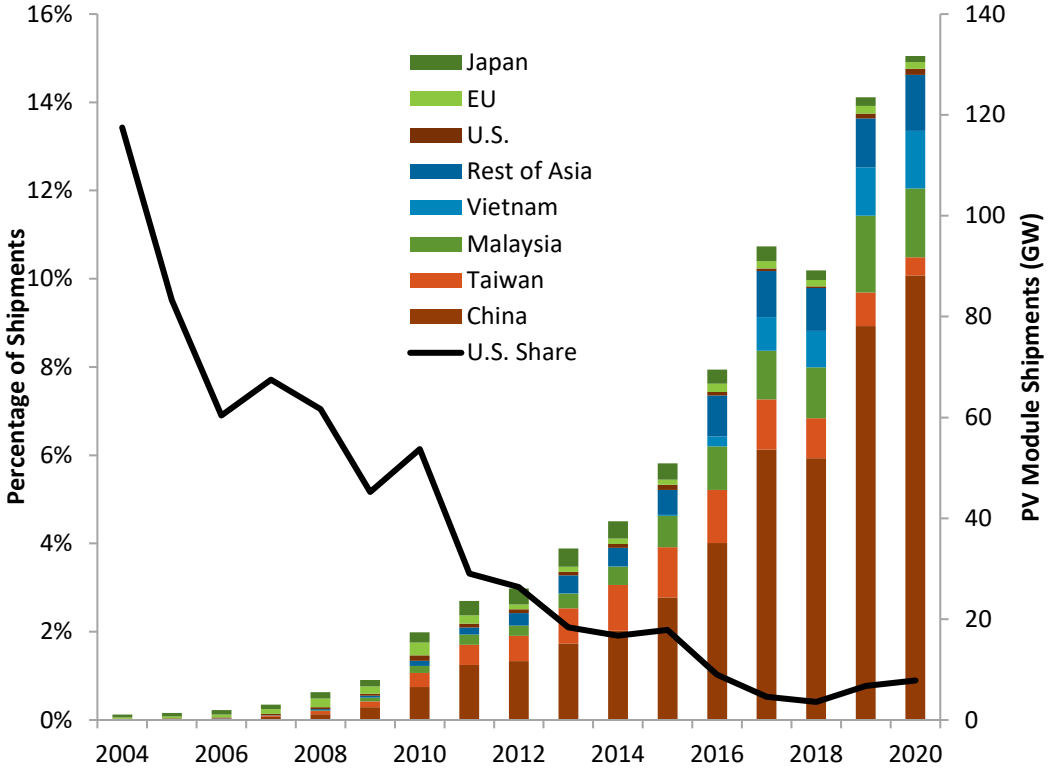


- In a select data set of utility-scale PV systems (149 projects totaling 6.0 GW_{AC}) owned by 25 regulated utilities, the average system size has trended upward as system pricing has trended downward over the past 5 years. And system size increases have trended upward while system pricing decreases have slowed.
  - The average system size in this data set was 14 MW_{AC} in 2015 and 83 MW_{AC} in 2020.
  - The average system size in 2020 (83 MW_{AC}) represented a 60% increase from 2019 alone.
- System prices in this data set may be lower than the national average, as they do not include data from higher-cost regions, such as California, the Northeast, or the Mid-Atlantic—areas with far less utility ownership of PV systems.
  - System prices in this data set were further lowered in 2020 because of numerous large solar plants (>70 MW_{AC}) coming online, mostly in the Southeast.

Sources: FERC Form 1 filings from the from the following utilities: Alabama Power, Allete, Arizona Public Service, Avangrid, DTE, Duke Energy, El Paso Electric, Florida Power and Light, Georgia Power, Indiana Michigan Power, Kentucky Utilities, Nevada Power, Pacific Gas and Electric, Public Service of New Mexico, Southern California Edison, Tampa Electric, Tucson Electric, United Illuminating, UNS Electric, Virginia Electric.

- **In 2020, global PV shipments were approximately 132 GW—an increase of 7% from 2019.**
- **In 2020, 88% of PV shipments were mono c-Si technology, compared to 35% in 2015 (when multi peaked at 58%).**
- **In 2020, the average module efficiency of modules installed in the United States was approximately 19.7% for mono c-Si, 17.5% for multi c-Si, and 17.7% for CdTe.**
- **Module and cell imports picked up significantly in March and April 2021; the first 4 months of the 2021 had a flat level of PV imports, y/y (9.8 GW).**

Global Annual PV Shipments by Region*

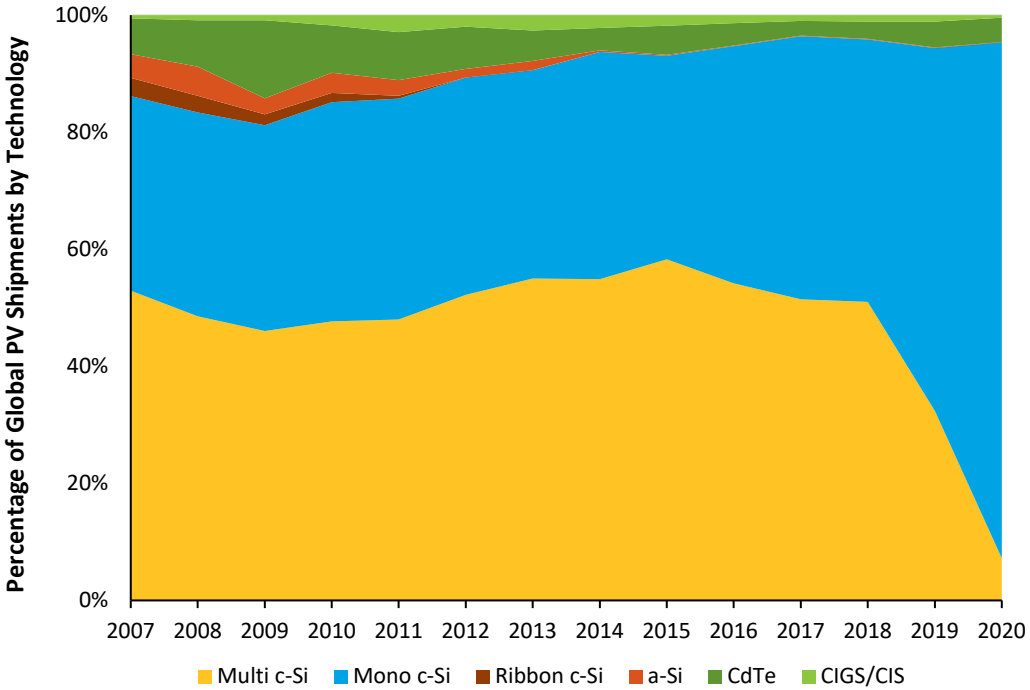


- In 2020, global PV shipments were approximately 132 GW—an increase of 7% from 2019.
- Since 2004:
  - The U.S.-manufactured percentage of global PV shipments declined from around 13% to less than 1%.
  - Chinese-manufactured share of global PV shipments grew from 1% to 67%.
  - Together the Malaysian-, Vietnamese-, and South Korean-manufactured percentage of global PV shipments went from 0% to 24% (with Vietnamese growth coming on rapidly during the last 5 years).

***Note:** Excludes inventory sales and outsourcing.

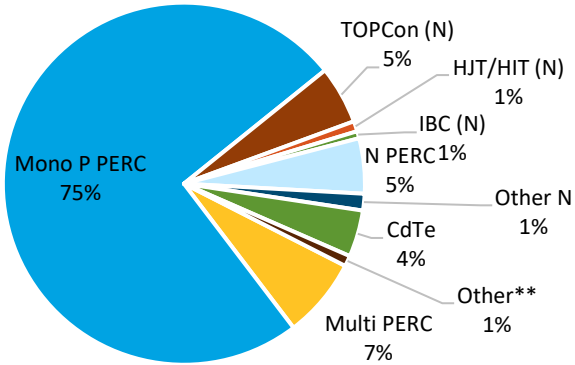
Source: 2004-2020: Paula Mints. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2020/2021." SPV Market Research. Report SPV-Supply9. April 2021.

Global Annual PV Shipments by Technology*



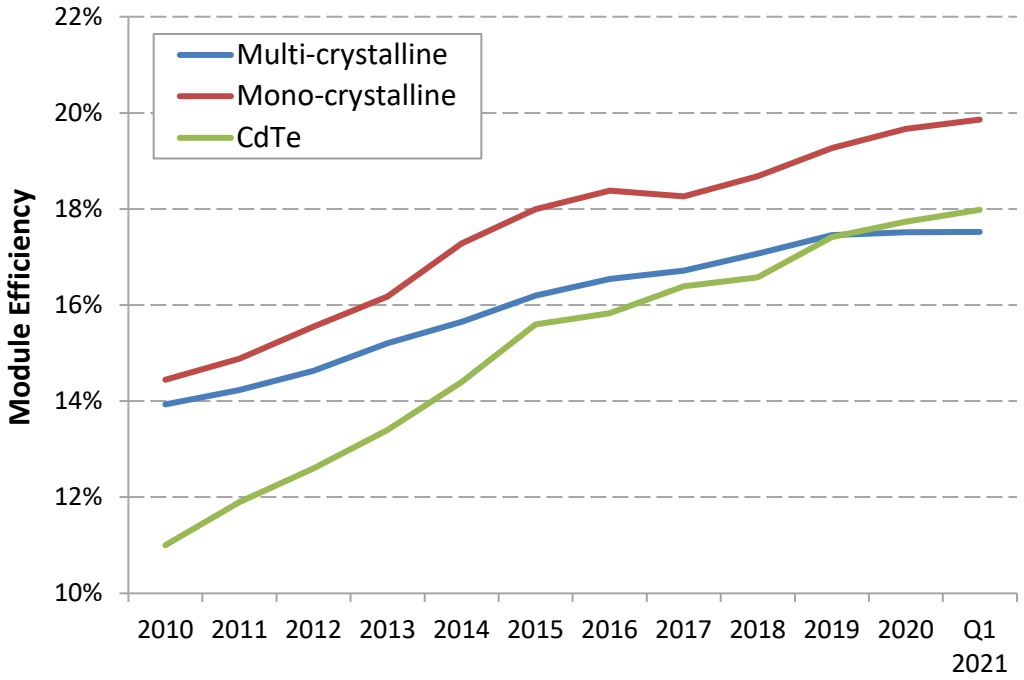
- In 2020, 88% of PV shipments were mono c-Si technology, compared to 35% in 2015 (when multi peaked at 58%).
- Mono P PERC was the dominant cell type in 2020, though n-type shipments grew 181%, y/y, to 13% of the market.

2020 Market Share by Cell Type



***Notes:** Excludes inventory sales and outsourcing.
** Includes "Standard Multi c-Si", "Standard Mono c-Si", "a-Si", and "CIS/CIGS."
Source: 2004-2020: Paula Mints. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2020/2021." SPV Market Research. Report SPV-Supply9. April 2021.

PV Efficiency Improvements



- From 2010 to 2020, the efficiency of modules installed in the United States increased significantly:
  - 14.4% to 19.7% for mono c-Si
  - 13.9% to 17.5% for multi c-Si
  - 11.0% to 17.7% for CdTe.
- Based on preliminary data for Q1 2020, the average efficiency of mono c-Si (19.9%) and CdTe (~18%) panels installed in the United States have continued to increase, while multi c-Si continues to lag.

Sources: CdTe: First Solar Investor Relations, average module efficiency produced. c-Si (60/72/144 cell) California Interconnection Dataset (03/31/21).

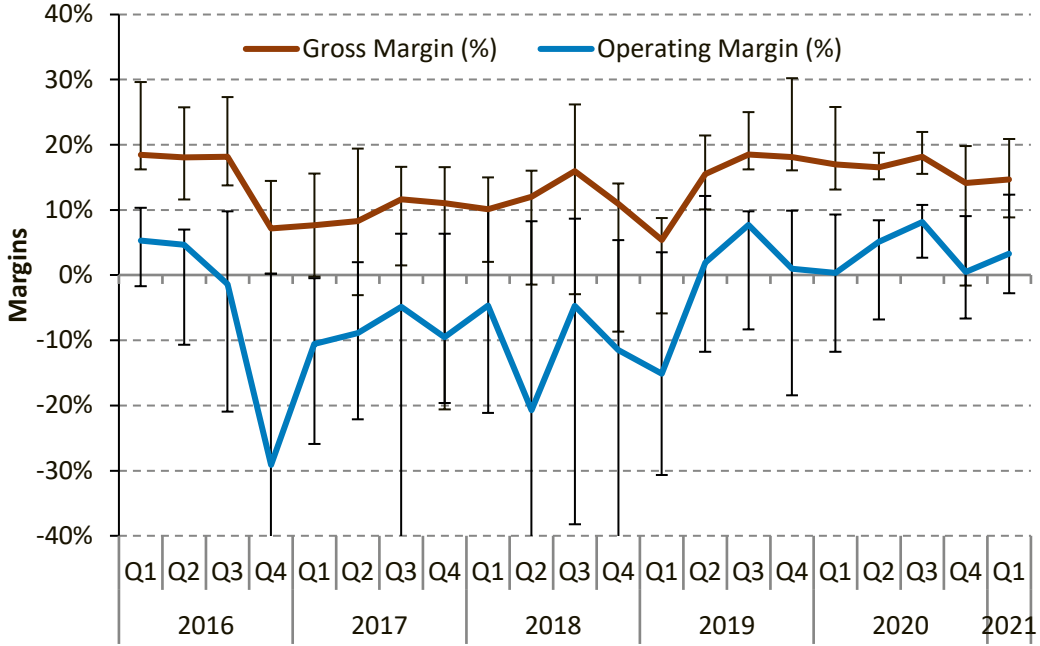
Global Leading PV Manufacturers, by Shipments

Ranking	2015	MWp	2019	MWp	2020	MWp
1	Trina	3,631	Tongwei	12,752	LONGI	14,683
2	JA Solar	3,617	LONGi	10,957	Tongwei	12,100
3	Hanwha Q-Cells	3,400	Jinko Solar	9,708	JA Solar	10,751
4	Canadian Solar	2,691	Canadian Solar	8,600	Aiko Solar	10,521
5	First Solar	2,518	Aiko Solar	7,610	Trina Solar	9,001
6	Jinko Solar	2,400	JA Solar	7,560	Jinko Solar	8,655
7	Yingli	2,388	Trina Solar	6,006	Canadian Solar	8,337
8	Motech	2,100	First Solar	5,400	Zhongli	7,435
9	NeoSolar	2,100	Hanwha Q- Cells	5,185	Suntech	6,313
10	Shungfeng- Suntech	1,970	UREC	4,219	First Solar	5,500
Total Above		**26,815**		**77,997**		**93,294**
Total Ship. MWp		**50,877**		**123,485**		**131,709**

- From 2015 to 2020, shipments from the top 10 PV manufacturers grew from 27 GW to 93 GW, with some companies shipping more than 10 GW annually.
- New companies quickly moved to top spots, in part through the rapid growth of mono c-Si production.
- The list of leading companies remained relatively stable between 2019 and 2020, as the top ten manufacturers grew their market share from 63% to 71%.

***Note:** Excludes inventory sales and outsourcing.
Source: 2004-2020: Paula Mints. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2020/2021." SPV Market Research. Report SPV-Supply9. April 2021.

PV Manufacturers' Margins



- The median gross margin of the publicly traded PV companies represented to the left increased in Q1 2021, remaining above historical averages.
- There continues to be significant variation by individual companies as individual factors come into play.

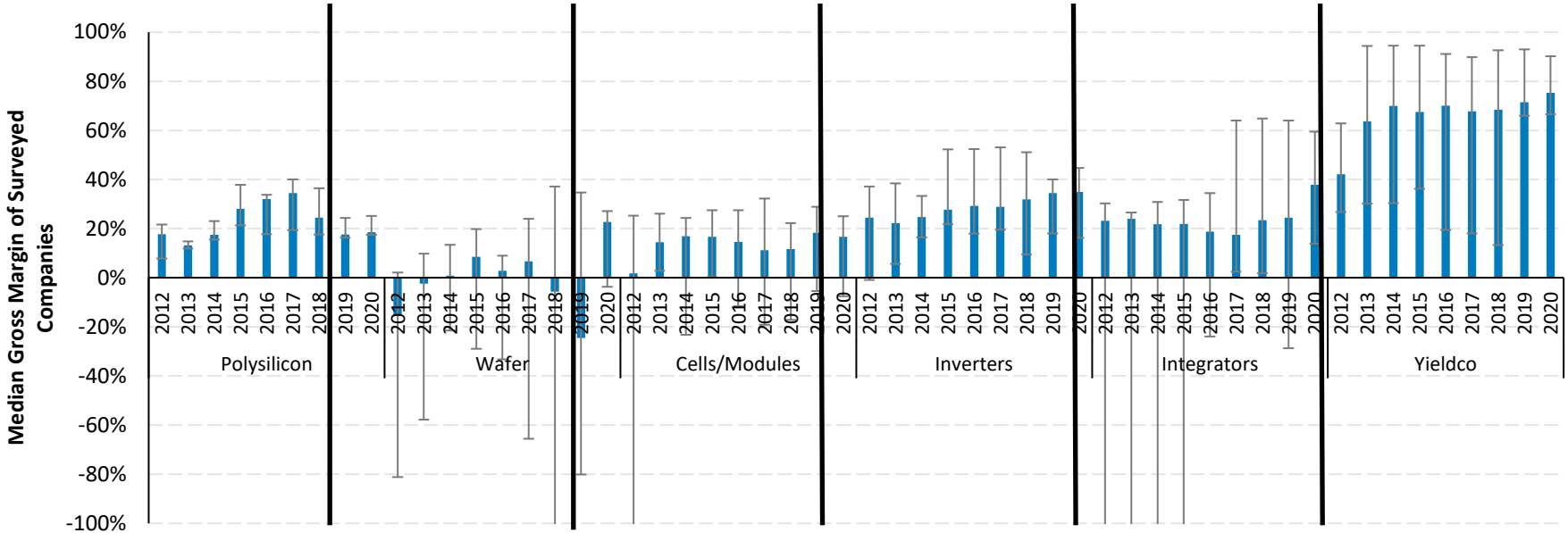
Lines represent the median, with error bars representing 80th and 20th percentiles for the following companies in Q1 2021: Canadian Solar, First Solar, Jinko Solar, LONGi, Maxeon, Motech Industries, Renesola, Risen, Shanghai Aerospace, Tongwei, Trina Solar, and United Renewable Energy. Margin data from Hanwha Q Cells, JA Solar, Sunpower, and Yingli are also included from Q1 2010 to Q4 2020 where available.

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

Gross Margin Across Supply Chain

- Of the sectors with improved gross margins in 2020, yieldcos, integrators, and inverters continued growth trends from previous years, while polysilicon and wafers reversed downward trends.

- All sectors saw increases in gross margin in 2020 compared to 2019 except cells/modules, which had a slight drop.
- Of the sectors that improved in 2020, wafers and integrators saw the most significant growth in gross margin.

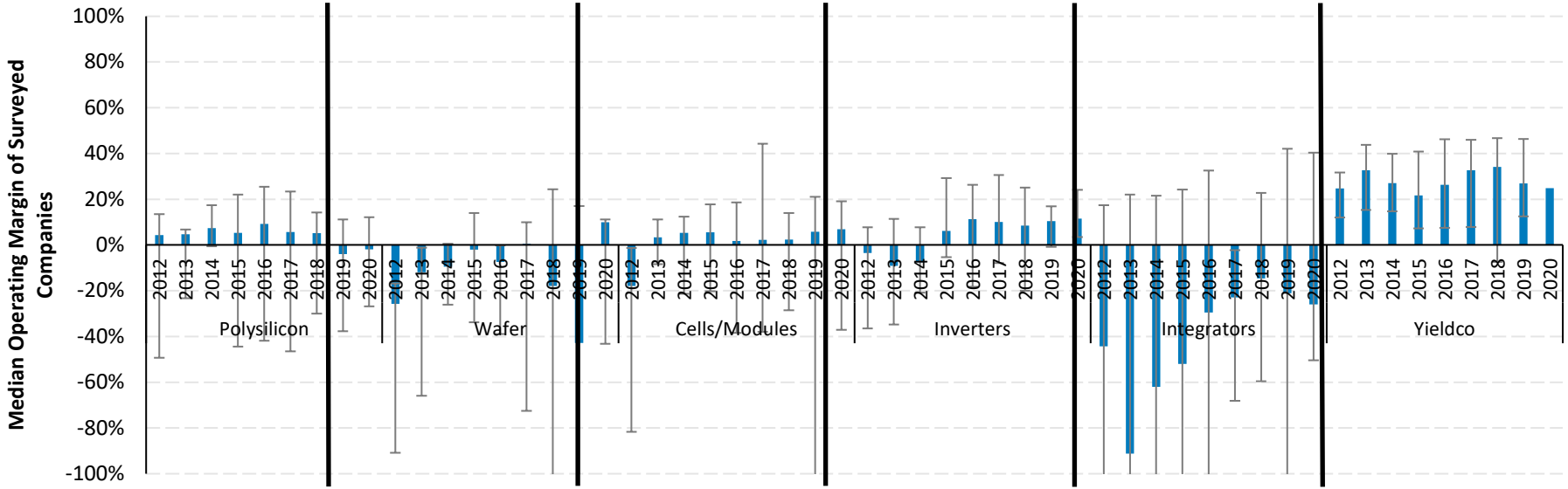


Sources: Company figures from public filings and finance.yahoo.com. Error bars represent high and low values of surveyed companies. Companies surveyed are Polysilicon – GCL Poly, REC Silicon, Wacker Chemie, Ferroglobe; Wafers - ReneSola, Wafer Works Corp, Danen Technology Group, Green Energy Technology Inc; Cells/Modules, Gintech, United Renewable Energy Corp, Motech, First Solar, JA Solar, Yingli, Trina Solar, Canadian Solar, PV Crystalox Solar, Hanwha Solar One, Jinko Solar, SunPower, LONGi, Tongwei; Inverters – SolarEdge; Enphase; SMA Solar; Advanced Energy Industries; Integrators - Real Goods Solar, SolarCity, Vivint Solar, Sunrun, Sunworks, Enlight Renewable Energy, Sunnova; IPP/Yieldco - Brookfield Renewable Partners; Algonquin Power & Utilities Corp; Clearwater Energy, Northland Power, Pattern Energy, Terraform Power, TransAlta Renewables.

Operating Margin Across Supply Chain

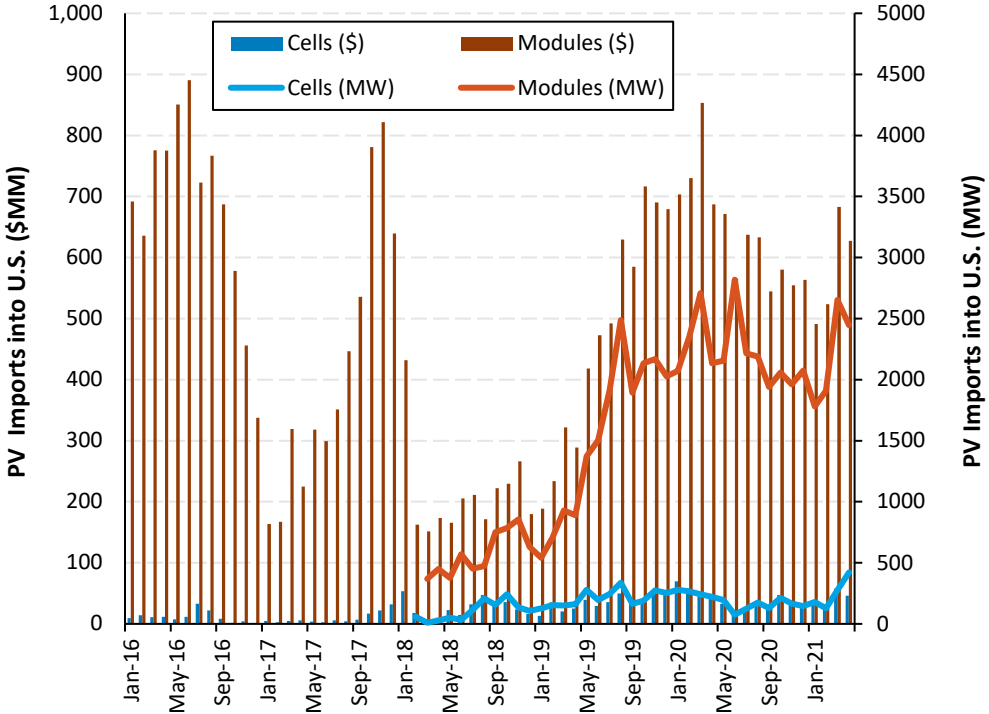
- Integrators and polysilicon firms lost money on average in 2020, but the former increased their losses while the latter narrowed theirs.

- Inverters and cells/modules saw consistent increases in profitability from 2018 to 2020.
- Yieldcos have historically had positive operating margins (which continued in 2020), but their margins have decreased for 2 years straight.
- Wafers achieved operating profitability in 2020 on average for the first time in at least 8 years.



Sources: Company figures from public filings and finance.yahoo.com. Error bars represent high and low values of surveyed companies. Companies surveyed are: Polysilicon – GCL Poly, REC Silicon, Wacker Chemie, Ferroglobe; Wafers - ReneSola, Wafer Works Corp, Danen Technology Group, Green Energy Technology Inc; Cells/Modules, Gintech, United Renewable Energy Corp, Motech, First Solar, JA Solar, Yingli, Trina Solar, Canadian Solar, PV Crystalox Solar, Hanwha Solar One, Jinko Solar, SunPower, LONGi, Tongwei; Inverters – SolarEdge; Enphase; SMA Solar; Advanced Energy Industries; Integrators - Real Goods Solar, SolarCity, Vivint Solar, Sunrun, Sunworks, Enlight Renewable Energy, Sunnova; IPP/Yieldco - Brookfield Renewable Partners; Algonquin Power & Utilities Corp; Clearwater Energy, Northland Power, Pattern Energy, Terraform Power, TransAlta Renewables.

Module and Cell Import Data

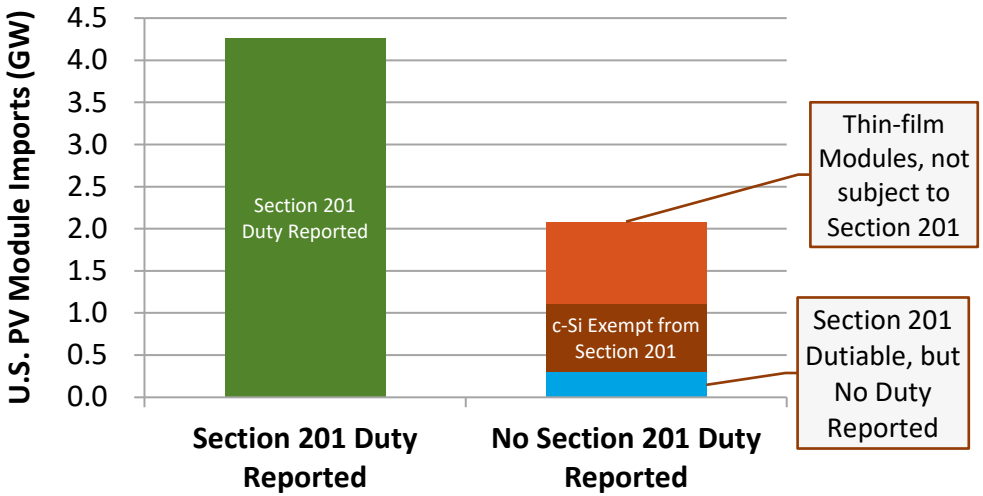


- 6.3 GW of PV modules were imported into the United States in Q1 2021, down 11% y/y.
- 0.5 GW_{DC} of cells were also imported in Q1 2021, down 26%.
  - Module and cell imports picked up significantly in March and April 2021; the first 4 months of the 2021 have a flat level of PV imports, y/y (9.8 GW).
- In addition to imports, First Solar produced approximately 500 MW_{DC} of CdTe PV modules.

Note: We adjusted Thailand's reported imports in megawatts for February because of a likely reporting error.

Sources: First Solar public filings; Imports, by Value and MW: U.S. International Trade Commission, 2021.

Q1 2021 U.S. Module Imports by Tariff

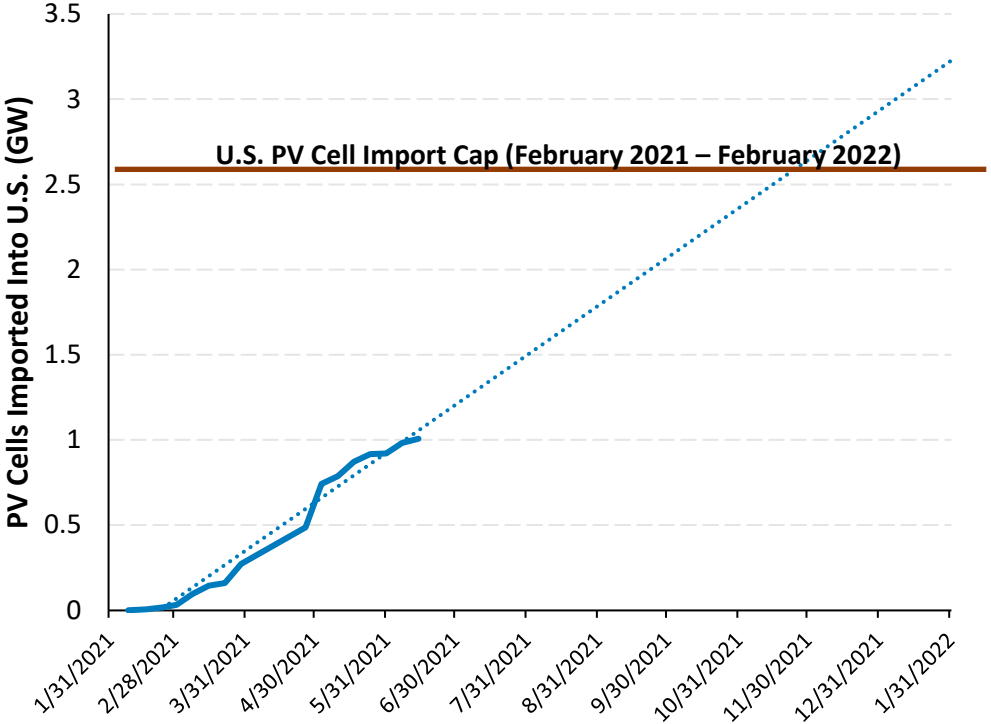


- In Q1 2021, 2.1 GW_{DC} of imported PV modules (33% of all PV module imports) did not report a tariff.
  - In 2020, 55% of imports (most of which were c-Si) did not report a tariff. The difference is likely due to the removal of the bifacial tariff exemption in late 2020.
- For approximately 0.3 GW of imported c-Si modules—subject to Section 201—no duties were reported. Why this happened is unclear.

Note: Module data uses codes 8541406015, 8541406020, and 8541406035. 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, and technologies not applicable reported under HTS code 854140603. We assume all panels subject to Section 201 duties have been reported under "Dutiable- HS chapter 99." We adjusted Thailand's reported imports in megawatts for February because of a likely reporting error.

Source: Imports, by MW: U.S. International Trade Commission, 2021.

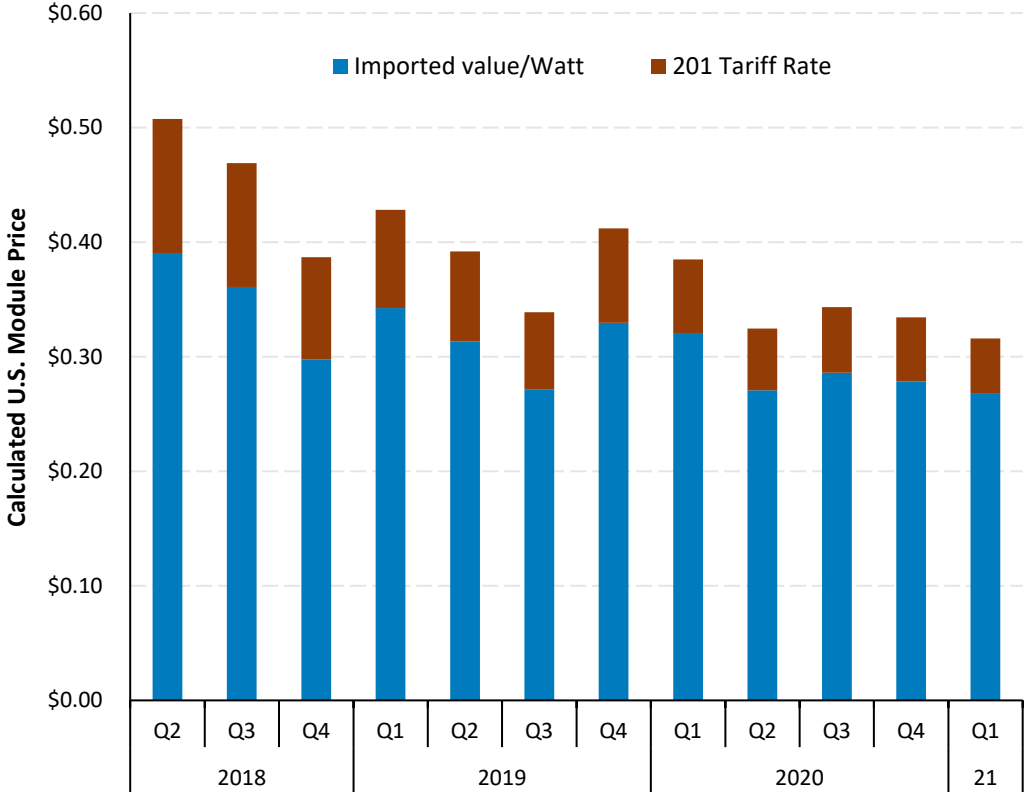
Cell Import Data by Tariff



- A 2.5-GW_{DC} quota exempts the first 2.5 GW of imported c-Si PV cells each reporting year subject to the Section 201 tariff.
  - In the first 3 years of the tariffs, the United States did not reach the cap.
- Based on PV cell imports since February 2021, the United States is projected to exceed the cap in October; however, this higher level is because of the week of April 26–May 3, when more than 250 MW of cells were imported. Excluding that week, the United States would still be projected to fall short of the cap.

Note: Cell data uses HTS codes 8541406025.
Sources: Imports, by MW: U.S. International Trade Commission, 2021; U.S. Customs and Protection Commodity Status Reports.

Calculated U.S. Module Pricing

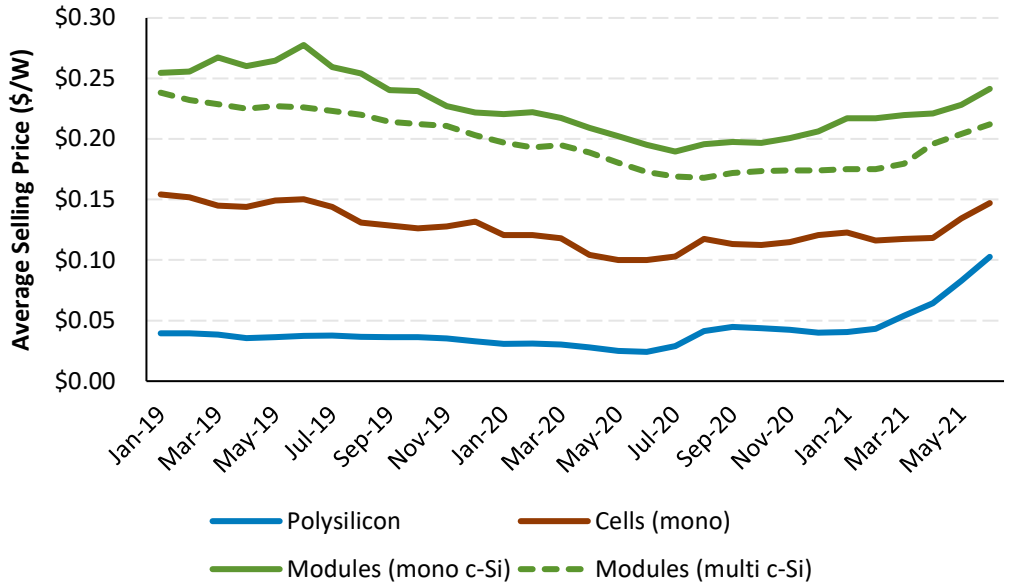


- Based on the reported value and capacity of imported PV modules, the average price of a PV module in the United States before tariffs dropped from $0.39/W in Q2 2018 to $0.27/W in Q1 2021.
- Additionally, as a result of the underlying price reduction and step down of the Section 201 tariff, these duties have been cut by 60%, on a per-watt basis (from approximately $0.12/W to $0.05/W).

Sources: Imports, by Value and MW: U.S. International Trade Commission, 2020.

- **Mono c-Si PV module prices rose 17% in the first half of 2021, to $0.24/W—a price not seen since 2019.**
  - A large reason for this is because polysilicon, the key feedstock to most PV modules, was up 169% in H1 2021 and 352% y/y, to $28.5/kg at the end of June; prices were as low as $6.3/kg in May and June of 2020.
- **In Q1 2021, U.S. mono c-Si module prices were flat—similar to global trends—but they were still trading at a 55% premium over global ASP.**

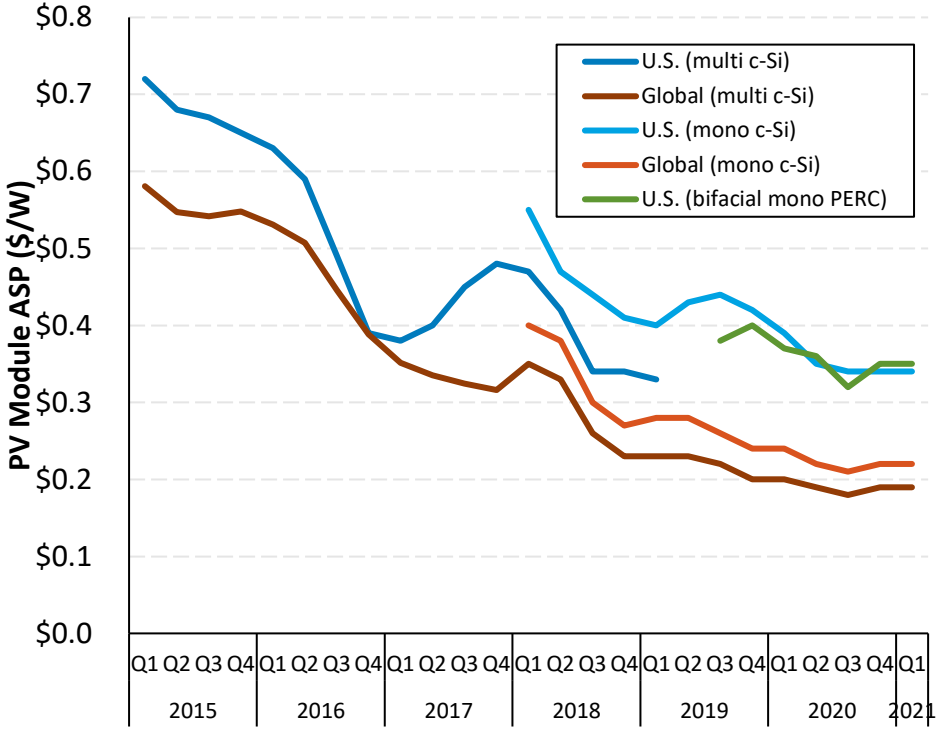
PV Value Chain Spot Pricing



- Mono c-Si PV module prices rose 17% in the first half of 2021, to $0.24/W—a price not seen since 2019.
  - Multi c-Si PV modules rose 22% to $0.21/W—a price also not seen since 2019.
- Polysilicon was up 169% in H1 2021 and 352% y/y to $28.5/kg at the end of June; prices were as low as $6.3/kg in May and June of 2020.
  - In June 2020, polysilicon represented approximately 10%–15% of mono c-Si module ASP. In June 2021, it represented 40%–50% of mono c-Si module ASP.

Source: BloombergNEF Solar Spot Price Index (06/21/21).
Kilogram to Watt Conversion: 4.78 grams per watt (2016); 4.73 grams per watt (2017), from Cowen & Co. (05/11/17) add Deutsche Bank (07/19/17); 4.35 (2019); 4.10 (2019); 3.85 (2020); 3.60 (2021) from Bernreuter.

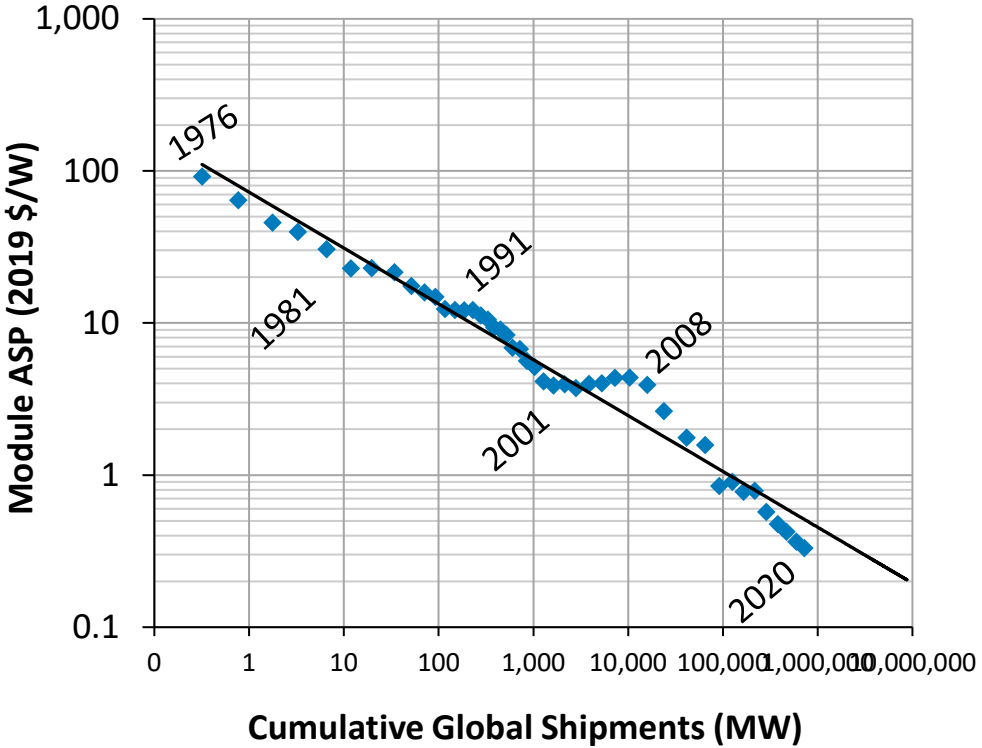
Module Average Selling Price: Global versus United States



- In Q1 2021, U.S. mono c-Si module prices were flat—similar to global trends—but they were still trading at a 55% premium over global ASP.
  - Before Q4 2020, bifacial modules were trading a few cents below mono c-Si in the United States because of an exemption to the Section 201 tariffs; however, that exemption was removed in Q4 2020.

Source: Wood Mackenzie Power & Renewables/SEIA.

PV Experience Curve



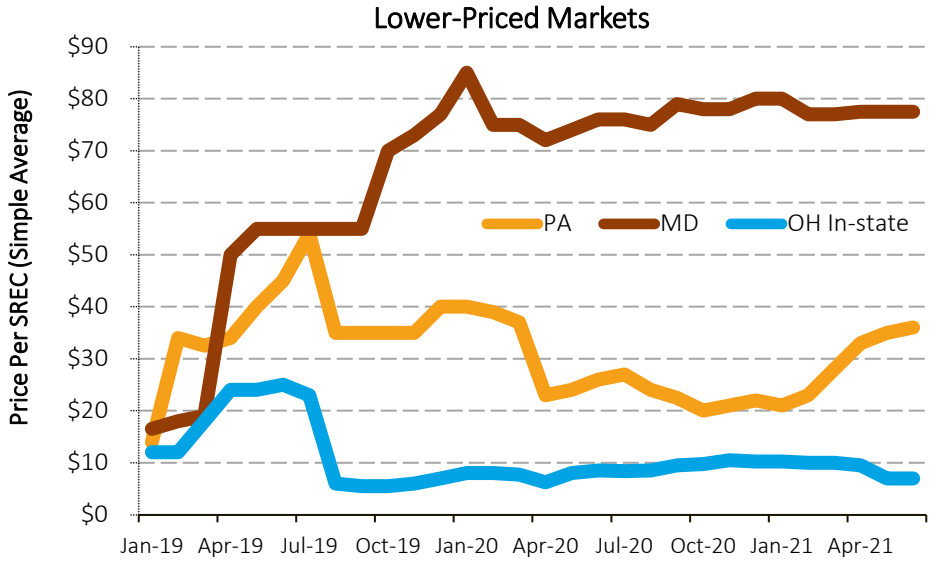
- This experience curve displays the relationship, in logarithmic form, between the average selling price of a PV module and the cumulative global shipments of PV modules.
- For every doubling of cumulative PV shipments from 1976 to 2020, there has been on average a ~22% reduction in PV module price.
- Since 2008, the PV industry has experienced accelerated improvements, putting module ASPs below the historical experience curve since 2012.
  - In 2020, actual module pricing was $0.33/W, which was well below what the historical experience curve would have suggested ($0.51/W).

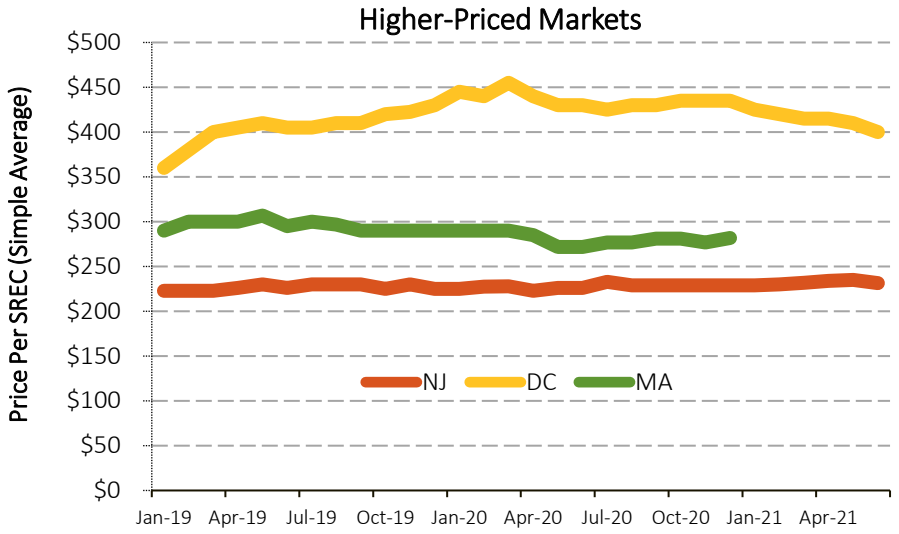
Source: SPV Market Research. Report SPV-Supply9. April 2021.

- **In H1 2021, the S&P 500 was up 14%, while solar stocks were down 13%.**
- **H1 2021 stock performances varied by company in part due to increases in material costs.**

SREC Pricing

- Pennsylvania SRECs have increased 64% in 2021, with the introduction of legislation to significantly increase its RPS solar carve-out.
  - All other SREC markets were relatively flat or went down.
- On June 1, Maryland's updated RPS was passed into law. It gives the state more time to get to its 14.5% solar carve-out by 2030 (starting in 2022) and increases the compliance payment penalties (starting in 2023).

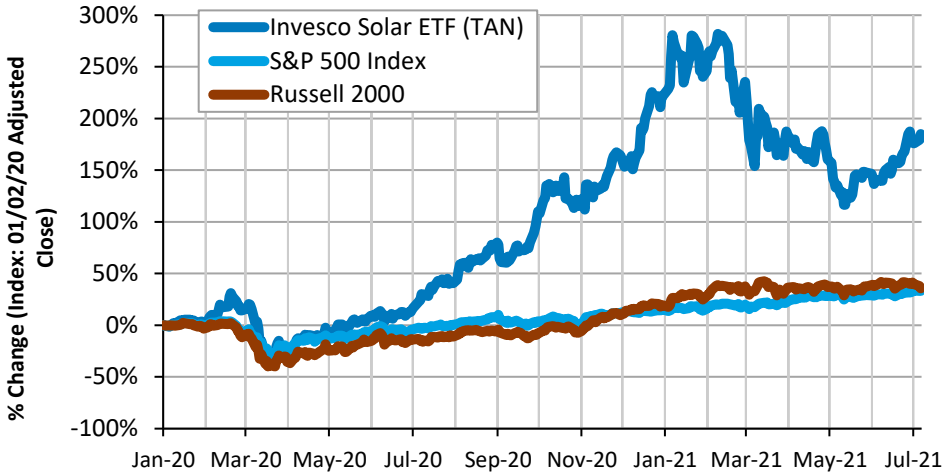




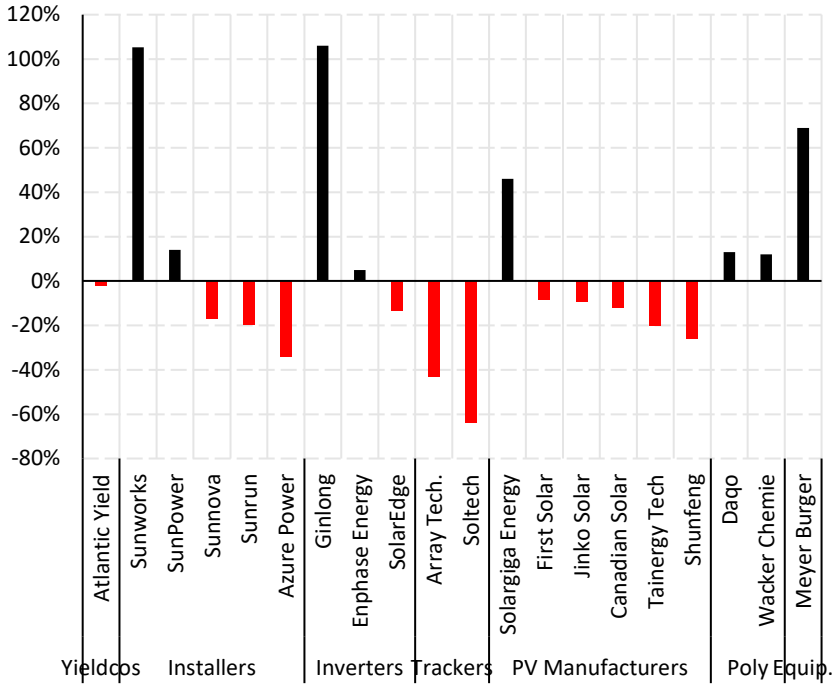
Source: SRECTrade, https://www.srectrade.com/, accessed 06/29/21. SRECTrade (06/04/21)

Stock Market Activity

- In H1 2021, the S&P 500 was up 14%, while solar stocks were down 13%.
  - The downturn in solar stocks is likely due to a broader correction in clean energy ETFs after the huge gains that followed last year's U.S. presidential election.
- H1 2021 stock performances varied by company.
  - Installers and PV tracker manufacturers have lost market value in part due to increases in material costs.
  - Polysilicon manufacturers have performed well due to increased polysilicon pricing.



Individual Stock Performance (H1 2021)



Note: The TAN index is weighted toward particular countries and sectors. As of 08/31/20, 52% of its funds were in U.S. companies. Its top ten holdings, representing 63% of its value, were Sunrun, SolarEdge, Enphase, First Solar, Xinyi, Vivint Solar, Daqo, SunPower, Solaria Energia, and Encavis.

Source: Stock market: Yahoo Finance (07/07/21).

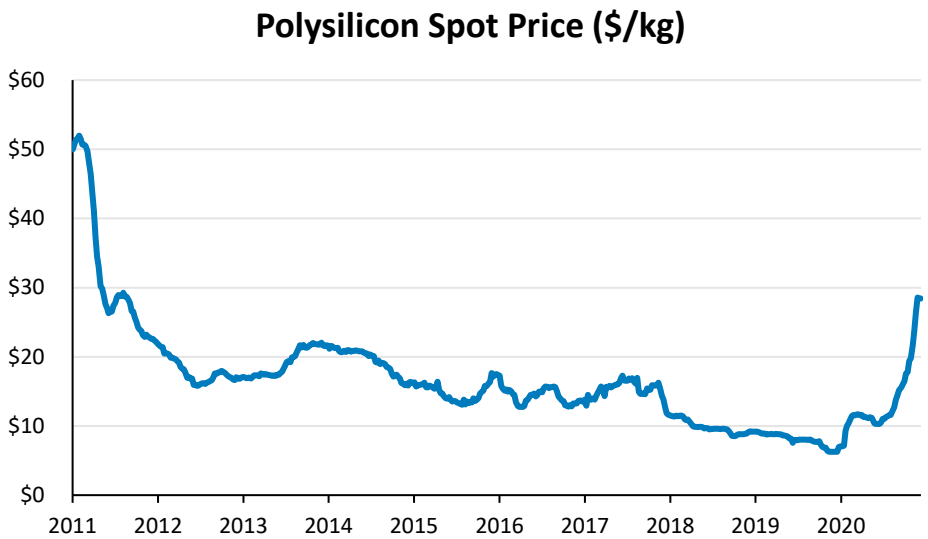
- **PV systems are facing significant upward pressure for the first time in over a decade because of increases in polysilicon price and supply-chain disruptions caused in large part by the COVID-19 pandemic.**

PV Price Increases

- PV systems are facing significant upward pressure for the first time in over a decade.
  - Global PV module price increased 17% in the first 6 months of 2021, after falling by approximately 90% over the previous 10 years.
    - The 352% increase in polysilicon price, the key raw material for produce PV modules, has been attributed as the major culprit of increased PV module price.
    - In late 2020 and early 2021, there was also a significant shortage of EVA and glass.
  - PV system price increases are being felt as a result of the increased prices of steel, aluminum, and copper—all materials that are used to rack and wire PV modules.
  - Additionally, some inverters (in particular microinverters) are expecting delays because of the broader semiconductor shortage.
  - Finally, freight charges have increased significantly, which is particularly impactful to solar PV installations in a country like the United States that imports a significant amount of PV equipment.
- Developers, analysts, and manufacturers have said the higher prices are affecting demand and might delay projects out to 2022.

Sources: Seattle Times (05/24/21); Norton Rose Fulrbight (06/15/21).

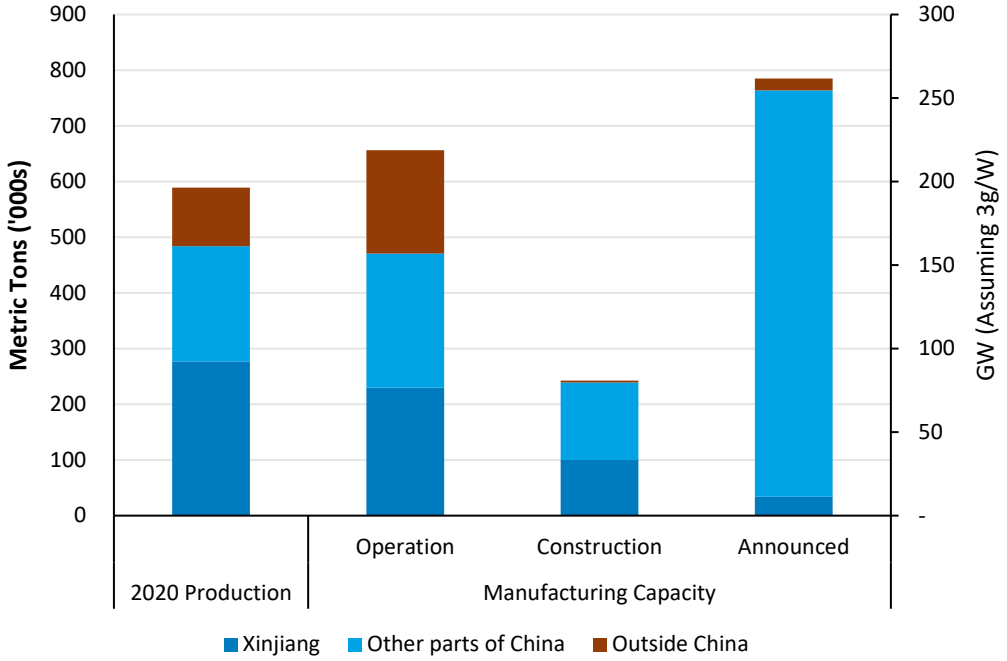
Solar Module Price Increase: Polysilicon



- Polysilicon prices increased threefold from $6.27/kg in June 2020 to $28.46/kg in June 2021.
  - The price increase has been attributed to a supply/demand imbalance caused by significant capacity expansion in wafer and cell manufacturing. Now that polysilicon is the limiting factor, downstream entities (wafer and cell producers) have been stockpiling polysilicon supplies in anticipation of growing demand, especially a ramp-up in utility-scale deployment in China.
- Although, new polysilicon capacity came online in early 2021, expected surging demand later this year means shortages are expected to persist in the short term until polysilicon capacity expansions come online in 2022–2023.
  - Potential trade barriers might also impact polysilicon price and availability through trade barriers for the use of polysilicon produced from China's Xinjiang region, which currently hosts 35% of global polysilicon manufacturing capacity.

Sources: Bloomberg 5/23/21, PV Tech 4/24/21, PV Magazine 5/18/21, BloombergNEF Solar Spot Price Index (06/21/21).

Global PV Dependence of Xinjiang



- The U.S. and some other countries are currently examining ways of limiting solar-related products manufactured in Xinjiang from entering their supply chains, due to concerns over forced labor in the region.
- While 35% of global polysilicon manufacturing capacity is currently located in Xinjiang, 47% of polysilicon produced in 2020 was produced in that region.
  - Factories in Xinjiang operated above capacity in 2020, while factories in other regions suspended some or all operations last year because of flooding, explosions, or uneconomic market conditions.
- Global polysilicon manufacturing capacity is expected to more than double in the next few years, and a significant amount of capacity is under construction or has been announced.
  - 41% of polysilicon plants under construction are in Xinjiang, but only 4% of capacity announcements are there.
  - Most of the announced capacity is represented by three Chinese plants outside of Xinjiang:

Company	Chinese Province	Scheduled Online Year	Capacity ('000 MT)	Potential Additional Capacity
East Hope	Ningxia	2023	250	150
Xinte	Inner Mongolia	2022	100	100
GCL-Poly	Inner Mongolia	N/A	300	N/A

Sources: BNEF, "2Q 2021 Global PV Market Outlook;" "1Q 2021 Global PV Market Outlook." PVTech (03/01/21). Bernreuter Research (02/08/21, 05/21/21).

Semiconductor Chip Shortage Overview

A severe semiconductor chip shortage has affected many industries since mid-to-late 2020, with the automotive, IT, and appliance industries being hit hardest. The primary cause is two-fold:

- In the short-term, a faster than expected economic recovery led many manufacturers to quickly scale up chip orders after scaling down at the beginning of the pandemic. This left chip suppliers unprepared to meet surging demand, which led to delays and long wait times. Certain industries (e.g., microinverters) were more affected because chip manufacturers prioritized higher margin products (e.g., videogame consoles).
  - Enphase reported in Q1 that despite an anticipated demand boom, the firm will likely be constrained by chip supply for at least the rest of the year.
  - SolarEdge, on the other hand, reportedly stockpiled enough supply to meet demand for the year.
- Chip suppliers across the world have indicated an intent to expand capacity, but this could take a year or more, further contributing to the shortage.

Sources: Aljazeera (04/29/21); CNBC 5/4/21, PV Tech 4/28/21, PV Magazine 2/9/21, Greentech Media 8/26/20

Solar Module Price Increase: Shipping and Other Materials

- *Freight/shipping* costs have increased 3-4X in the past three quarters for shipments from China to the West (most prominently for solar modules).
  - Sudden demand spikes across many industries for goods shipped from China to the West triggered the cost increases. It was reported that only 4 of every 10 containers sent to North America from China were sent back, with 6 remaining at the arrival port. Some containers have been sent back empty because of the increased demand.
- Prices for many *steel* commodities are also up, with some inputs doubling in price since early 2021.
  - Some firms in the solar industry, such as those that make trackers, rely heavily on steel. For example, Array Technologies reported that almost half the cost of the PV trackers it produces is cost related to steel.
  - For both steel and shipping, where impacts are widespread across sectors, costs are expected to normalize once the economic recovery from the pandemic reaches later stages and supply can catch up to demand across more sectors.
- A *glass* shortage in China, where prices doubled at the end of 2020, continued to plague Chinese solar supply chains in Q1 2021.
  - The shortage was driven by a combination of a growing preference for bifacial modules, which require more glass, larger format panels, and China's environmental regulations, which had restricted increases in glass production capacity.
  - Analysts expect shortages to persist throughout the first half of 2021, but new capacity is expected to come online later in the year.

Sources: Bloomberg 5/23/21; Hellenic Shipping News (06/04/21); NYTimes (03/06/21); PV Magazine 1/29/21 5/18/21 6/3/21; Reuters 12/3/20.

Thank You

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Special thanks to Nate Blair, Adam Warren, Mike Meshek, and Madeline Schroeder.

List of Acronyms and Abbreviations

ASP	average selling price
BNEF	Bloomberg New Energy Finance
CAPEX	capital expenditures
C&I	commercial and industrial
C-Si	crystalline silicon
CC	combined cycle
CdTe	cadmium telluride
CSP	concentrating solar power
DC	direct current
DPV	distributed PV
EIA	U.S. Energy Information Administration
ETF	exchange traded fund
EVA	ethyleen vinyl acetate
FIT	feed-in-tariff
G&A	general and administrative expenses
GW	gigawatt
GWh	gigawatt-hour
H1	first half of year
H2	second half of year
HECO	Hawaii Electric Company
HIT/HJT	heterojunction
IBC	interdigitated back contact
IEA	International Energy Agency
IPP	independent power producer
IRENA	International Renewable Energy Agency
ITC	investment tax credit
kg	kilogram
kW	kilowatt
kWh	kilowatt-hour
LMI	low and moderate income
m	meter
MLPE	module-level power electronics
Mono c-Si	monocrystalline
Multi c-Si	multicrystalline
MW	megawatt
MWh	megawatt-hour
NEM	net energy metering
PERC	passivated emitter and rear contact
Poly	polysilicon
PPA	power purchase agreement
PUC	public utilities commission
PV	photovoltaic
R&D	research and development
ROW	rest of world
Q	quarter
S&P	Standard and Poor's
SEIA	Solar Energy Industries Association
SG&A	selling, general and administrative expenses
SMART	Solar Massachusetts Renewable Target
SREC	solar renewable energy certificate
TAN	Invesco Solar ETF
TopCon	tunnel oxide passivated contacts
TW	terawatt
TWh	terawatt-hour
W	watt
y/y	year over year
YTD	year to date