

Q2/Q3 2019 Solar Industry Update

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November 12, 2019

Executive Summary

- In October 2019, the United States announced it was rescinding the exemption of bifacial modules and cells it had granted in June 2019. The decision has been challenged in court.
- While most analysts estimate an increase in global PV installations in 2019, projections range from 105 GW_{DC} to 130 GW_{DC}.
- BNEF reported in October 2019 6.9 GW of CSP plants were installed worldwide, and it expected another 1.7 GW of capacity to come on-line by 2023.
- In H1 2019, the United States installed 4.8 GW_{DC} of PV, a 3% increase over H1 2018.
 - Analysts estimate U.S. solar installations in 2019 will be between 11 GW_{DC} and 14 GW_{DC}—a significant increase over 2017–2018.
- Eight states generate over 5% of their electricity from solar, with California leading the way at around 19%.
- The United States installed approximately 438 MWh (226 MW) of energy storage onto the electric grid in the first half of 2019—up 55% y/y.
- For H1 2018 to H1 2019, EnergySage reported a 4% reduction in the average gross costs of a residential system, which fell to \$2.99/W.
- Despite tariffs, PV modules and cells are being imported at historically high levels, with 14 GW of total imports of PV cells and modules now being available to the U.S. market.
 - If PV cell imports stay at current import levels for the rest of the year, they will fall just short of the total Section 201 exclusion for exempting the first 2.5 GW of imported cells, by the end of the term.
- In H1 2019, U.S. c-Si and thin-film module production reached historical highs—up 3.9X and 1.2X respectively, y/y.
- In Q3 2019, PV module and component prices fell to historical low again, with multi and mono c-Si module ASP falling to \$0.21/W and \$0.24/W in September respectively.
 - U.S. multi and mono c-Si module ASP were 52% and 54% higher in price than the global average.

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



1 **State and Federal Updates**

2 **Global Solar Deployment**

3 **U.S. PV Deployment**

4 **PV System Pricing**

5 **Global Manufacturing**

6 **Component Pricing**

7 **Market Activity**



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4 PV System Pricing

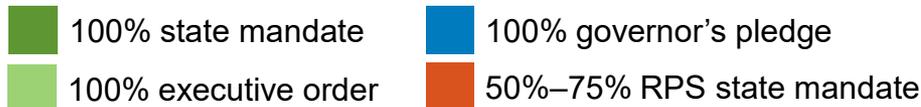
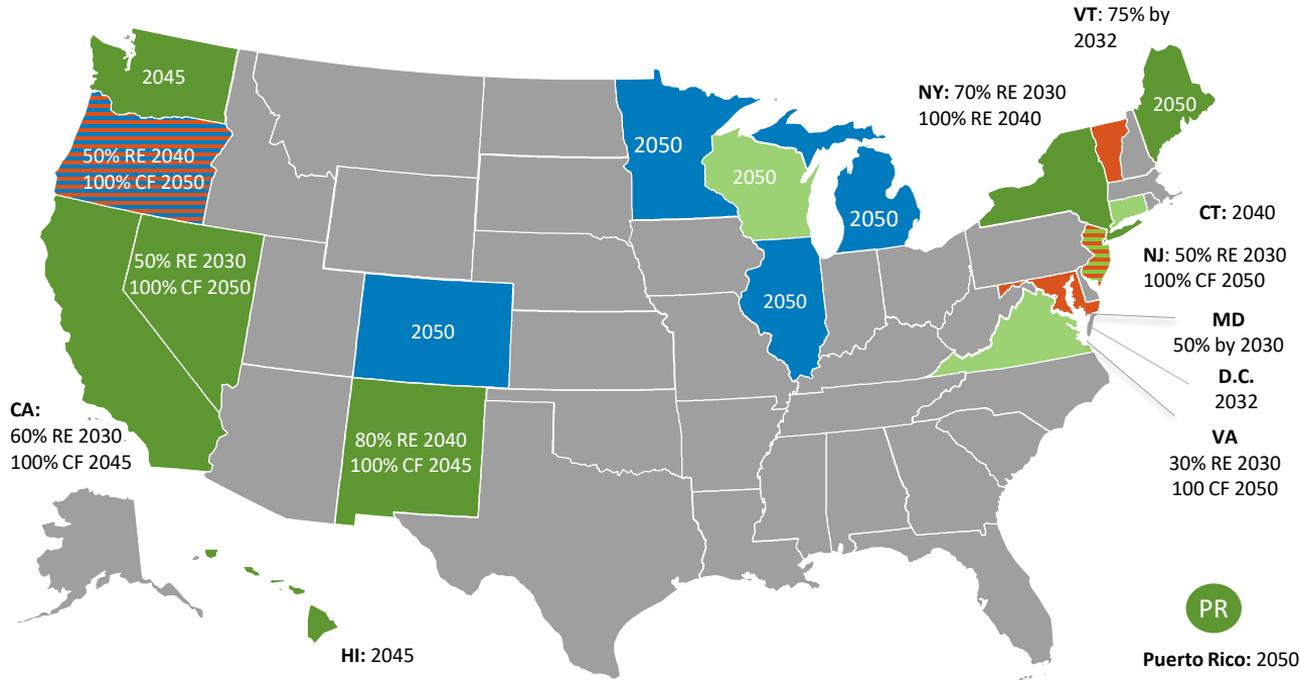
5 Global Manufacturing

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- In Q3 2019, three governors signed executive orders committing their states to 100% carbon-free power and joining eight other states that have made similar commitments.
- In October 2019, the United States announced it was rescinding the exemption of bifacial modules and cells it had granted in June 2019. The decision has been challenged in court.
- In October 2019, FERC published a notice of proposed rulemaking that would give states more flexibility in implementing PURPA, potentially hindering solar development in certain states.

States' Commitments to 50%–100% Carbon-Free Electricity



- In Q3 2019, the governors of Connecticut, Virginia, and Wisconsin signed executive orders committing their states to 100% carbon-free (CF) electricity.
- Electric utility companies, Duke Energy and DTE, also committed to carbon-free electricity by 2050, joining Xcel Energy, PSNM, Idaho Power, and Avista Energy.
 - Duke Energy also plans to double its renewable portfolio by 2025 and reduce carbon emissions 50% by 2030.

Sources: “100% Commitments in Cities, Counties, and States, Sierra Club.” Sierra Club. <https://www.sierraclub.org/ready-for-100/commitments>; www.dsireusa.org, June 2019; League of Conservation Voters; EIA Form 861; PBS (09/17/19); Utility Dive (09/05/19; 09/27/19).

U.S. Tariff Update

Bifacial Module Exemption

- In June 2019, the USTR granted an exclusion to the Section 201 tariff for all bifacial modules and cells.
- Unlike monofacial panels, bifacial modules can generate electricity from sunlight hitting either side of the module and thus require a transparent back.
 - Not all bifacial cells are equal: the higher the bifaciality rating, the more electricity that can be generated from the backside.
- Most bifacial module manufacturing has been in China (which has AD/CVD and Section 301 tariffs in place on top of any Section 201 tariffs for products entering the United States); however, there has been a significant ramp-up in Southeast Asian countries.
 - In addition to any production benefits, these modules and cells would be tariff-free, unlike most other imported c-Si PV modules.
 - Wood Mackenzie estimates there is 11 GW–15 GW of bifacial-ready manufacturing capacity in Southeast Asia.
- In October 2019, the U.S. announced it was rescinding the exemption of bifacial modules and cells starting on October 28.
- In November 2019, the U.S. Court of International Trade granted SEIA and Invenergy a temporary restraining order on the withdrawal of the Section 201 bifacial exemption, which is effective through November 21.

FERC Proposes Changes to PURPA

- In October 2019, FERC published a notice of proposed rulemaking that would give states more flexibility in implementing PURPA.
 - PURPA, enacted in 1978 and amended by Congress most recently in 2005, requires utilities in states without wholesale markets to contract with “qualifying facilities” if the facilities produce power at less than the utilities “avoided cost.” For solar projects under 20 MW in size, this has come in the form of long-term fixed contracts.
 - The FERC chairman believes renewables can compete today without subsidies or regulation.
- The proposed rules would:
 - Give states authority to let utilities pay qualifying solar facilities varying rates based on market conditions; payments could vary throughout the day and change over time, removing the certainty of cash flow.
 - Lower the threshold of qualifying facilities from 20 MW to 1 MW
 - Modify the “one-mile rule” allowing utilities to argue that facilities less than 10 miles apart could constitute a single facility.
- Comments to the notice are due in December 2019.



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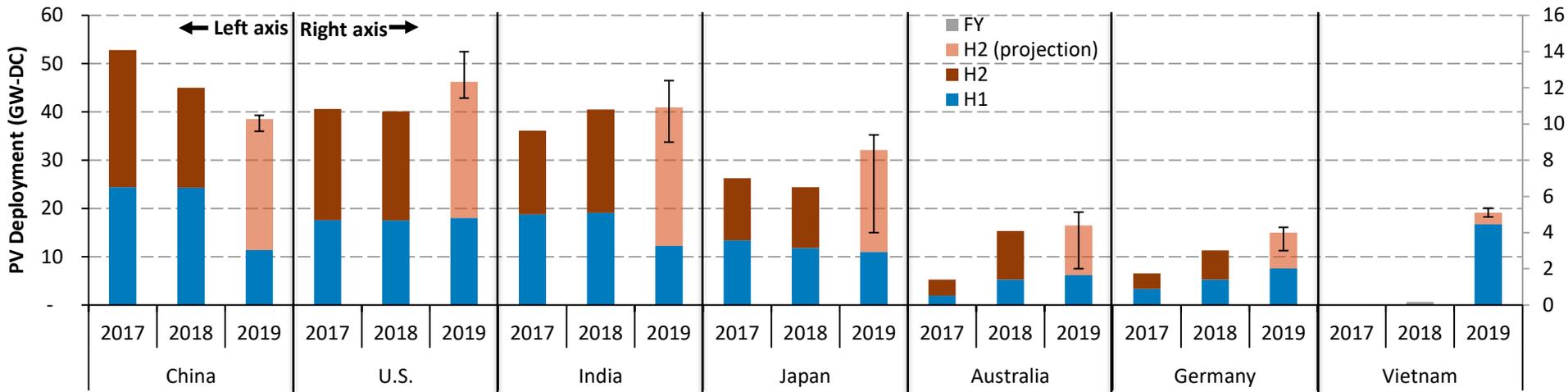
6 Component Pricing

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- **H1 2019 PV deployment from countries representing 80% of 2018 annual installations were 35% below H1 2018 levels, but they are projected to be flat y/y.**
- **While most analysts estimate an increase in global PV installations in 2019, projections range from 105 GW to 130 GW.**
- **BNEF reported in October 2019 that 6.9 GW of CSP plants were installed worldwide, and it expects another 1.7 GW of capacity to come on-line by 2023.**

Global PV Deployment: Key Markets Update

- The leading solar markets of China, the United States, India, Japan, Australia, and Germany represented approximately 80% of 2018 PV demand.
- H1 2019 deployment from these countries is 35% below H1 2018 levels, with most of the reduction coming from China and India. However, analysts expect H2 2019 deployment to bring these countries totals to similar levels as 2018.
- The German PV market continues to recover and is expected to have its largest year since 2012, when it was the world's largest market.
 - With approximately 46 GW installed at the end of 2018, Germany has set a new target of 98 GW by 2030.
- Vietnam was unexpectedly the third-largest market in H1 2019 due to a rush to build before the June 30 feed-in-tariff deadline.



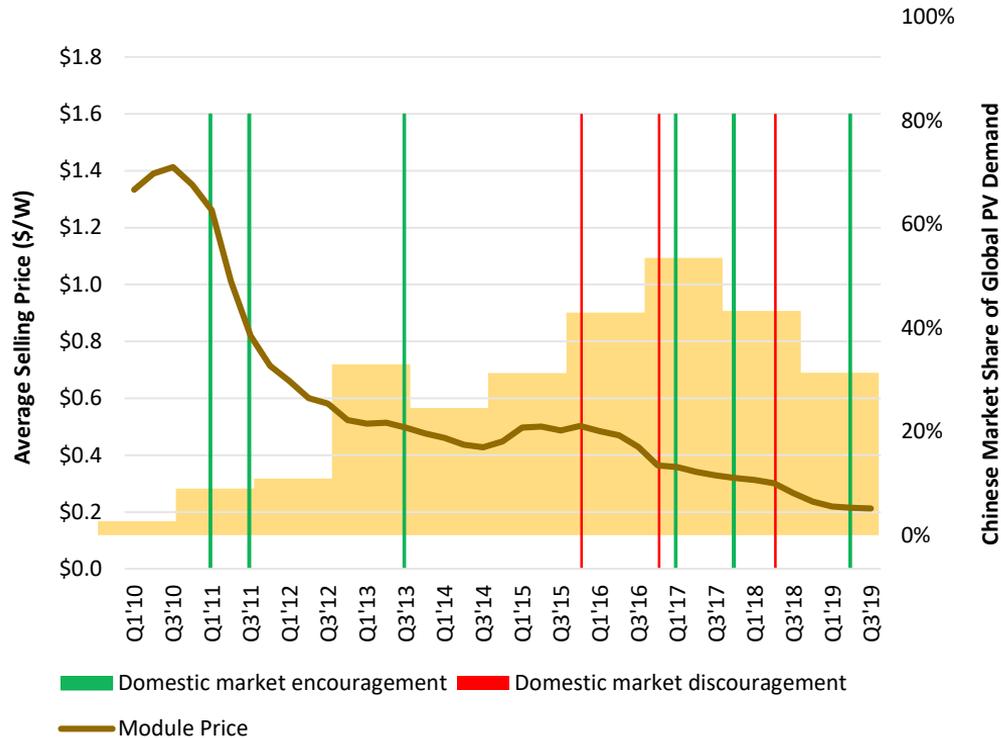
Note: FY = full year. 2019 Japanese value represent shipments, not installations.

Sources: Projections: See Slide 13. Historical: NREL, "Q2/Q3 2018 Solar Industry Update;" Wood Mackenzie/SEIA, "U.S. Solar Market Insight, Q3 2019"; Mercom (09/19/19, 09/23/19); IEA "PVPS Snapshot 2019;" JPEA (October 2019); Bloomberg NEF, "Vietnam Solar Surprises in 1H 2019."

Impact of Module Price from Chinese Management of Domestic Deployment

- Because of China's strong presence in PV manufacturing, the ASP of modules has had a large effect on a significant portion of Chinese companies.
- Though the underlying cost of PV modules and components are important factors in module ASP, supply and demand balance also plays an outsized role.
- China has many goals for increasing the domestic deployment of PV systems, including environmental benefits and increased electrification of the country; however, it has also stated that increased PV deployment can benefit its manufacturers by creating greater demand for their products.
 - The larger the share of global PV demand, the greater the impact a change in Chinese deployment may have on the supply and demand balance.
- However, China must also balance domestic manufacturing interests with the cost of stimulating deployment, as well as bringing too much demand on-line in a short period of time.
- To manage the growth of PV deployment, China has encouraged or discouraged domestic PV deployment, through adjustments to its FIT scheme and solar deployment targets, among other things.

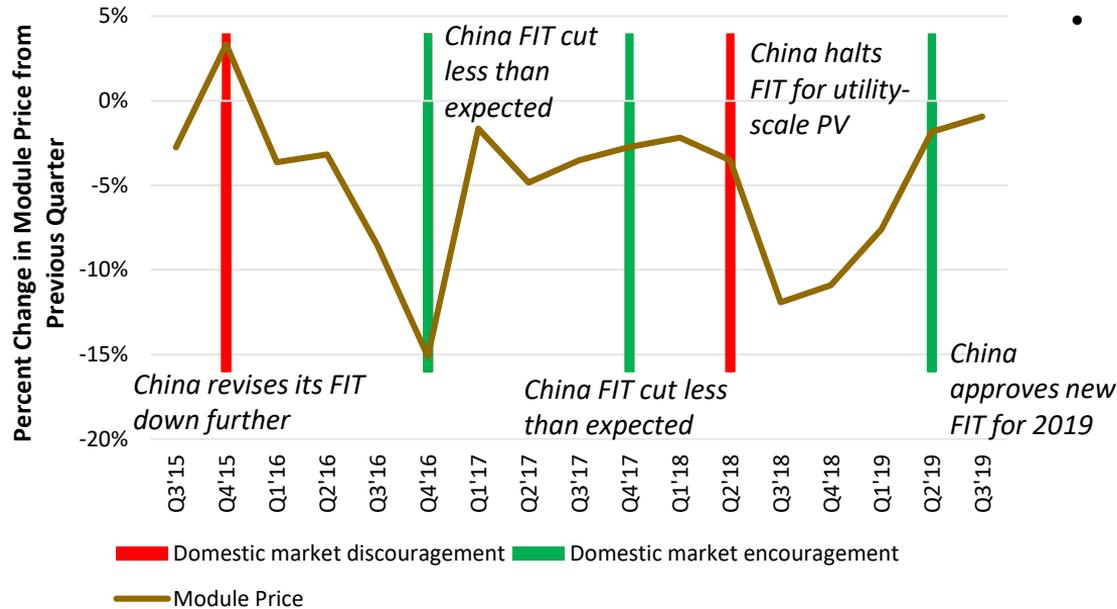
Impact of Module Price from Chinese Management of Domestic Deployment (cont.)



- Early in its FIT program, China had little global market share and therefore did not greatly impact the overall supply/demand balance.
- As China’s market power has grown, decisions about future domestic PV deployment appear to have influenced price.

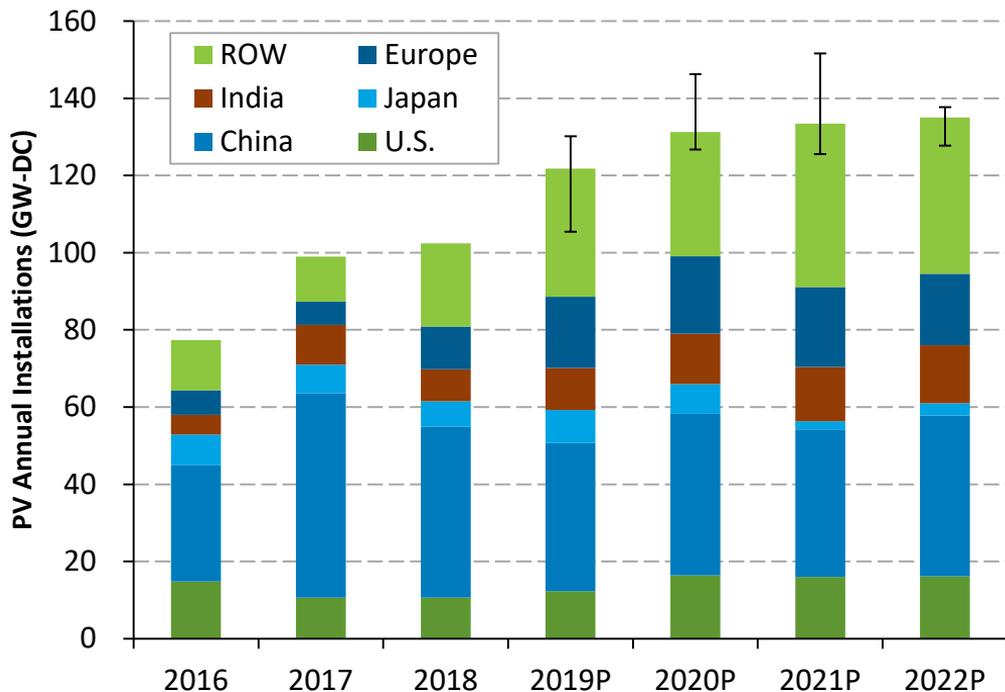
Sources: Module ASP (PVinsights); market announcements: Cleantechnica (12/08/16; 07/15/19); Digitimes (12/15/15); Forbes (06/18/18); NY Times (01/05/17); PV Magazine (11/31/11; 12/22/17); Seeking Alpha (09/11/13).

Impact of Module Price from Chinese Management of Domestic Deployment (cont.)



- Since 2015, China has either encouraged or discouraged domestic PV deployment in several instances. Announcements about these appear to have dramatically affected module ASP.
 - When the FIT was cut more than expected, module ASP dropped, owing to fewer Chinese projects getting built and causing a surplus of panels. When the FIT cut was less than expected or the program was restarted, module ASP appears to have recovered or held steady.

Annual Global PV Demand



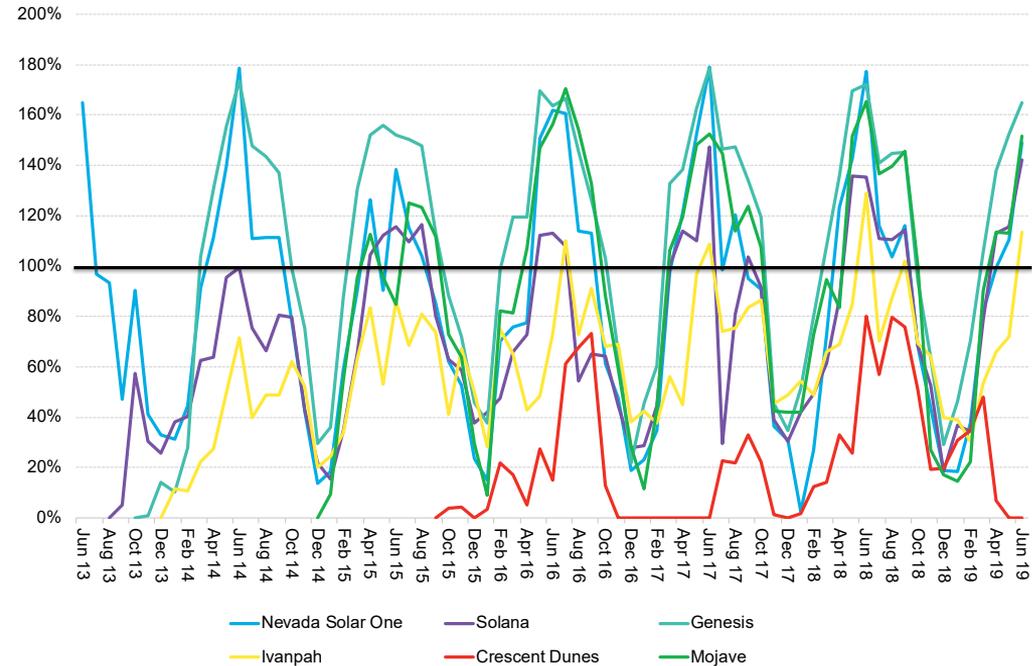
- Though most analysts estimate an increase in global PV installations in 2019, projections range from 105 GW to 130 GW.
 - The expected drop in Chinese installations in 2019 is projected to be more than offset by increases in other large markets, as well as a significant increase from other countries (e.g., Australia and Vietnam).
- Analysts expect China, with 29%–32% of the total global market, to remain the largest PV market through 2022.
- Median analysts' figures estimate that 522 GW of PV will be installed globally from 2019 to 2022, which would more than double current installed capacity.

Note: P = projection. Bar represents median projection. Error bars represent high and low projections.
Sources: BNEF (08/27/19); Cowen & Co. (05/14/19, 07/12/19); Goldman Sachs (10/21/19), Wood Mackenzie Power and Renewables (September 2019, October 2019).

Global CSP Installations and Performance

- BNEF reported in October 2019 6.9 GW of CSP plants were installed worldwide, and it expected another 1.7 GW of capacity to come on-line by 2023 in Chile, China, Morocco, and the UAE.
- BNEF states that while parabolic trough plants are performing well, the underperformance of tower and heliostat projects indicates these technologies are difficult to master.
 - In the United States, two tower projects (Ivanpah and Crescent Dunes) have performed more poorly to date than trough plants installed around the same time.
 - In September 2019, CSP Today reported that an Abengoa Chinese trough plant (Xina Solar One) met its performance targets in record time, indicating advancement in CSP construction and operation.

Actual generation, as % of expected average monthly generation



SolarReserve sues DOE

- In October 2019, SolarReserve filed a lawsuit against the LLC that owns Crescent Dunes (or “Tonopah,” the 110-MW solar thermal tower plant with 10 hours of storage) and the U.S. Department of Energy.
 - The project has experienced operational issues, and the electricity off-taker, NV Energy, terminated the PPA due to failure to generate the required amount of power.
 - According to the lawsuit, the DOE sent a notice of default of the loan to SolarReserve and is trying to replace its sole board manager of the project LLC. SolarReserve believes this could result in the project filing bankruptcy.



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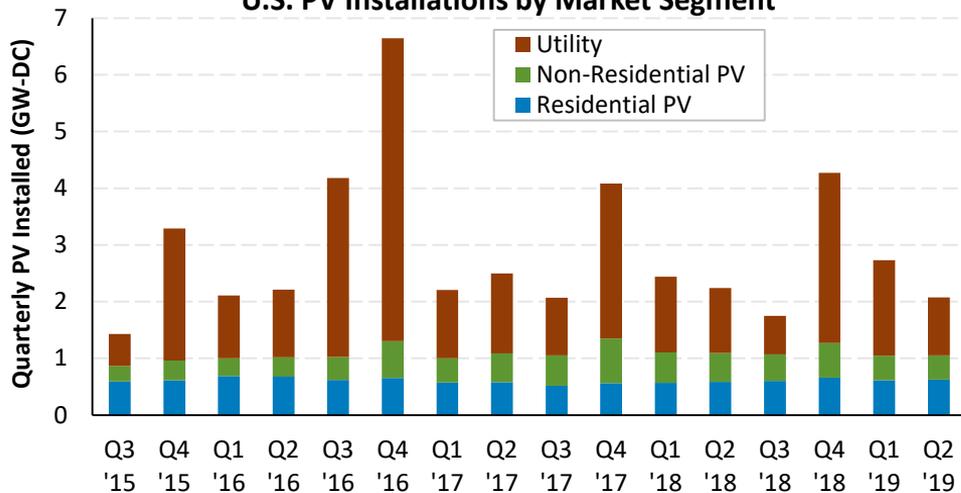
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- In H1 2019, the United States installed 4.8 GW_{DC} of PV—a 3% increase over H1 2018.
- Eight states generate over 5% of their electricity from solar, with California leading the way at around 19%.
- Analysts estimate U.S. solar installations in 2019 will be between 11 GW_{DC} and 14 GW_{DC}—a significant increase over 2017–2018.
- The United States installed approximately 438 MWh (226 MW) of energy storage onto the electric grid in the first half of 2019—up 55% y/y.

U.S. Installation Breakdown

- In H1 2019, the United States installed 4.8 GW_{DC} of PV—a 3% increase over H1 2018.
 - The residential PV market continues to recover, approaching 2016 levels, as new markets compensate for low to flat growth from more mature markets.

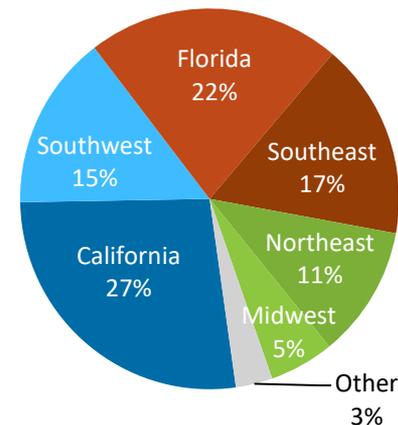
U.S. PV Installations by Market Segment



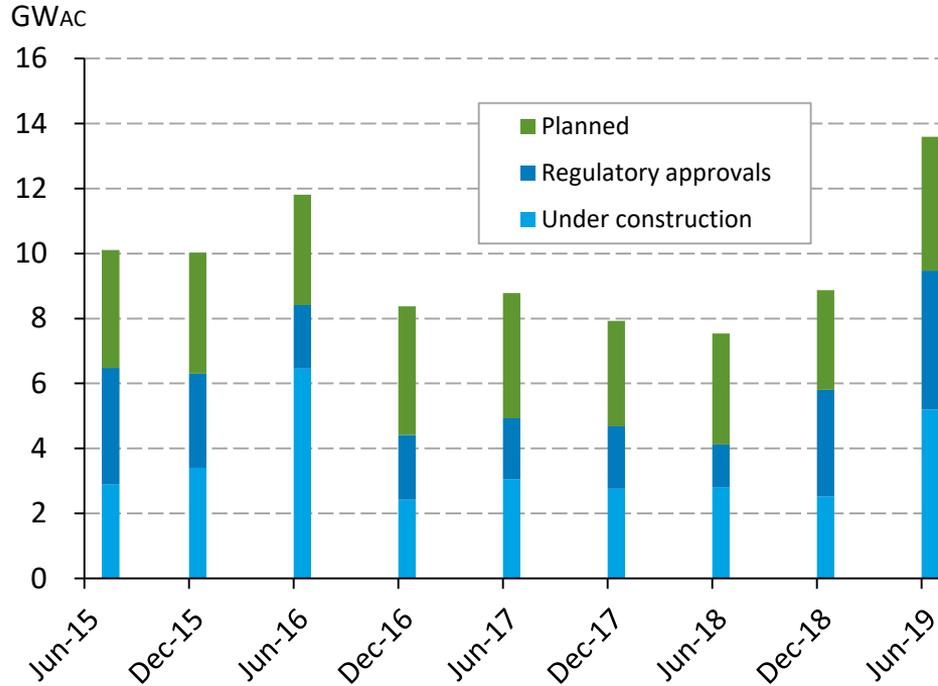
Sources: Wood Mackenzie Power and Renewables/SEIA: [U.S. Solar Market Insight Q3 2019](#).

- The nonresidential U.S. PV market has been hampered by regulatory and policy changes in major markets, like California, Massachusetts, and Minnesota.
- Utility-scale installations in H1 2019 represented a large portion of total PV installs, and there are currently a record-high 8.7 GW_{DC} under construction.
 - Recently signed PPAs have ranged from \$18/MWh to \$35/MWh.
- Approximately 49% of the PV systems installed H1 2019 were in California and Florida.

H1 2019 U.S. PV Installations by Region (4.8 GW_{DC})



EIA PV Project Pipeline



According to EIA data, the U.S. PV project pipeline hit a record high in the first half of 2019, and the capacity of projects under construction had not been this high since 2016, when a record level of PV projects were installed.

Major Business Realignments for Largest U.S. PV Companies

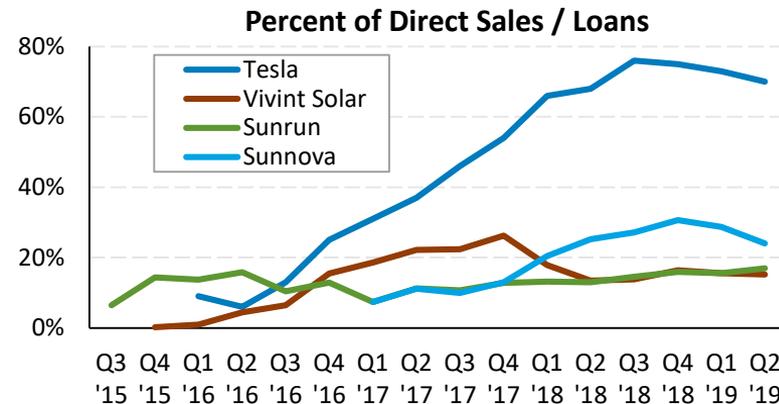
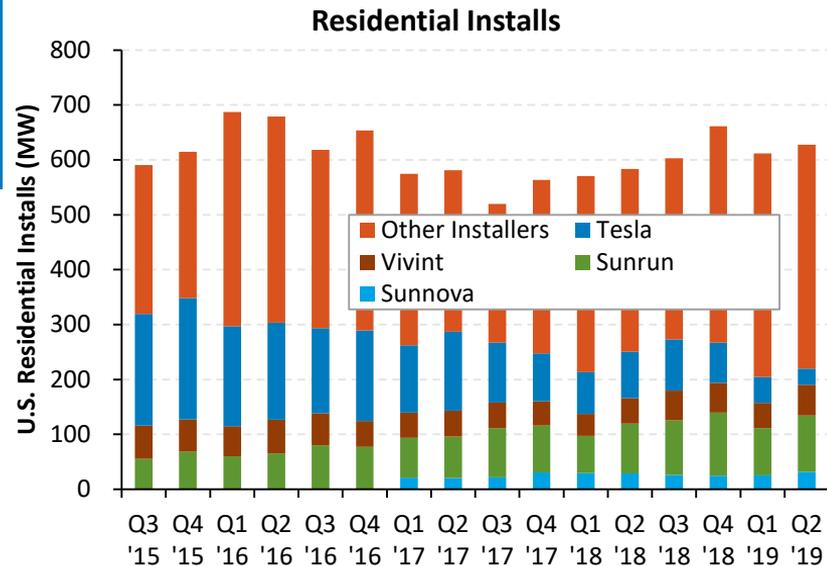
- In the second half of 2019, the two largest U.S. based PV manufacturers decided to separate PV project development from PV manufacturing.
 - In September, citing the success of its Series 6 panels, First Solar announced it was exiting the U.S. EPC business in order to focus on the scaling, developing, and selling of its PV modules.
 - First Solar expects to have 5.4 GW of manufacturing capacity by early 2020—tripling its capacity in five years.
 - Not long ago, First Solar produced most of its profit from its development arm, where virtually all of its panels were used.

Major Business Realignment for Largest U.S. PV Companies (continued)

- In November, SunPower announced plans to spin its module development and manufacturing into a separate company, Maxeon, which is headquartered in Singapore.
 - Maxeon is receiving a \$300 million equity investment from a longtime Chinese JV partner, Tianjin Zhonghuan Semiconductor, one of the largest wafer manufacturers worldwide, with 30 GW of manufacturing capacity.
 - The investment will help Maxeon increase PV manufacturing capacity more quickly, with 1.9 GW of next generation technology and 0.5 GW of previous generation IBC manufacturing by the end of 2019, as well as expanding its P-Series manufacturing joint venture from 2 GW to 5 GW by the end of 2021.
 - However, the lease and operation of a portion of the Oregon manufacturing facility that SunPower previously owned when it purchased SolarWorld will remain with SunPower, and it will continue to do early-stage research in PV technology.
 - Maxeon will also sign an exclusive multiyear deal with SunPower, which will focus on being an energy service provider (i.e., on distributed PV and storage) in North America.
 - SunPower noted that 80% of its Q3 2019 commercial project bookings in California included storage, and there was tremendous opportunity to up-sell storage on its existing 1.5 GW of commercial clients.
 - In May 2018, SunPower exited utility-scale solar development to focus on the North American distributed PV market.

Sunnova, Sunrun, Tesla, and Vivint Residential Market Share

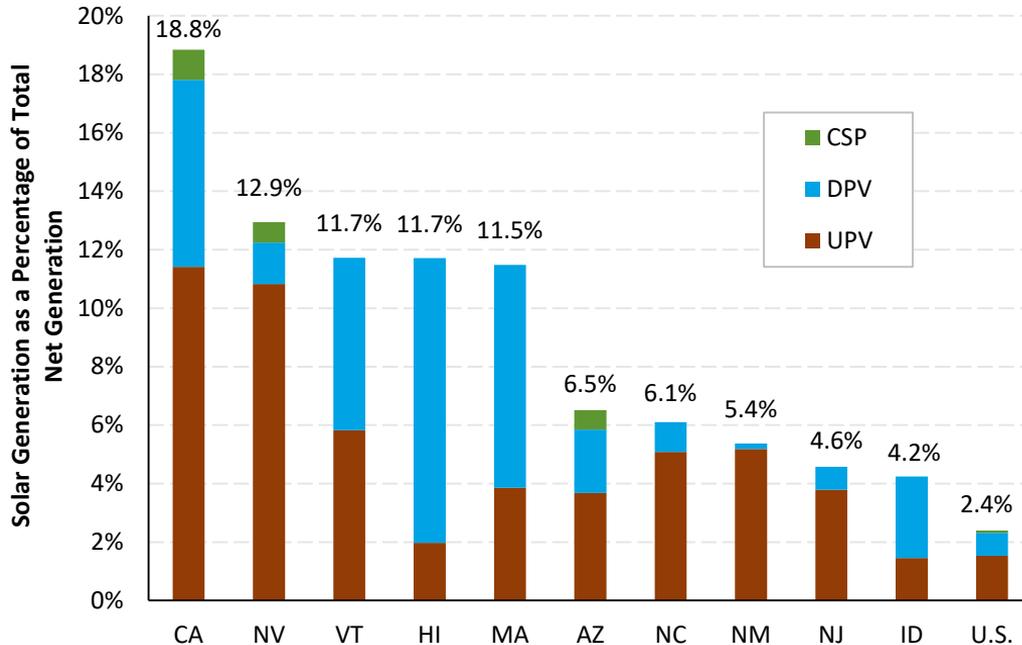
- Third-party ownership (TPO) has declined in recent years, dropping to 38% of residential, 14% of small nonresidential, and 34% of large nonresidential systems in the 2018, according to *Tracking the Sun: 2019 Edition*.
- Sunnova, Sunrun, and Vivint experienced 11%, 14%, and 19% increases in sales in Q2 2019 respectively, y/y.
- Tesla sales are down 65% over the same period, to their lowest quarterly installation levels since 2012.
 - Tesla sales recovered slightly in Q3 2019, though they are still well below previous volumes.
 - Tesla continues to focus on direct sales, while well over 75% of Sunnova, Sunrun, and Vivint sales still come from leases or PPAs.
 - Tesla CEO Elon Musk said in a June pretrial deposition (regarding the purchase of SolarCity by Tesla) that he shifted a significant amount of resources from Tesla’s solar division during the ramp-up in production of its Model 3 car. It is now shifting resources back.
- Despite lackluster PV sales, Tesla Powerwall system sales continue to grow, with more than 1.3 GWh installed in the past year.
 - Sunrun now offers its Brightbox storage solution service in nine states and Puerto Rico.



Note: Sunnova, Sunrun, Tesla, and Vivint installation data may include a small portion of commercial or other sectors.

Source: BNEF (10/30/19), Corporate filing, SEIA / Wood Mackenzie [Solar Market Insight Q3 2019](#).

Solar Generation as a Percentage of Total Generation, H2 2018–H1 2019

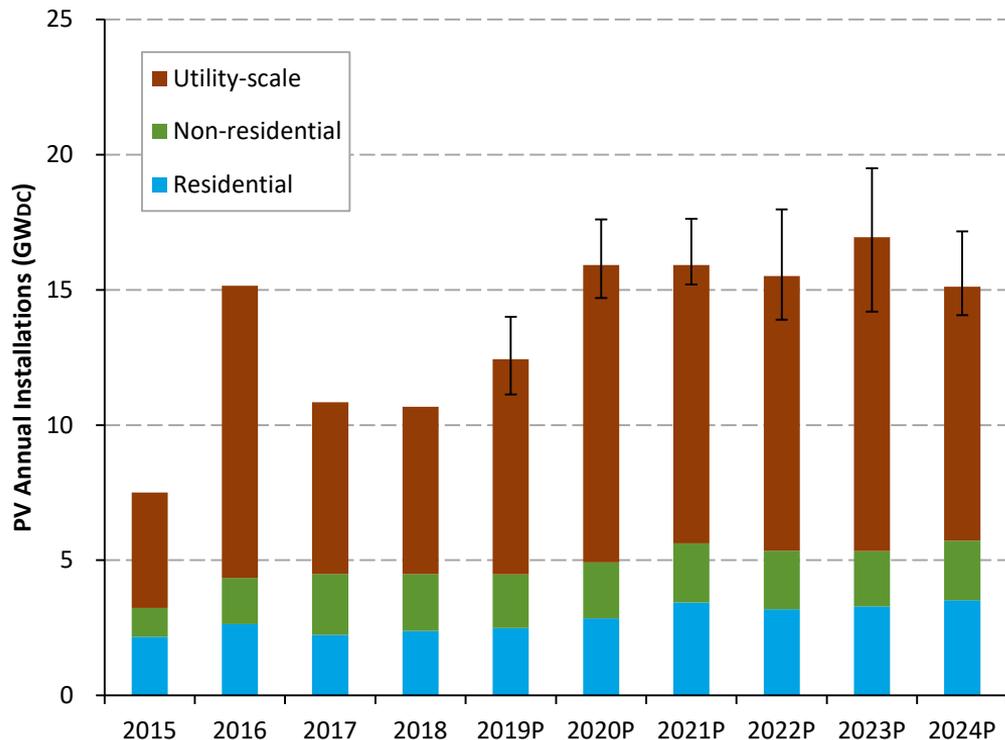


Note: EIA monthly data for 2019 are not final. Additionally, smaller utilities report information to EIA on a yearly basis, and therefore, a certain amount of solar data has not yet been reported. “Net Generation” includes DPV generation. Net generation does not take into account imports and exports to and from each state and therefore the percentage of solar consumed in each state may vary from its percentage of net generation.

Source: U.S. Energy Information Administration, “Electricity Data Browser.” Accessed October 30, 2019.

- Eight states generate over 5% of their electricity from solar.
 - Nationally, 2.4% of electricity is generated from solar.
- The role of utility versus distributed solar varies by state, with northeastern states and Hawaii relying more on DPV.

Annual U.S. PV Demand Projections



- Analysts estimate U.S. solar installations in 2019 will be between 11 GW and 14 GW—a significant increase over 2017–2018.
 - Most of the growth is expected to come from the utility-scale sector.
- According to median analyst projections, 93 GW of PV will be installed between 2019 and 2024 in the United States, which is close to 1.5X the cumulative installed capacity at the end of 2018.
 - Despite the 2024 cliff, where all projects installed in that year will receive no greater than a 10% tax credit (as opposed to the 30% enjoyed in 2019), analysts do not expect a significant reduction in PV system installations.

Note: P = projection. Bar represents median projection. Error bars represent high and low projections.

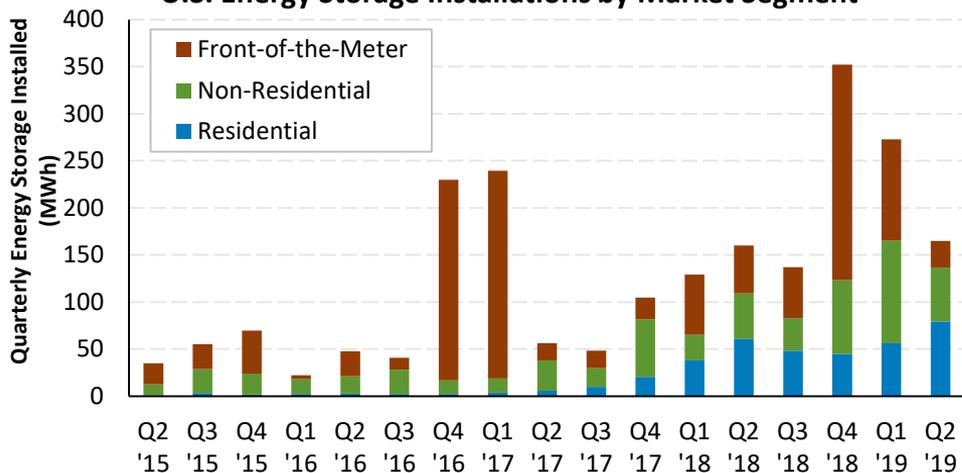
Sources: BNEF (09/03/19); Cowen (05/14/19); Goldman Sachs (10/31/19); Wood Mackenzie (October 2019).

U.S. Energy Storage Breakdown

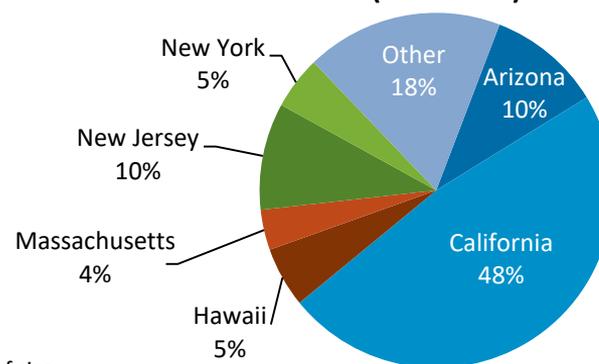
- The United States installed approximately 438 MWh (226 MW) of energy storage onto the electric grid in the first half of 2019—up 55% y/y and buoyed by record levels of deployment in the residential and nonresidential sectors, with California and Arizona leading the way.
 - In H1 2019, front-of-the-meter installations were down 61% y/y.

- In Q2 2019, Massachusetts rolled out a new draft of its Clean Peak Standard rules, which are supposed to be especially beneficial for storage projects.
- In Q2 2019, Long Island began a new storage incentive program, and New York City proposed new fire code standards for outdoor storage permitting.
 - Safety is a concern for batteries in a highly concentrated area like New York City. Other large cities are expected to look to New York City when crafting their own permitting rules.

U.S. Energy Storage Installations by Market Segment



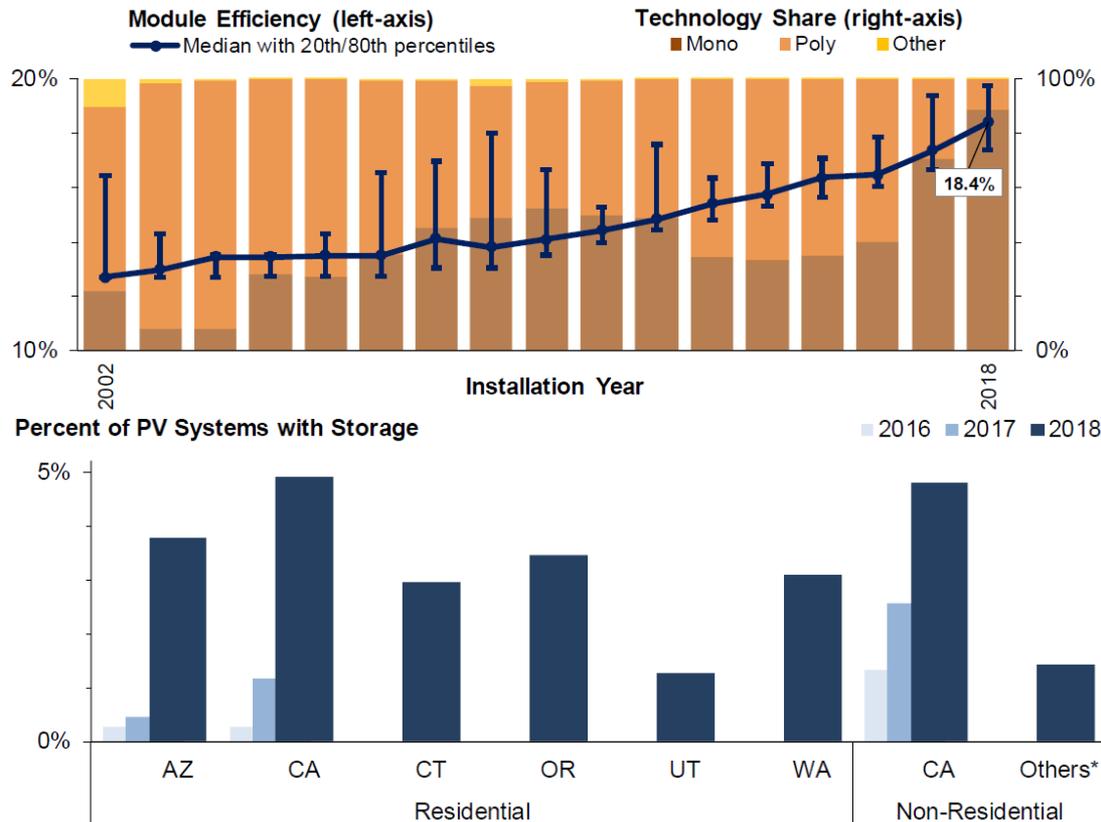
Q1 2019 U.S. Energy Storage Installations by Region (438 MWh)



Note: projects deployed on the utility side of the meter are classified as front-of-the-meter regardless of size.

Sources: Wood Mackenzie Power & Renewables and Energy Storage Association, "[U.S. Energy Storage Monitor](#)."

Five New Things to Know from *Tracking the Sun XII*



1. The median module efficiency of U.S. distributed PV systems was 18.4%, up 1 percentage point y/y. A large reason for this is the growing adoption of mono c-Si panels over multi c-Si.
2. MLPE have continued to gain share across the sample and represent 85% of residential systems, 65% of small nonresidential systems, and 22% of large nonresidential systems installed in 2018.
3. Roughly half (52%) of all large nonresidential distributed PV systems in the 2018 sample are ground-mounted, while 7% have tracking. Small nonresidential (17%) and residential PV systems (3%) had much smaller levels of use.
4. Panel orientation has become more varied over time, with 57% of systems installed in 2018 facing south, 23% west, and most of the remainder east.
5. A small but increasing share of distributed PV projects is paired with battery storage, typically ranging from 1% to 5% in 2018 across states in our data set, though much higher penetrations occurred in Hawaii and in several individual utility service territories.

PG&E Update

- Wildfires in California, and PG&E's liability for their damage, caused the company to declare bankruptcy in January 2019.
 - In August 2019, PG&E said they would honor all preexisting PPAs, despite early wind and solar contracts being significantly above current market rates. Dropping the contracts may have had a chilling affect on financing solar and wind projects by creating more uncertainty in PPAs.
- Because of the wildfires and fears of causing additional fires, PG&E has shut off power to millions of customers several times this year, sometimes for multiple days.
 - Also, the company said precautionary forced-power shut-offs could be expected for the next ten years.
- The growing instances of loss of power have caused many residents to consider installing PV-plus-batteries on their homes.
 - Sunrun said that 25% of its California customers last year purchased battery storage systems, with that figure rising to 60% in parts of Southern California.
 - Though customers would still need to be connected to the grid, CBS News estimates these battery systems could power a home for about a half a day.



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- **Based on partial data, from 2018 to 2019, the median reported PV system price in California, Connecticut, Massachusetts, and New York fell 2% to 9% depending on system size.**
- **From H1 2018 to H1 2019, EnergySage reported a 4% reduction in the average gross costs of a residential system, to \$2.99/W.**

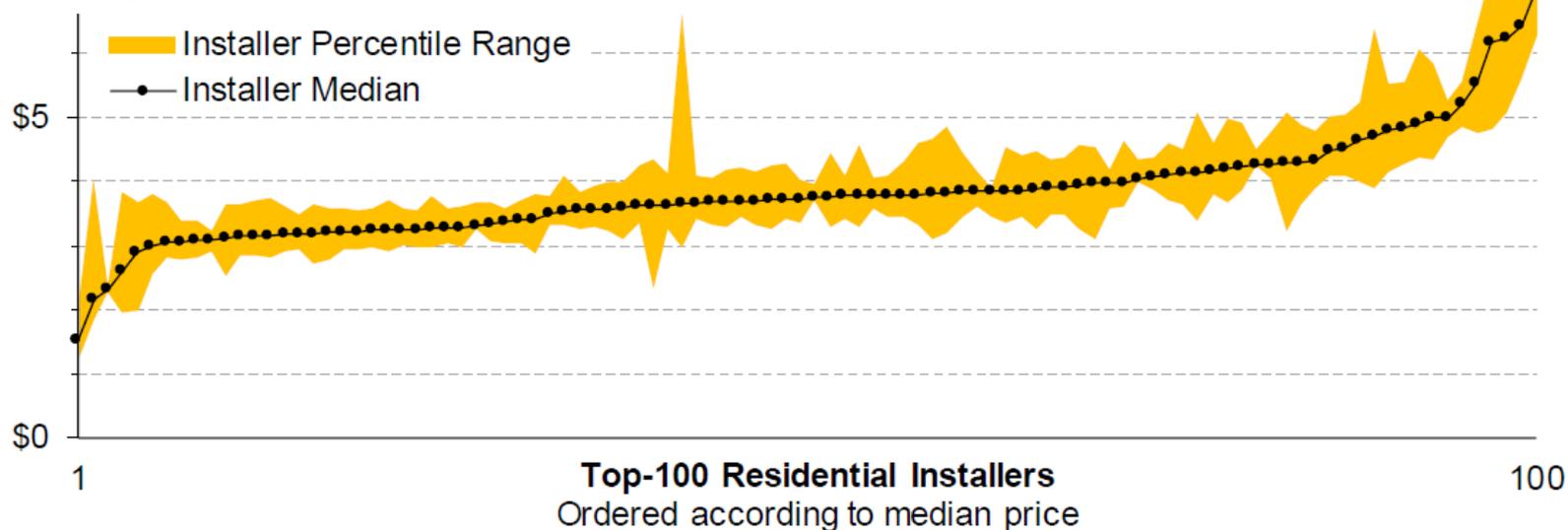
Tracking the Sun: Wide Pricing Variability Exists across Major Residential Installers in 2018

- Ignoring the tails, median prices across the top-100 residential installers in 2018 generally ranged from \$3.0/W to \$5.0/W, with most below \$4.0/W.

- Differences reflect installer-level attributes, such as pricing strategy and business model, firm size and experience, level of training, specialization and component preferences, as well as simply features of the markets in which each installer operates (especially for local/regional firms).

2018 Residential Systems

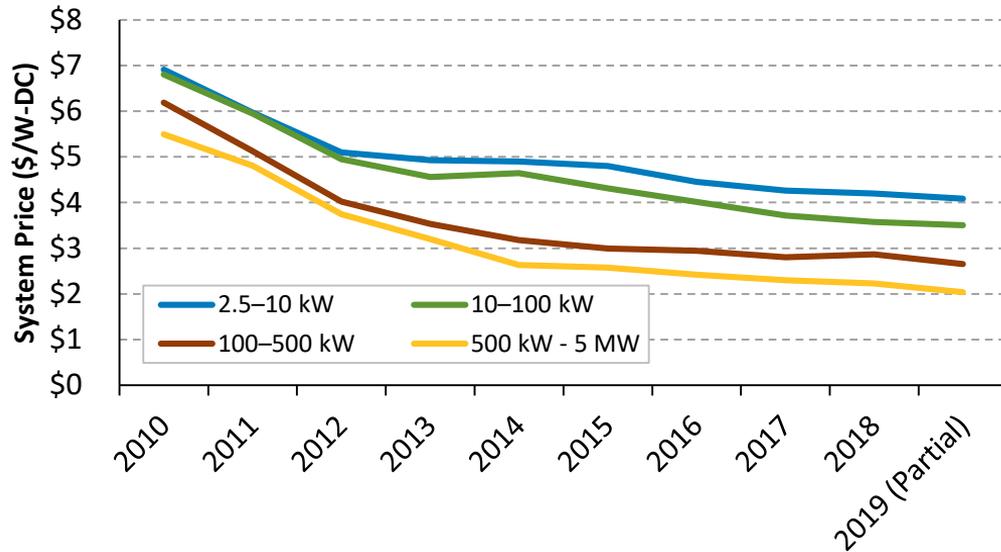
(2018\$/W_{DC})



Note: Each dot represents the media installed price of an individual installer, ranked from lowest to highest, while the shaded band shows the 20th to 80th percentile range for each installer.

Source: Barbose, G. and N. Darghouth. 2019. *Tracking the Sun: Pricing and Design Trends for Distributed Photovoltaic Systems in the United States 2019 Edition*. Berkeley, CA: Lawrence Berkeley National Laboratory. November 2019.

System Pricing from Select States



Based on partial data for 2018–2019, the median reported PV system price in California, Connecticut, Massachusetts, and New York fell:

- 3% to \$4.09/W for systems of 2.5 kW–10 kW
- 2% to \$3.51/W for systems of 10 kW–100 kW
- 7% to \$2.65/W for systems of 100 kW–500 kW
- 9% to \$2.04/W for systems of 500 kW–5 MW.

Preliminary 2019 YTD MW: CA (437), CT (35), MA (57), NY (194)

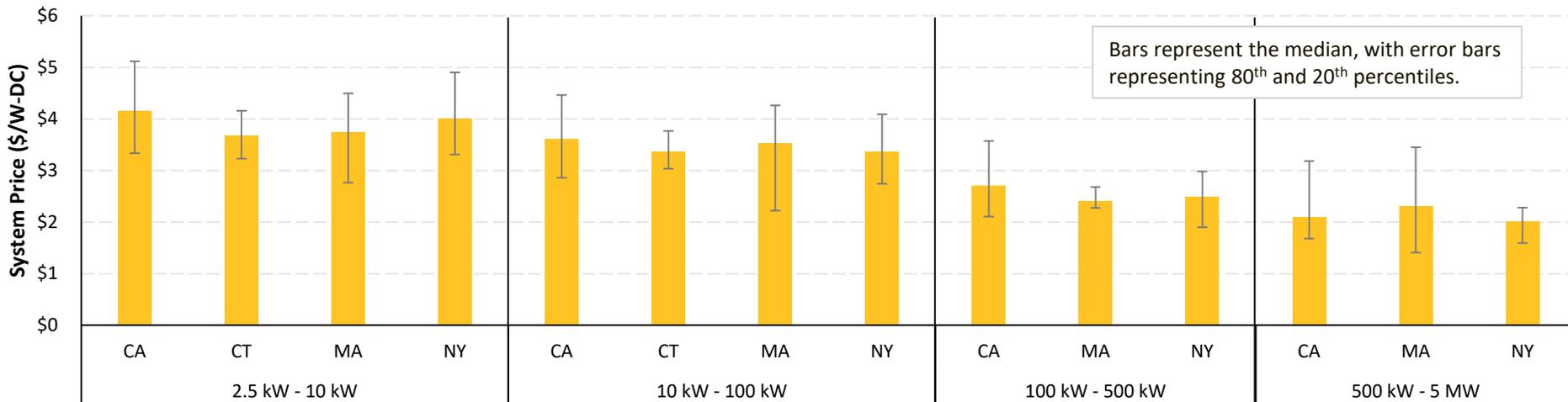
Note: System prices above \$10/W and below \$1/W were removed from the data set.

Sources: CA NEM database (07/31/19); CT Green Bank (09/30/19); MA SREC program (08/19/19); NYSERDA (09/30/19).

System Pricing from Select States, 2019 YTD

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

- Based on initial data in 2019 (YTD), the median price of a small system in Connecticut was about 12% less than the median price in California.
- In 2019 (YTD), the 20th and 80th percentile prices in California for a small system were \$3.34/W and \$5.12/W respectively.



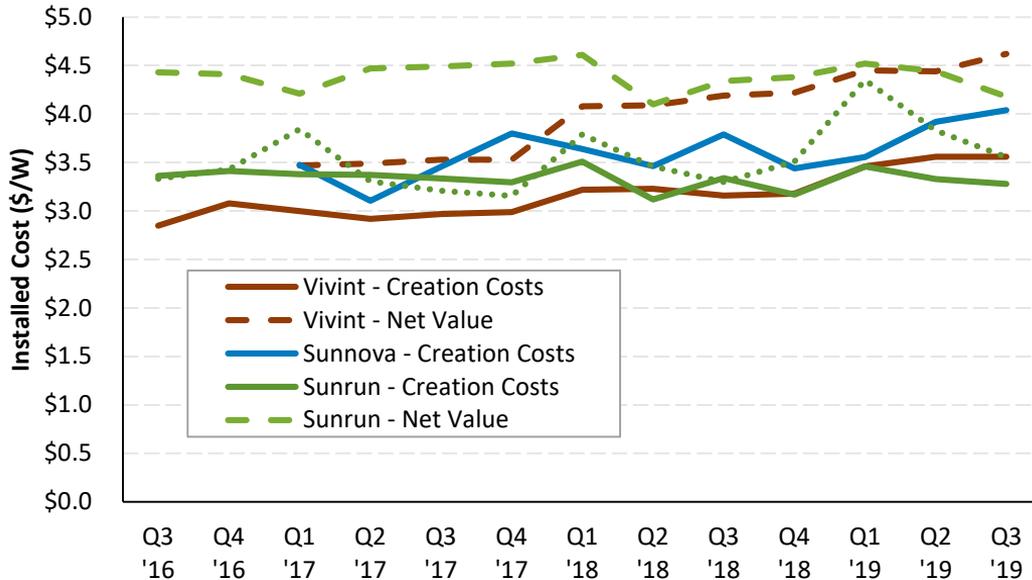
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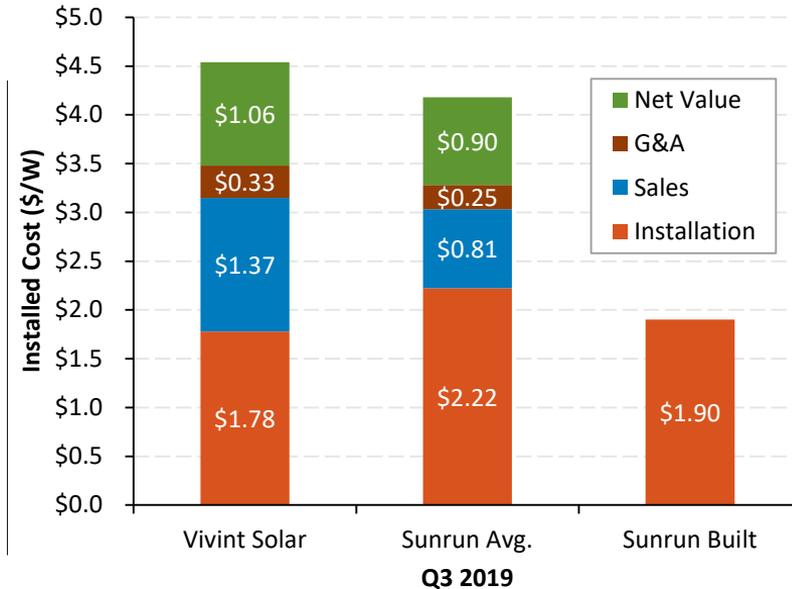
Sources: CA NEM database (07/31/19); CT Green Bank (09/30/19); MA SREC program (08/19/19); NYSEDA (09/30/19).

Sunnova, Sunrun, and Vivint Cost and Value

- For the past three years for Sunnova, Sunrun, and Vivint:
 - Total system costs have remained relatively flat or increased.
 - Hardware costs have decreased.



- In Q3 2019, totals costs for Vivint- and Sunrun-built systems were approximately \$3.25/W–\$3.50/W.
- Sunrun and Vivint still report a PV system net value of \$4.0/W–\$4.5/W.

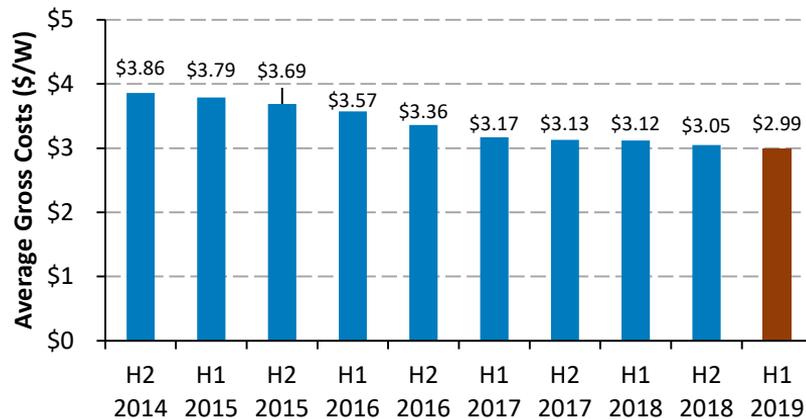


Sources: Corporate filings.

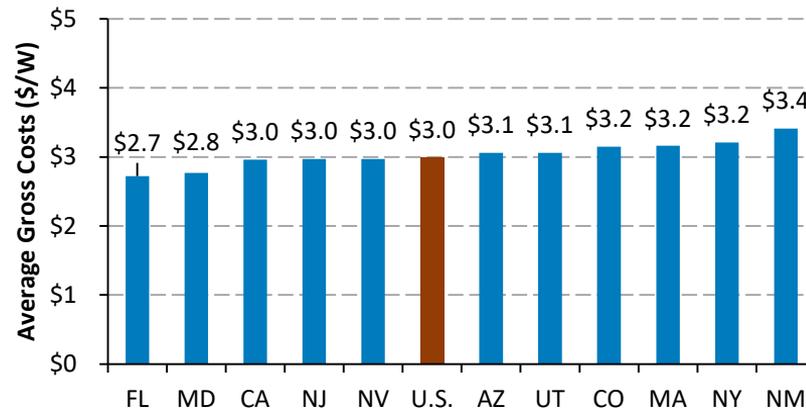
System Costs Reported by EnergySage, H1 2019

- From H1 2018 to H1 2019, EnergySage reported a 4% reduction in the average gross costs of a residential system.
- EnergySage quotes also reported an average system payback period of eight years.
 - Payback periods varied by state and were more closely tied to local policies and incentives than differences in system price.
- Residential system quotes varied by state. In H1 2019, the average gross cost of a residential system in New Mexico was 25% higher than the average gross cost of a residential system in Florida.
- In H1 2019, the average customer’s maximum and minimum quotes ranged by \$0.4/W.

Cost over Time



Cost by State, H1 2019





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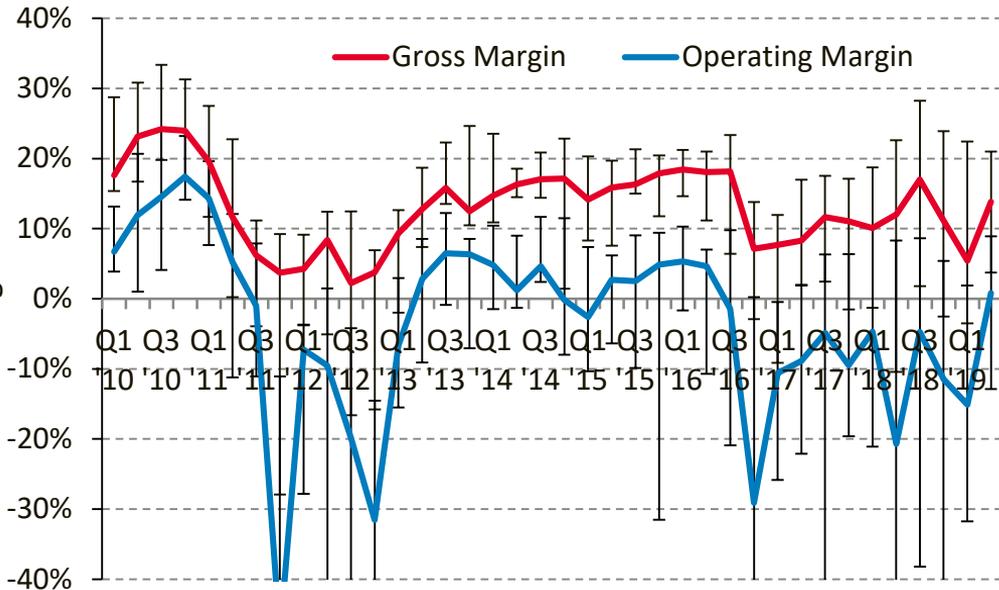
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6 Component Pricing

7 Market Activity

- Performance of solar companies rebounded, on average, in Q2 2019 as the ASP of modules stabilized.
- Despite tariffs, PV modules and cells are being imported at historically high levels, with 14 GW of total imports of PV cells and modules available to the U.S. market.
- If PV cell imports stay at current import levels for the rest of the year, they will fall just short of the 2.5-GW quota by the end of the term.
- In H1 2019, U.S. c-Si and thin-film module production reached historical highs and were up 3.9X and 1.2X respectively, y/y.

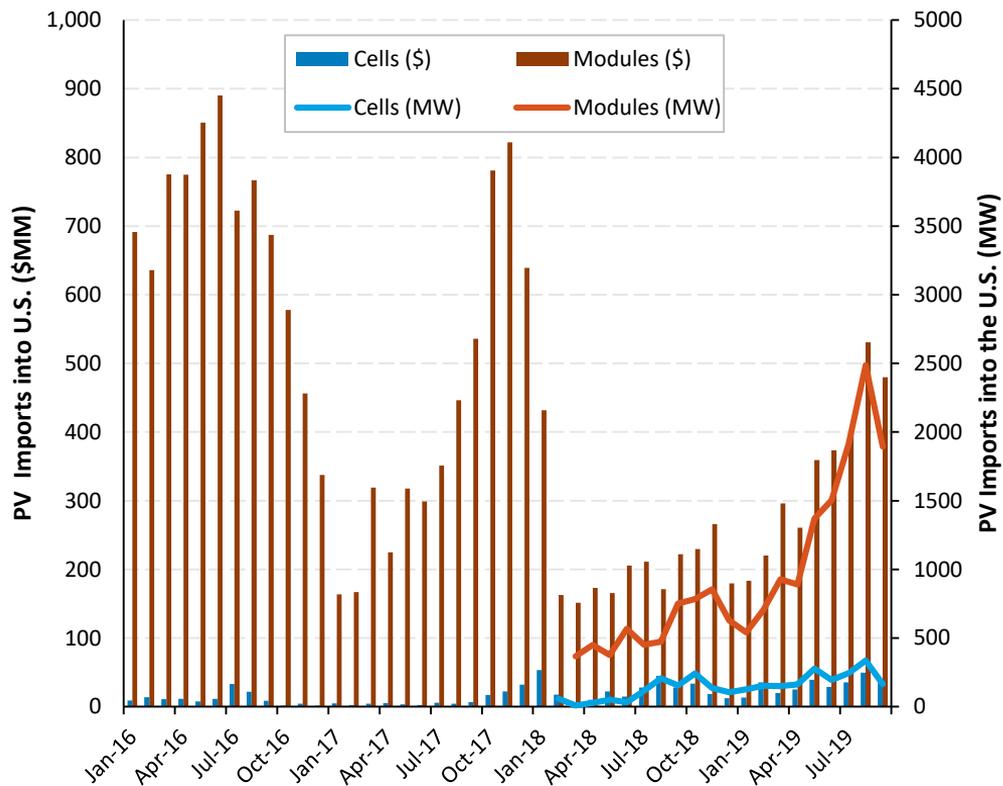
PV Manufacturers' Margins



Line represents the median, with error bars representing 80th and 20th percentiles for the following companies in Q2 2019: Canadian Solar, First Solar, HT-SAAE, Jinko Solar, LONGi, Motech Industries, Neo Solar Power, ReneSola, Risen Energy, and SunPower. When they are available, margin data from Hanwha Q Cells, JA Solar, Trina, Yingli, and Hareon Solar are also included for Q1 2010 to Q1 2019.

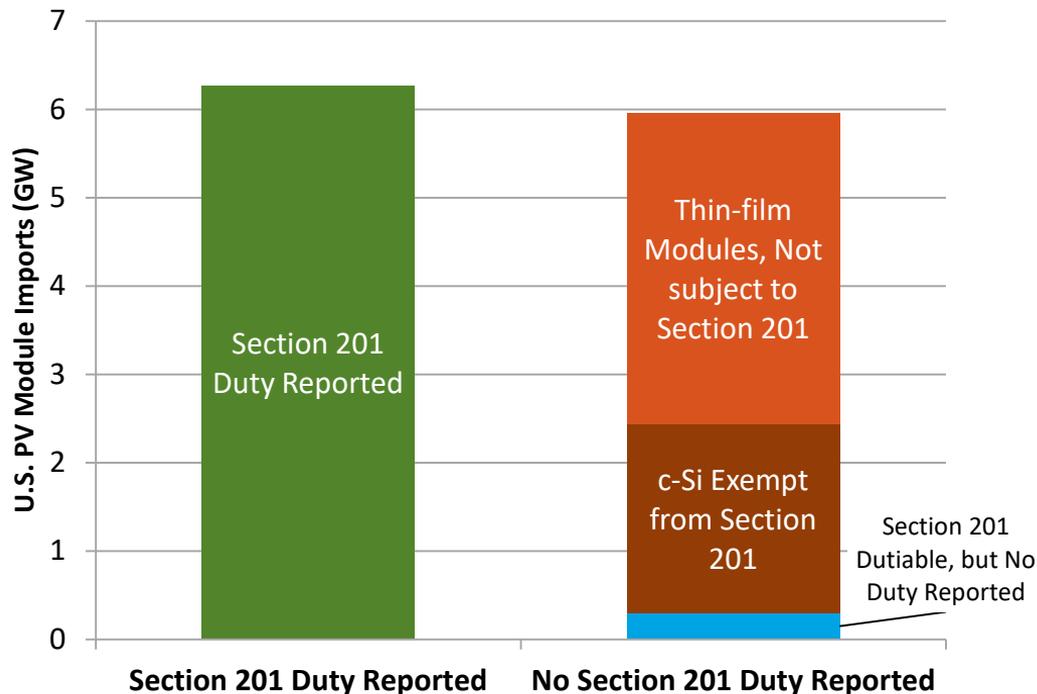
- Performance of solar companies rebounded, on average, in Q2 2019 as the ASP of modules stabilized.
 - For the first time in nearly three years, the median operating margin was positive.
- First Solar released its Q3 numbers, showing profitability for the first time in FY 19.
 - The company also opened its new factory three months ahead of schedule, making it the largest PV manufacturer in the United States.
- Not all manufacturers have done well.
 - Hareon Solar went into liquidation bankruptcy and was delisted.

Module and Cell Import Data



- Despite tariffs, PV modules and cells are being imported at historically high levels.
 - 12.2 GW of PV modules were imported in the first nine months of 2019, with 6.3 GW imported in the Q3.
 - Another 1.8 GW of cells were imported in the first nine months of 2019, with 0.7 GW coming in Q3.
- Total imports of PV cells and modules were 14 GW available to the U.S. market.

Q1 2019–Q3 2019 Module Imports by Tariff

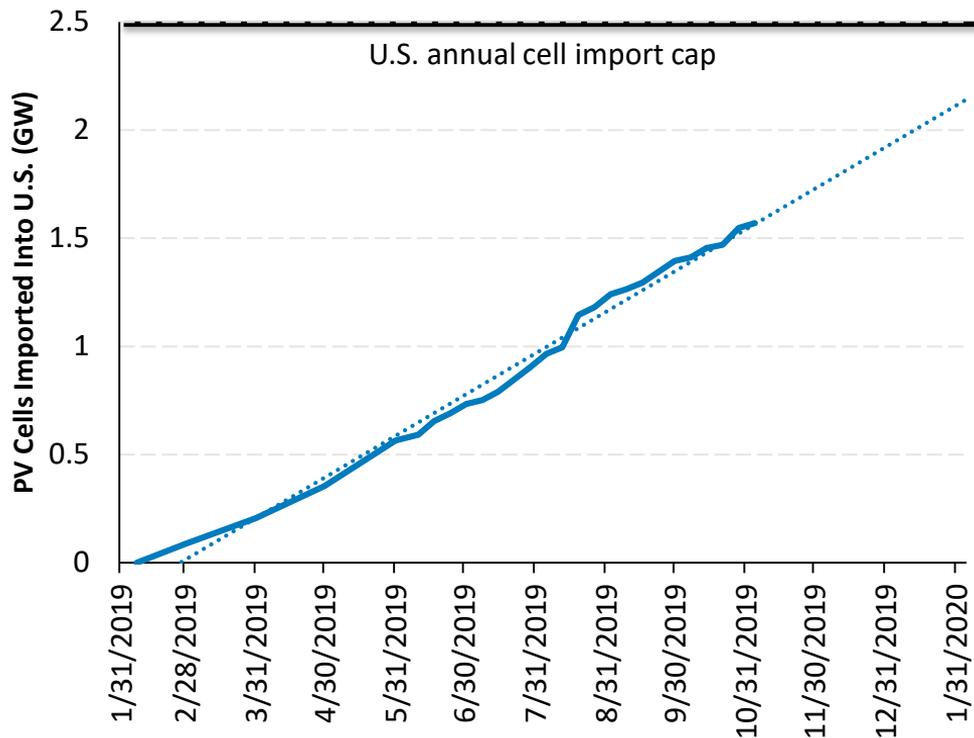


- In the first nine months of 2019 almost half of all imported PV modules were not reporting a tariff.
 - Most of these modules (3.5 GW) are thin-film; however, another 2.1 GW—mostly from South Korea, Vietnam, Thailand, Malaysia, and Mexico—are reporting their modules as c-Si and exempt from the Section 201 duties.
 - The imports from Mexico are likely SunPower IBC panels, which received an exemption.
 - Another portion may be bifacial modules, which were exempt from Section 201 duties from June through October of 2019.
 - Approximately 0.3 GW of c-Si modules, subject to Section 201, were imported; however, no duties were reported. It is unclear why this happened.

Note: module data uses codes: 8541406015, 8541406020, 8541406035. We assume 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.”

Sources: Imports, by MW: U.S. International Trade Commission, 2019.

Cell Import Data by Tariff



Note: cell data uses HTS codes 8541406025

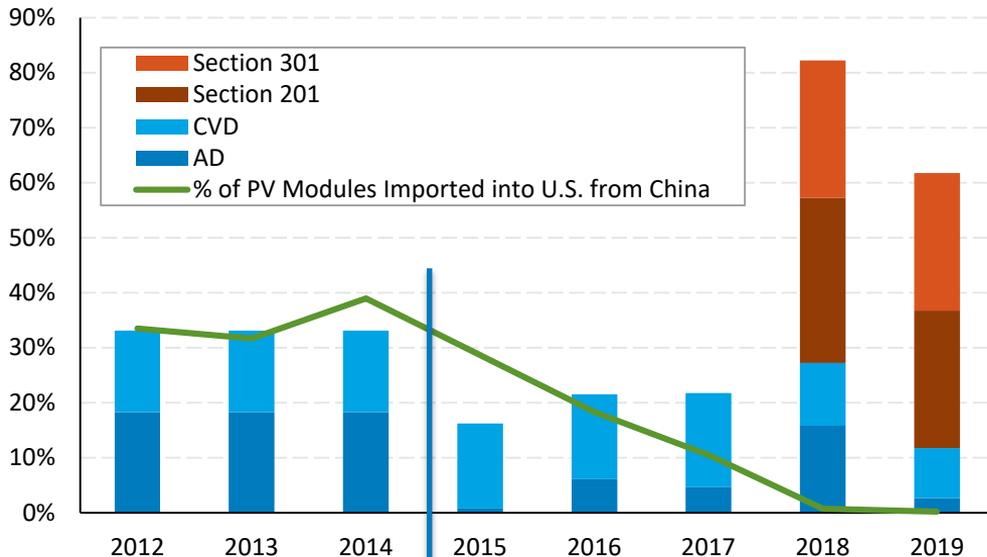
Sources: Imports, by MW: U.S. International Trade Commission, 2019; U.S. Customs and Protection Commodity Status Reports.

A 2.5-GW quota (from February 7, 2019 through February 6, 2020) exempts the first 2.5 GW of imported c-Si PV cells, subject to the Section 201 tariff.

- From February through October, approximately 1.6 GW of cells, subject to the quota, were imported, or 175 per month.
 - Since May, monthly imports have increased to 200 MW.
- If PV cell imports stay at current import levels for the rest of the year, they will fall just short of the 2.5-GW quota by the end of the term.
- A significant amount of c-Si module assembly was completed in the first half of 2019, more than doubling the U.S. capacity to around 5 GW. Approximately 400 MW of cells per month would be needed to run these plants at full capacity—or double what is currently being imported.
 - Manufacturing plants may still be working out production issues or scaling their workforce to be able to run three shifts.
 - If plants do ramp up to full capacity, they may hit the cap.

U.S. Duties on Chinese PV Modules

Combined *minimum* duties on Chinese Modules (using Chinese Cells)



United States closes loophole in late 2014, placing larger tariffs on Chinese modules that use cells from other countries.

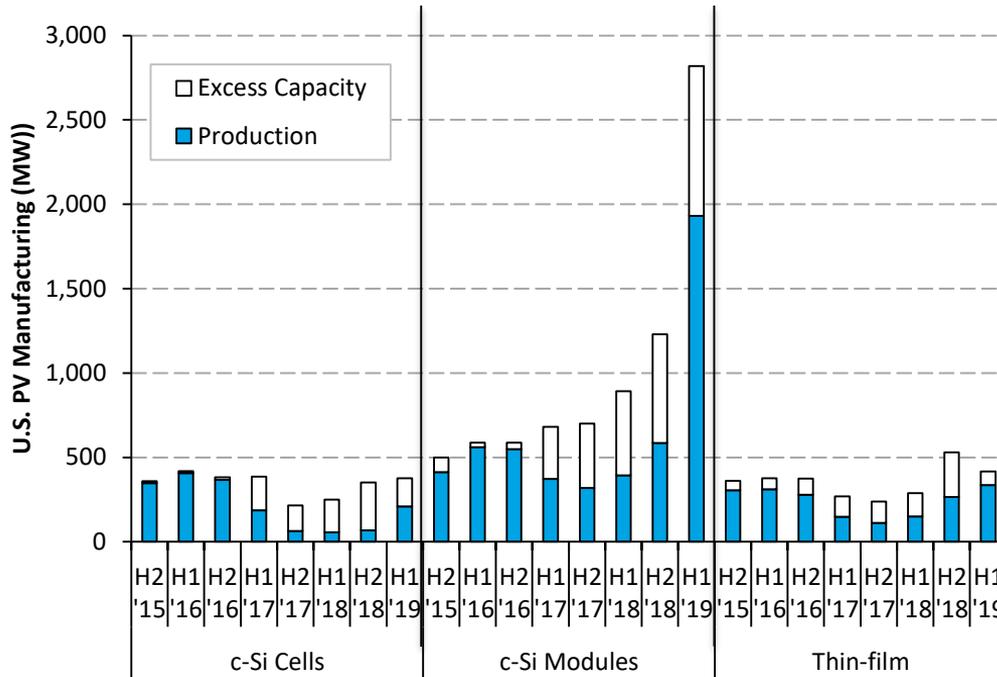
Chinese companies expand PV manufacturing to other Asian countries to circumvent EU restrictions and U.S. duties.

- China still manufactures most PV modules; however, since 2018, virtually none of them have gone to the U.S. market.
- In 2018, the EU lifted its restrictions on Chinese modules, shifting import supply back from other Asian countries.
- In July 2019, the U.S. significantly reduced AD/CVD duties on many Chinese manufacturers (though some are still subject to tariffs as high as 250%).
- No manufacturer pays the minimum for both AD and CVD duties (currently set at 11.8%).
 - As of July 2019, China Solar has the lowest combined rate (14.3%), while Jinko Solar, Canadian Solar, and JA Solar are subject to a rate of 14.7%.
- The reduction in AD/CVD duties will likely not open the U.S. market to Chinese modules until the Section 301 duties are also lifted, as well.
 - While virtually all imported c-Si modules are subject to Section 201 tariffs, only Chinese manufacturers are subject to Section 301 tariffs.

Note: Duties in graphic do not necessarily reflect levels for the entire year, as several changes to rates occurred mid-year.

Sources: Smith et al. (2019); U.S. International Trade Commission.

U.S. Module and Cell Manufacturing



- In H1 2019, U.S. c-Si and thin-film module production reached historical highs—up 3.9X and 1.2X respectively, y/y.
 - Manufacturers continue to ramp up manufacturing capacity and production, so H2 2019 is likely to see further increases in production.
- In H1 2019, U.S. PV cell production increased 2.8X y/y, but it is still below previous historical levels.
 - Tesla increased production but is still behind in its ramping capacity schedule.

Source: Wood Mackenzie Power and Renewables/SEIA: [U.S. Solar Market Insight Q3 2019](#) and previous U.S. Solar Market Insight reports.



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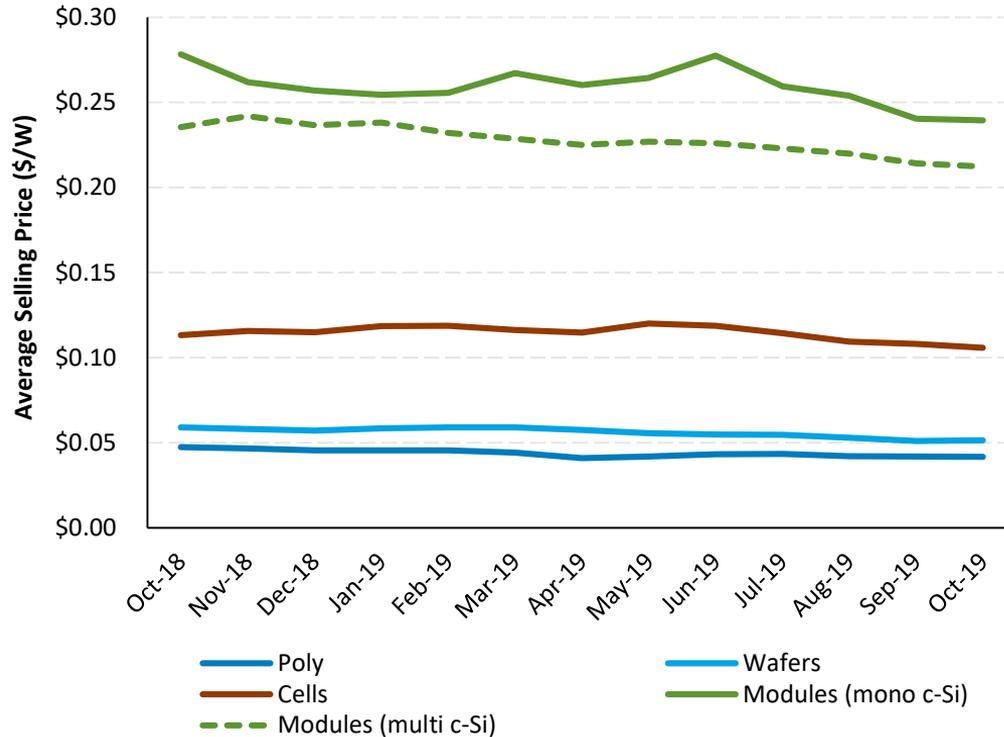
5 Global Manufacturing

6 Component Pricing

7 Market Activity

- In Q3 2019, PV module and component prices fell to historical lows again, with multi and mono c-Si module ASP falling to \$0.21/W and \$0.24/W in September, respectively.
- U.S. multi and mono c-Si module ASP were 52% and 54% higher than the global average.
- Residential inverter pricing in the United States remained flat in Q2 19 due to tariffs imposed on Chinese inverters.

PV Value Chain Spot Pricing

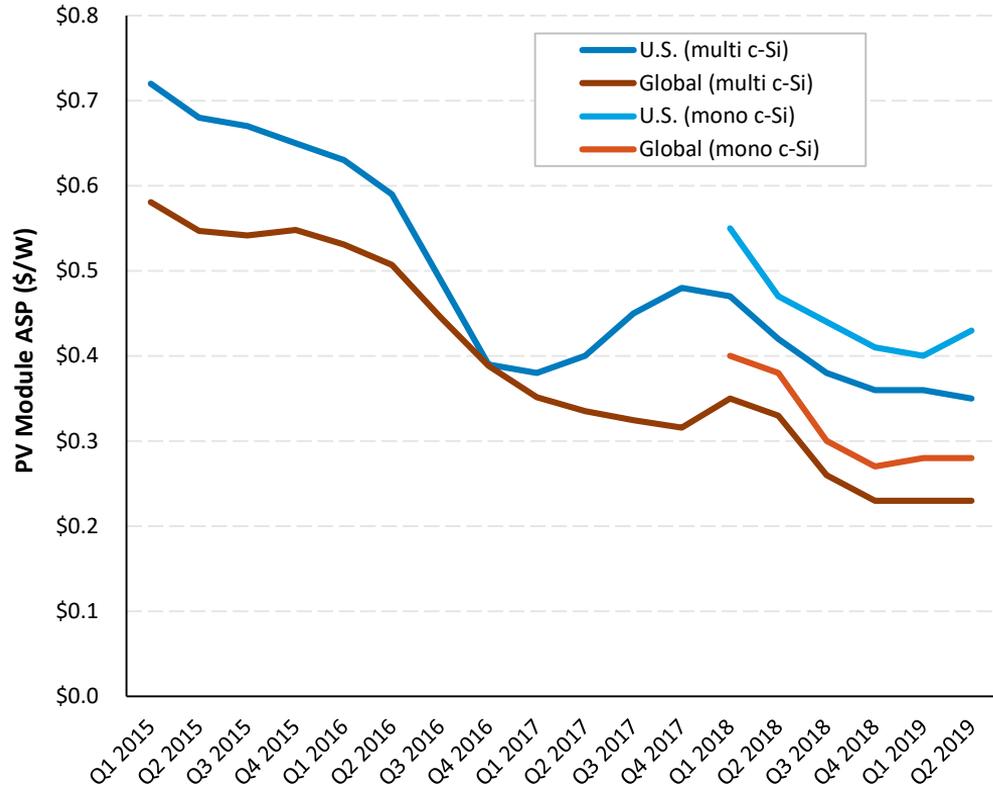


- In Q3 2019, PV module and component prices fell to historical lows again, with multi and mono c-Si module ASP falling to \$0.21/W and \$0.24/W in September, respectively.
 - Polysilicon ASP recorded a low of \$7.6/kg in September as well.

Source: BNEF Solar Spot Price Index (11/07/19).

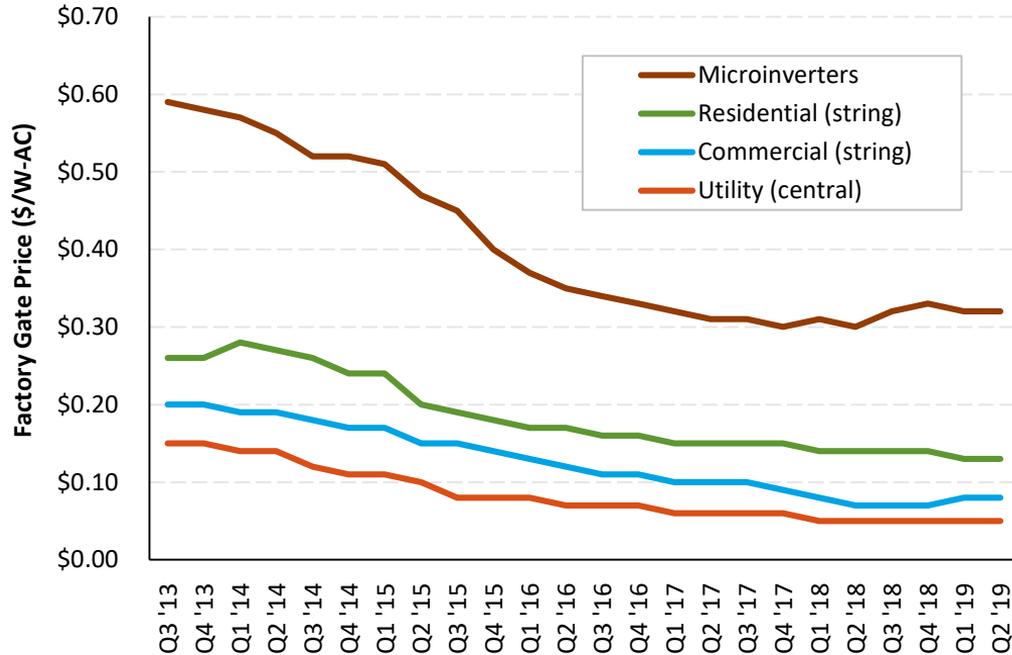
Kilogram-to-watt conversion: 4.78 grams per watt (2016); 4.73 grams per watt (2017, 2018, 2019), from Cowen & Co. (05/11/17); Deutsche Bank (07/19/17).

Module Average Selling Price: Global versus U.S.



- Q2 2019 was the first full quarter in which the Section 201 tariffs went down—from 30% to 25% (in February 2019); however, U.S. module ASP did not see commensurate price declines.
 - Strong U.S. demand, driven by developers and installers purchasing modules to qualify for the 30% ITC, contributed to no decline in prices. Particularly popular products (e.g., PERC modules) experienced price increases Q/Q.
- Multi and mono c-Si modules sold in the United States in Q2 2019 were 17% and 9% lower in price than modules sold in the United States in Q2 2018, respectively, but they were 52% and 54% higher in price than the global average.

Inverter Pricing



- Residential inverter pricing in the United States remained flat in Q2 '19 due to tariffs imposed on Chinese inverters.
 - Many of the larger-scale inverters are manufactured outside China and so were less impacted.
- Inverter manufacturers are adjusting their supply to mitigate the impact of the tariff.
 - In June 2019, Enphase commenced microinverter shipments from Mexico.



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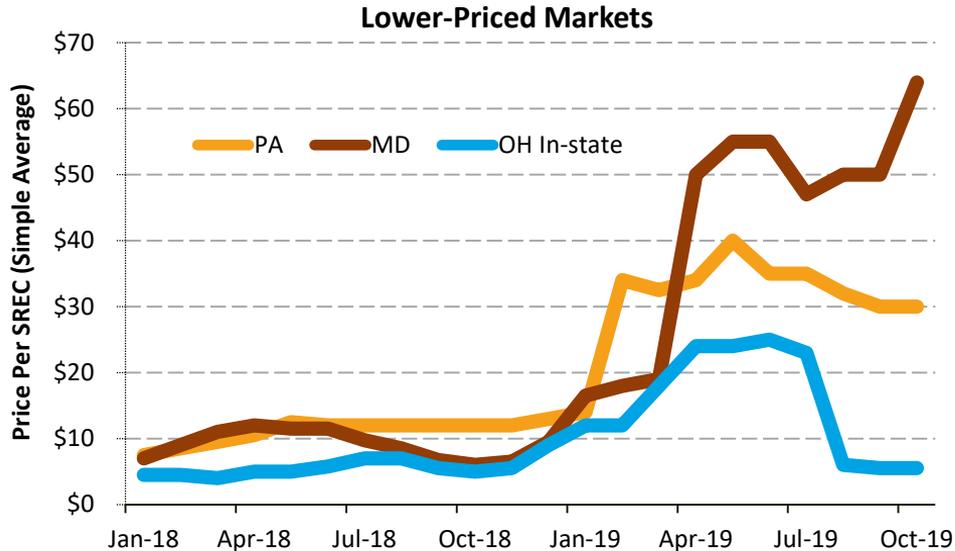
6 Component Pricing

7 Market Activity

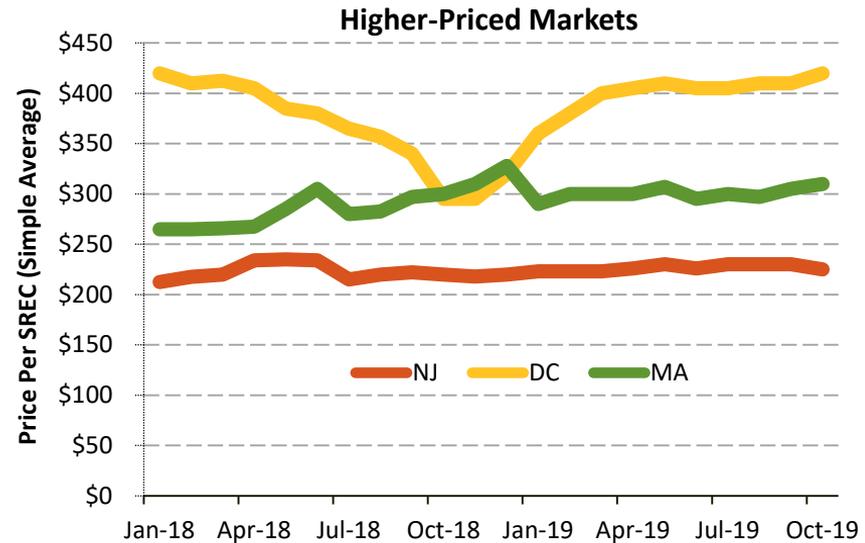
- **Maryland's SREC prices hit a three-year high due to an increase in the RPS implemented earlier this year.**
- **Though solar stocks greatly outpaced the rest of the market over the past year, in Q3, the growth stagnated and stocks held about steady with the market.**

SREC Pricing

- Maryland's SREC prices hit a three-year high due to an increase in the RPS implemented earlier this year.
 - The bill was enacted without the signature of the governor, who plans on proposing his own bill next year.

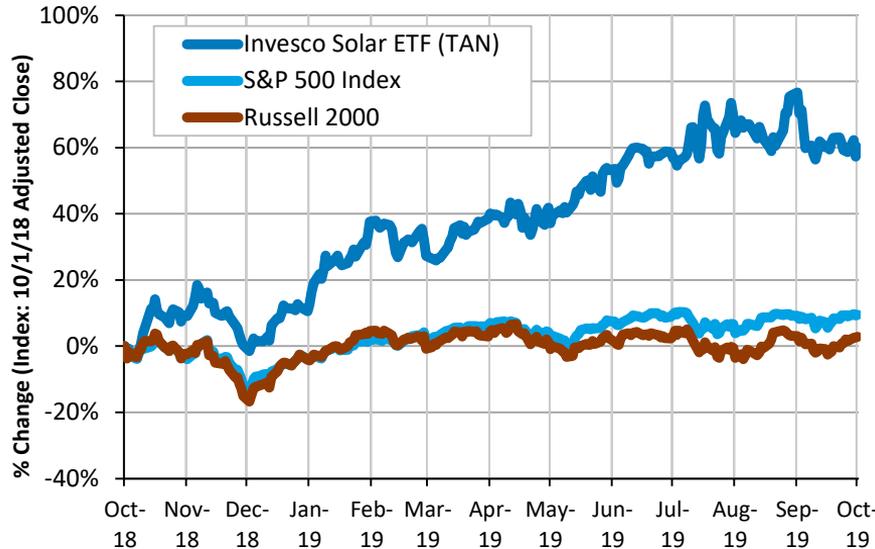


- After Ohio decreased the overall RPS and eliminated the solar carveout completely in July, SREC prices sharply declined but stabilized throughout the following months.
 - This was the first decrease in an RPS since Kansas eliminated its RPS in 2009.



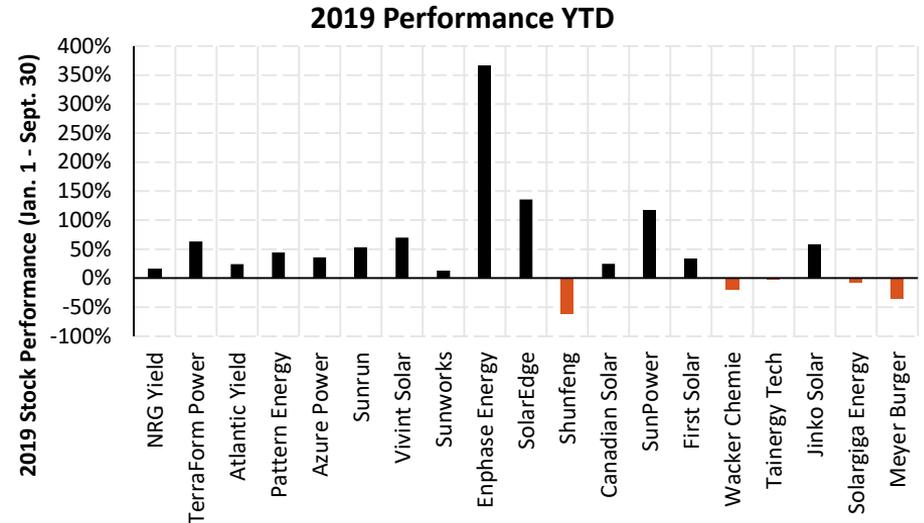
Stock Market Activity

- While solar stocks have greatly outpaced the rest of the market over the past year, in Q3 2019, growth stagnated, and stocks held about steady with the market.



Source: Stock market: Yahoo Finance (10/24/19).

- Not all solar submarkets or stocks performed the same in the first nine months of 2019.
 - Two inverter manufacturers, Enphase and SolarEdge, were the best performing solar-related stocks, well over doubling in value.
 - Recently updated rapid shutdown rules in many states have increased demand for module-level power electronics.
 - Equipment manufacturer Meyer Burger, polysilicon manufacturer Wacker Chemie, and solar cell manufacturer Shunfeng all have lost value this year.



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Thank You

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List of Acronyms and Abbreviations

• AC	alternating current	• NEM	net energy metering
• AD	anti-dumping duty	• PERC	passive emitter rear cell
• ASP	average selling price	• PG&E	Pacific, Gas, and Electric
• BNEF	Bloomberg New Energy Finance	• PPA	power purchase agreement
• CEO	chief executive officer	• PSNM	Public Service of New Mexico
• c-Si	crystalline silicon	• PURPA	Public Utility Regulatory Policies Act
• CSP	concentrating solar power	• PV	photovoltaic
• CVD	countervailing duty	• RE	renewable energy
• DC	direct current	• Q	quarter
• DPV	distributed photovoltaic	• Q/Q	quarter-over-quarter
• EIA	U.S. Energy Information Administration	• ROW	rest of world
• EPC	engineering, procurement, and construction	• RPS	renewable portfolio standards
• ETF	exchange traded fund	• S&P	Standard and Poor's
• FERC	Federal Energy Regulatory Commission	• SEIA	Solar Energy Industries Association
• FIT	feed-in-tariff	• SREC	solar renewable energy certificate
• FMV	fair market value	• TAN	Invesco Solar ETF
• GW	gigawatt	• TPO	third-party owner
• GWh	gigawatt-hour	• UAE	United Arab Emirates
• IBC	interdigitated back contact	• UPV	utility-scale PV
• ITC	investment tax credit	• USTR	United States Trade Representative
• kg	kilogram	• W	watt
• kW	kilowatt	• y/y	year-over-year
• kWh	kilowatt-hour	• YTD	year to date
• MLPE	module-level power electronics		
• MW	megawatt		
• MWh	megawatt-hour		