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Q2/Q3 2017
Solar Industry Update

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October 24, 2017

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NREL/PR-6A20-70406

Executive Summary

- The United States installed 4.5 GW_{DC} of PV in H1 2017—cumulative capacity reached 45.4 GW.
  - Analysts estimate the United States will install between 8.5GW and 12.5 GW in 2017.
- On September 22, the U.S. International Trade Commission (USITC) found that the domestic U.S. module and cell manufacturing industry had been seriously harmed by imports. The commissioners released proposed remedies in late October less severe than what the petitioners requested, and will officially file its proposal on November 13th, but it is up to the president to determine whether to put tariffs in place.
  - Analysts estimate a significant tariff could reduce U.S. PV demand by 36%–43% between 2018 and 2021.
- Utah and New Hampshire are the latest of approximately nine states to adopt successor programs to net metering, lowering the value of exported solar energy to the grid.
- Recent estimates for 2017 global PV demand ranged from 81 GW to 103 GW.
  - China (~42 GW), the United States (~11 GW), and India (~9 GW) are projected to be the largest markets in 2017.
- Most data suggest that U.S. PV system pricing, across market segments, continues its downward trajectory.
  - U.S. PV system pricing remains higher than in much of the world, including other developed regions.
- As of Q3 2017, the global ASP* for PV modules was approximately $0.32/W— U.S. pricing was approximately $0.10/W higher due to existing U.S. tariffs and stockpiling by companies in case of new tariffs from the Section 201 trade case.

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

Agenda

- State and Federal Updates
- Global PV Deployment
- U.S. PV Deployment
- PV System Pricing
- Global Manufacturing
- Component Pricing
- Market Activity

History of Current U.S. Solar Tariffs

- After a 2011 complaint by SolarWorld and six other companies, the USITC and the U.S. Department of Commerce investigated and then placed tariffs on Chinese panels with Chinese-made cells.
- This led to Chinese companies sending wafers to Taiwan and then shipping Taiwanese cells back to China. SolarWorld made a second complaint, which led to wider tariffs on Chinese panels/Taiwanese cells.
- China also placed tariffs on U.S. polysilicon (average 55%), which was widely viewed as a retaliatory measure.
- The United States currently has two kinds of tariffs on Chinese and Taiwanese panels:
  - Anti-Dumping Tariffs: a punitive tariff placed on countries that sell below cost to gain market share
  - Countervailing Duties: a punitive tariff placed on countries that receive "unfair" government subsidies
- The two tariffs differ for individual companies based on the extent to which the USITC believes they were involved in the practice.

Current Tariffs (2017):

Year Enacted:	Type:	Product:	Average Tarriff:
2012	AD/CVD	Chinse cells and modules made with Chinese cells	~25%
2014	AD/CVD	Taiwan cells and Chinese modules made with Taiwan cells	~65%
2018	?	All imported solar cells and modules	?

Timeline

2011 — **Oct 2011**: first SolarWorld complaint

2012 — **Dec 2012**: tariffs placed on Chinese panels with Chinese cells

2013 — **Dec 2013**: second SolarWorld complaint

2014 — **Jan 2014**: China places tariffs on polysilicon from the US and South Korea

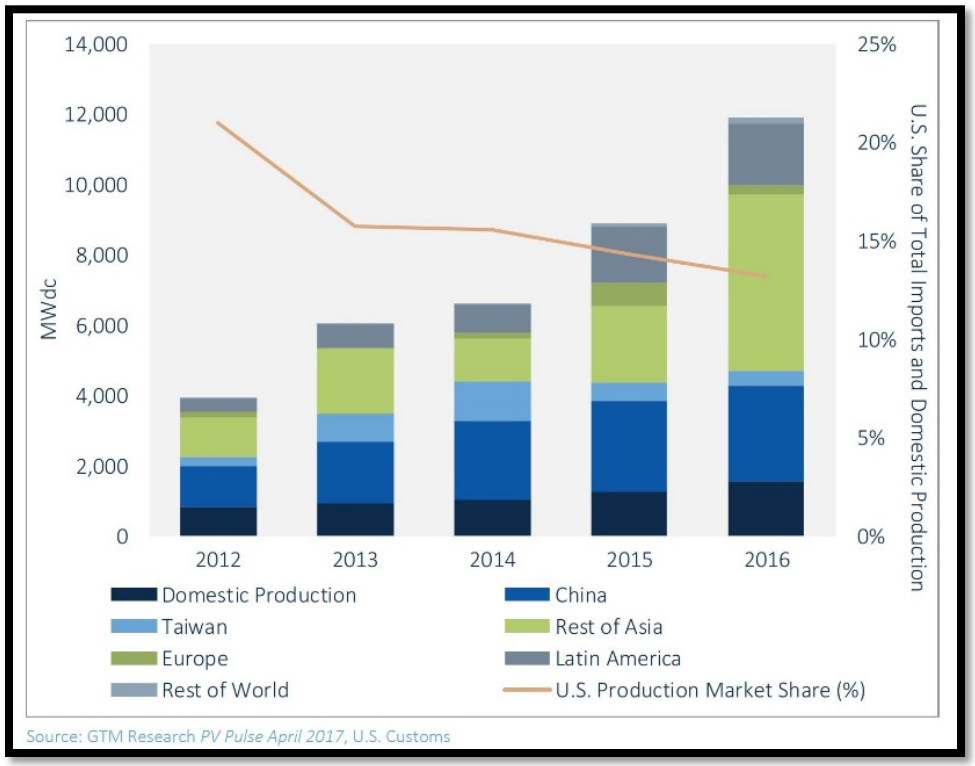
Dec 14: final decision placing tariffs on Taiwanese cells and Chinese panels with Taiwanese cells

Sources: Cardwell, Diane. "U.S. Imposes Steep Tariffs on Chinese Solar Panels." The New York Times. 2014; Editorial Board "U.S. Tariffs on Chinese Solar Panels Boomerang." The Washington Post. 2013.

Section 201 Solar Trade Case

- One of the most important developments in the U.S. solar industry is the possibility that significant new tariffs will be placed on imported solar cells and panels early next year.

Global PV Production and U.S. Market Share



- U.S. solar manufacturing shipments have steadily increased but at a much slower rate than demand has risen.
- This gap is filled by imports, most of which are from Asia. Asia's production has been increasing dramatically since 2007.
- Due in part to a fall in global prices, American solar manufacturers have struggled to become profitable, and a number of plants have closed.

Section 201 Trade Case

- Section 201 of the Trade Act of 1974 allows the United States, based on international trade law, to put temporary "safeguard" measures in place to protect domestic industry from foreign competition.
- Suniva requested the investigation after filing for bankruptcy in April 2017. SolarWorld joined the case in May.
- On September 22, 2017, the USITC found that the domestic U.S. module and cell manufacturing industry had been seriously harmed by imports. The commissioners released proposed remedies in late October less severe than what the petitioners requested, and will officially file its proposal on November 13th, but it is up to the president to determine whether to put tariffs in place.
- Safeguards can be initially imposed for four years, and they can then be renewed for another four years, up to a maximum of eight years.
- Remedies would apply to all imports but might exclude countries with whom the United States has special trade deals (e.g., Canada and Korea).
  - However, the USITC did find injury for imports from Mexico and Korea, though not for Canada or Singapore.

Differences between Trade Cases

Section 201

- Applied to all countries
- No "wrongdoing" by other countries required
- Higher standard for harm
- Highly political

AD/CVD

- Applied to one country
- Requires dumping or subsidies
- Lower standard for harm
- Bureaucratic process

The Process

Sources: USITC. "Understanding Safeguard Investigations."; SEIA. "Solar Section 201 Case – Frequently Asked Questions"; Ryan, David. "The Effects of Section 201 Safeguards on U.S. Industries." Georgetown Journal of International Law". 2012.

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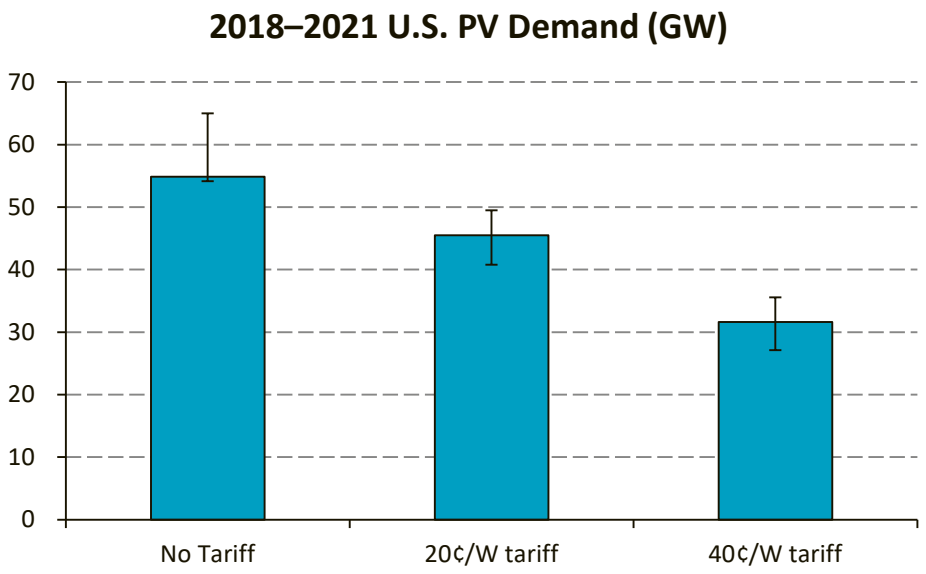
Projected Impact of tariffs

- Suniva originally requested a 40¢/W tariff on PV solar cells and a 78¢/W floor price on PV solar modules, which is the basis for the analysis below.
- They recently revised their request to a 25¢/W tariff for PV solar cells, a 32¢/W tariff on PV modules, and a floor price of 74¢/W on PV modules

Impact on Installed Capacity



Impact on Jobs

SEIA

"An estimated 88,000 jobs, about one-third of the current American solar workforce, would be lost…"

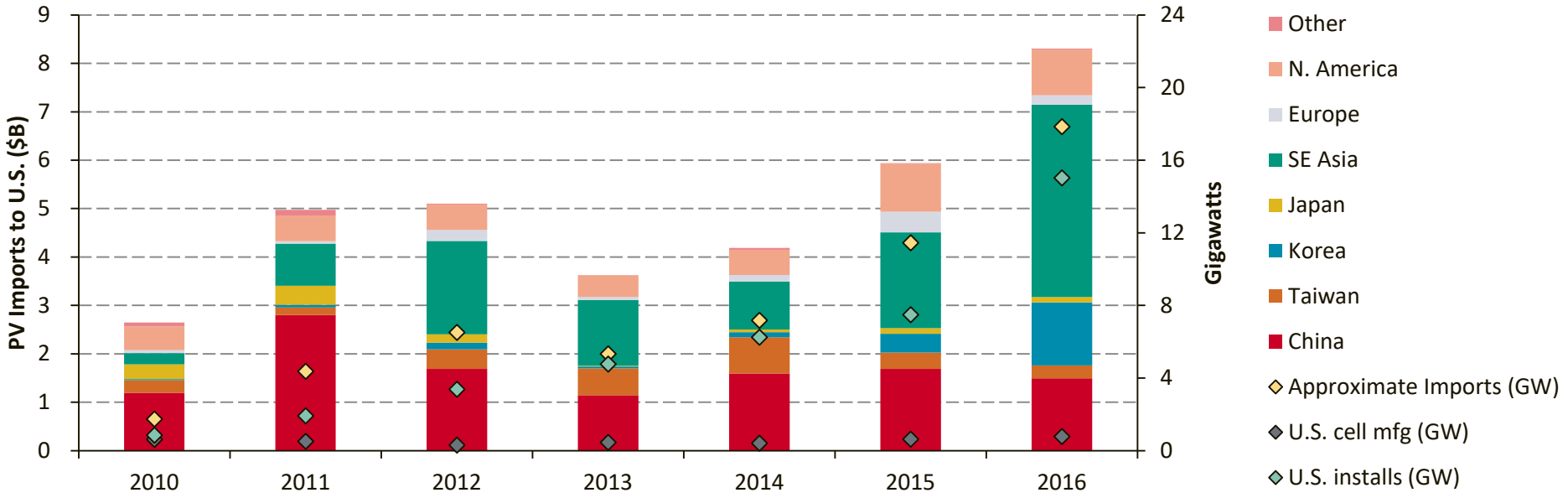
Mayer Brown (Suniva's lawyers)

"An affirmative finding… would result in a net gain in employment of at least between 114,796 and 144,298"

Note: Mayer Brown's jobs estimate is relative to today not to a future without new tariffs. Mayer Brown's estimates are based on a GTM research study, but they are also highly critical of that study's results.

Sources: GTM Research. "U.S. Solar Outlook Under Section 201" 2017; SEIA. "Suniva Trade Case Fact Sheet." 2017; Mayer Brown, "Impact of the Section 201 Remedy." 2017; BusinessWire. "Suniva Calls on GTM to Retract Inaccurate Report. 2017.

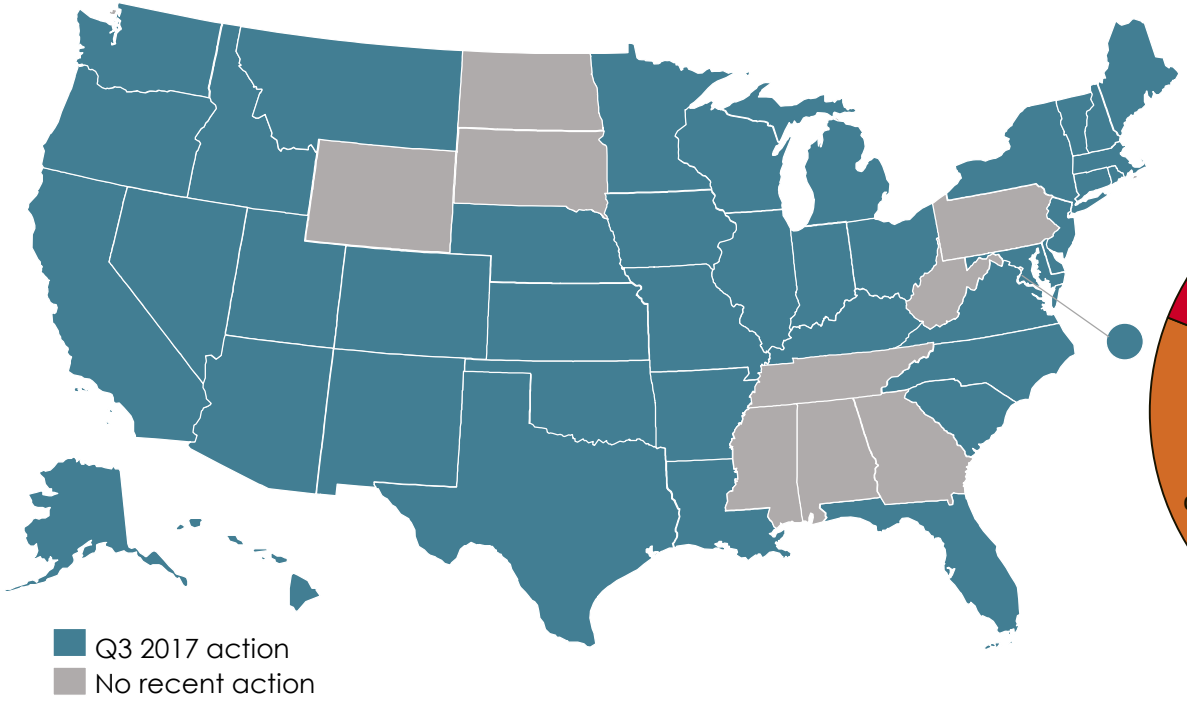
PV Module and Cell Imports to U.S. by Country

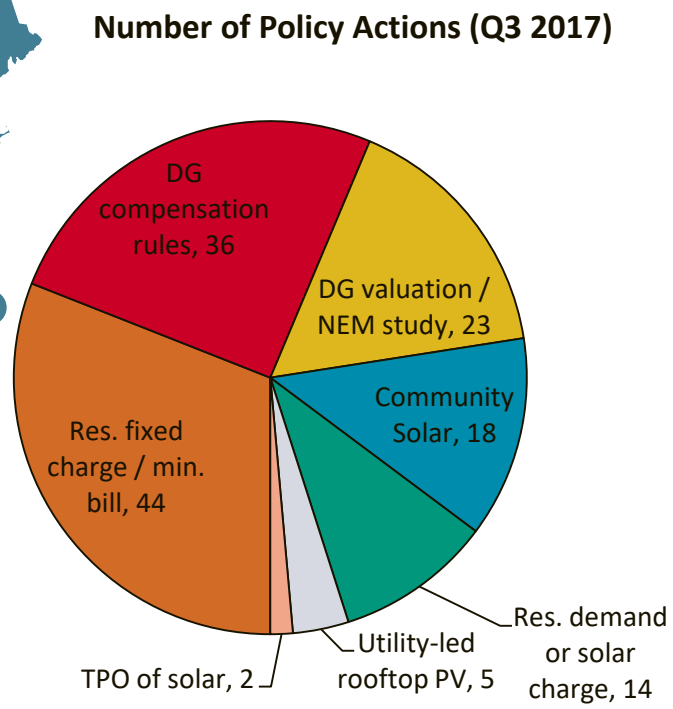


- Growing U.S. solar demand has been largely met by module and cell imports, mostly from Asia.
- The value of U.S. imports of PV modules and cells grew by three times from 2010 to 2016, while the approximate imports (GW) grew by nine times.
  - Imports grew faster in terms of GWs than dollars because of the reduction in price.
- Since 2012, Chinese imports have remained relatively flat by dollar value, though China has shipped more panels.
- In 2016, approximately 48% of module and cell value entering the United States came from South East Asia (62% of which came from Malaysia).
- Given the surplus of PV shipments into the United States the past seven years relative to installation levels, the United States likely has significant cell and module inventory should a tariff be put in place on foreign PV equipment in the future.

Note: GW of imports calculated by dividing the dollar value of imports by global module and cell ASP, plus 10% (to account for measures taken by companies to circumvent existing U.S. tariffs).
Sources: Imports, by value: U.S. International Trade Commission. Average module and cell price: IHS Markit, Technology Group, PV Integrated Market Tracker, October, 2017.

State Actions on Distributed Solar





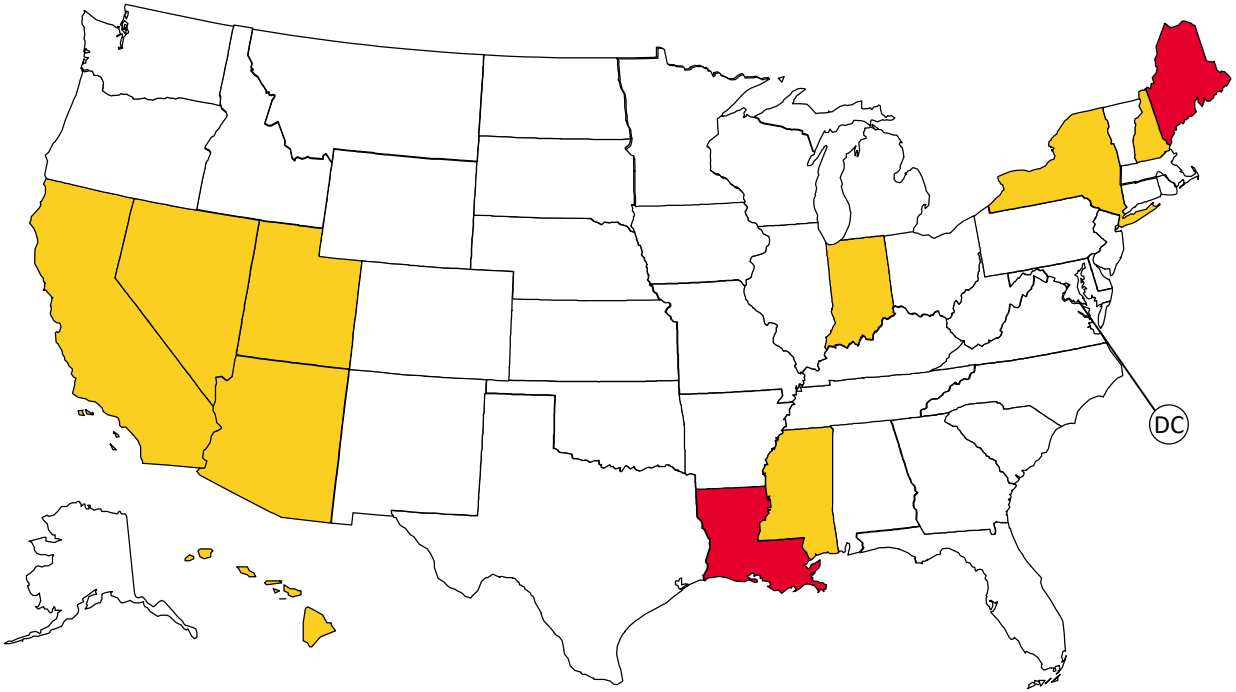
Forty-one states and Washington, D.C. took 142 separate actions on distributed solar policy and rate design during Q3 2017.

Sources: North Carolina Clean Energy Technology Center, *The 50 States of Solar: Q3 2017 Quarterly Report*, October 2017.

Since 2015, several states have lowered the credited value of exported electricity from DG PV.

Solar credited between wholesale and retail rate

Solar credited at wholesale rates or below



- Utah and New Hampshire are the latest states to adopt successor programs to net metering, lowering the value of exported solar energy to the grid.
- Michigan recently opted to continue net metering at the current compensation scheme until a successor can be approved.
- Seventeen states took action in Q3 2017 related to the development of a net metering successor tariff or adjusting credit rates for excess generation.

Sources: North Carolina Clean Energy Technology Center, *The 50 States of Solar: Q3 2017 Quarterly Report*, October 2017; PV Magazine (02/02/17, 06/19/17; 06/26/17); Utility Dive, 06/26/17.

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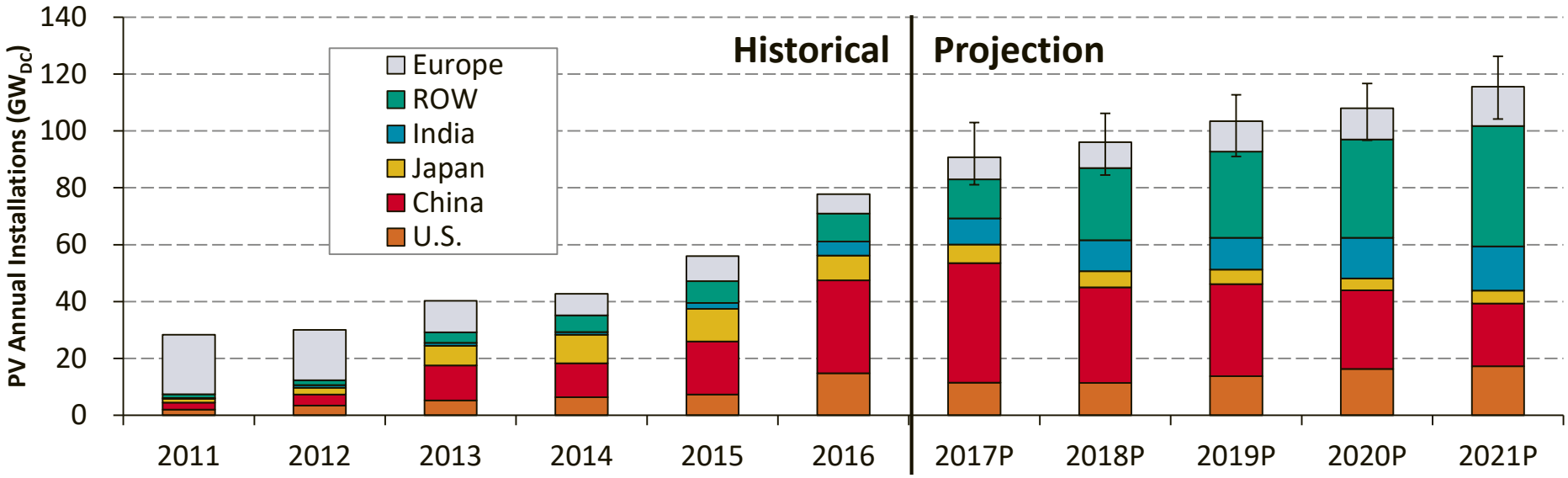
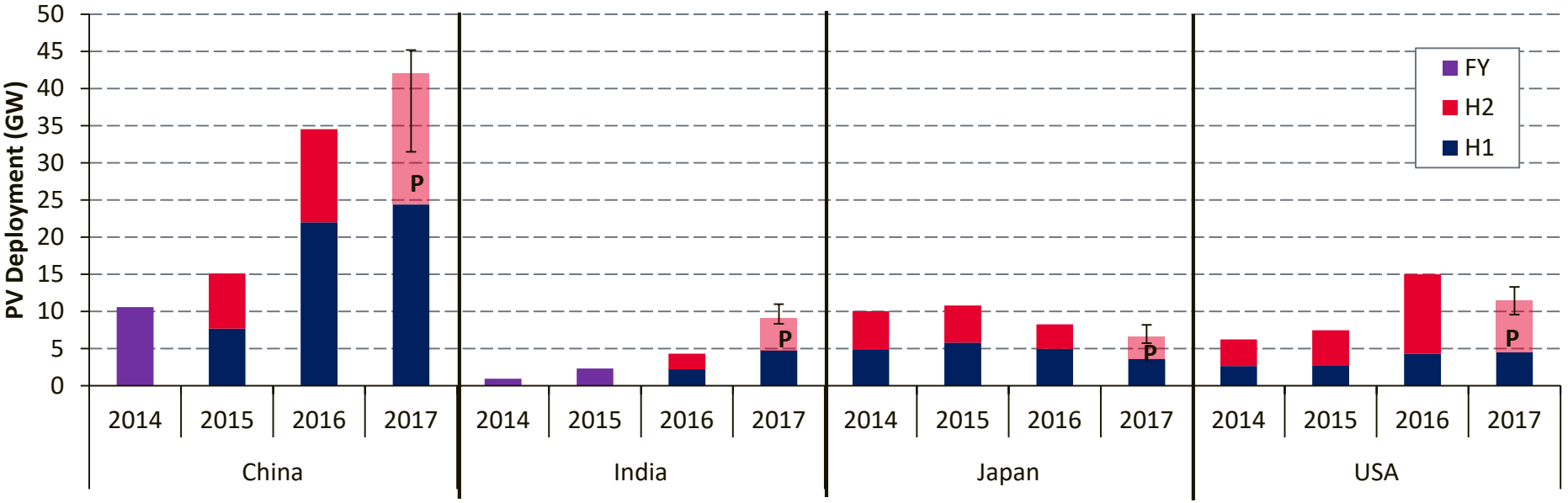
Annual Global PV Demand



- Analysts expect the rapid growth of the PV industry to continue in the near term.
- Recent estimates from analysts reported that global PV demand in 2017 will range from 81 GW to 103 GW, with a median of approximately 90 GW—a 17% increase from 2016 global installations. This installation level would bring the cumulative total to ~400 GW.
  - China (~42 GW), the United States (~11 GW), and India (~9 GW) are projected to be the largest markets in 2017.
- Annual global installations are projected to grow to by 104 GW–127 GW by 2021.
  - Median analyst figures estimate that 514 GW of PV will be installed globally from 2017 to 2021, with China, the United States, and India representing a large part of demand.
  - The majority of the growth is expected to come from emerging markets (ROW).

Note: P = projection. Bar represents median projection. Error bars represent high and low projections.
Sources: Data displayed represent the median figures from the following sources: BNEF (08/18/17); Cowen & Co. (09/14/17); Deutsche Bank (10/03/17); GTM Research (July 2017); IHS Markit, Technology Group, PV Demand Market Tracker, September, 2017.

Key Markets Update



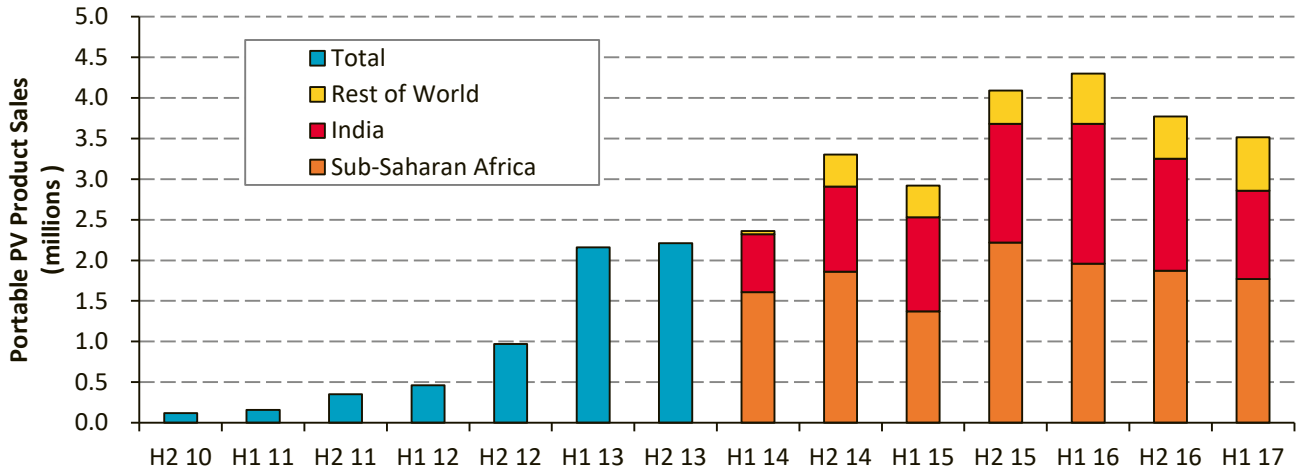
- The leading global PV markets, in most cases, had record levels of PV demand in H1 2017; analysts expect a very large second half of the year as well.
- China, with 25 GW, was by far the world's largest market in H1 2017.
  - Similar to H1 2016, Chinese companies rushed to qualify for higher FIT.
  - The United States (4.5 GW) and India (4.7 GW) had their largest first six months ever, while Japan contracted for the second straight year.
  - In H1 2017, the United States surpassed Germany to become the third-largest PV market, and it also surpassed Germany and Japan to become the second largest solar market (when CSP is included).
- The United States is expected to have a larger proportion of installs in H2 2017 than other leading countries; however, China's H2 2017 installs are expected to dwarf all other countries' total year deployment.

Note: P = projection for second half of 2017

Sources. Projections: See Slide 4. Historical: GTM/SEIA, "U.S. Solar Market Insight, Q3 2016"; IHS Markit, Technology Group, PV Demand Market Tracker, September, 2017; Mercom (01/02/17, 08/07/17); SolarServer (08/09/17).

Global Off-Grid Solar Market

- Approximately 1.2 billion people have no access to an electrical grid and spend $27 billion per year on lighting and mobile phone charging with kerosene, candles, flashlights, or other sources.
- Solar power technology has the potential to provide these services at a lower cost with fewer environmental impacts.
- 8.1 million portable solar products were sold in 2016 for $253 million.
  - 2016 sales represent a 16X increase from 2011.
  - 30.7 million products have been cumulatively sold since July 2010, providing over 100 million people with improved energy access and $5.2 billion in energy savings over the lives of the products.
  - 50% of sales in H1 2017 were in sub-Saharan Africa and 31% were in India.
- Off-grid solar product revenue is currently ~0.2% of the on-grid solar market; however, it has a much higher dollar-per-person impacted ratio.
- The downturn in demand for off-grid solar in H2 2016 and H1 2017 was attributed to demonetization that occurred in India in November 2016 (causing cash constraints) and drought in East Africa (increasing the cost of living and decreasing purchasing power), as well as to market growing pains.



Source: Global Off-Grid Lighting Association. "Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data: January – June 2017."

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Global Off-Grid Solar Market (cont.)

- Off-grid solar products offer varying degrees of service, from a single light to a solar home system.
  - In H1 2017, products with a capacity of less than 3 W represented 81% of reported sales.

Product Size (Watts)	Use	% of H1 2017 Market Revenue*
0–1.5	Single light only	13%
1.5–3	Single light and mobile charging	68%
3–10	Multiple lights and mobile charging	12%
11–20	Solar home system (SHS), entry level (3–4 lights, mobile charging, powering radio, fan, etc.)	4%
21–49	SHS, basic capacity (above plus power for TV and extended capacity)	
50–100	SHS, medium capacity (above but with extended capacities)	
100+	SHS, higher capacity (above but with extended capacities)	

Source: Global Off-Grid Lighting Association. "Global Off-Grid Solar Market Report Semi-Annual Sales and Impact Data: January – June 2017."

*Figures do not add to 100% in report.

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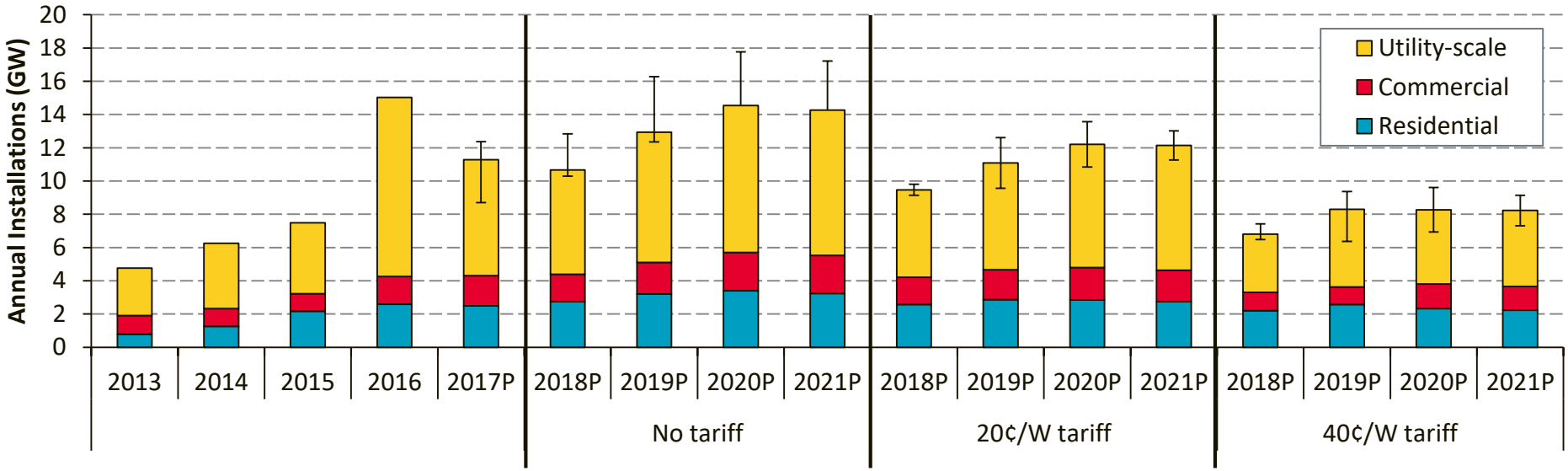
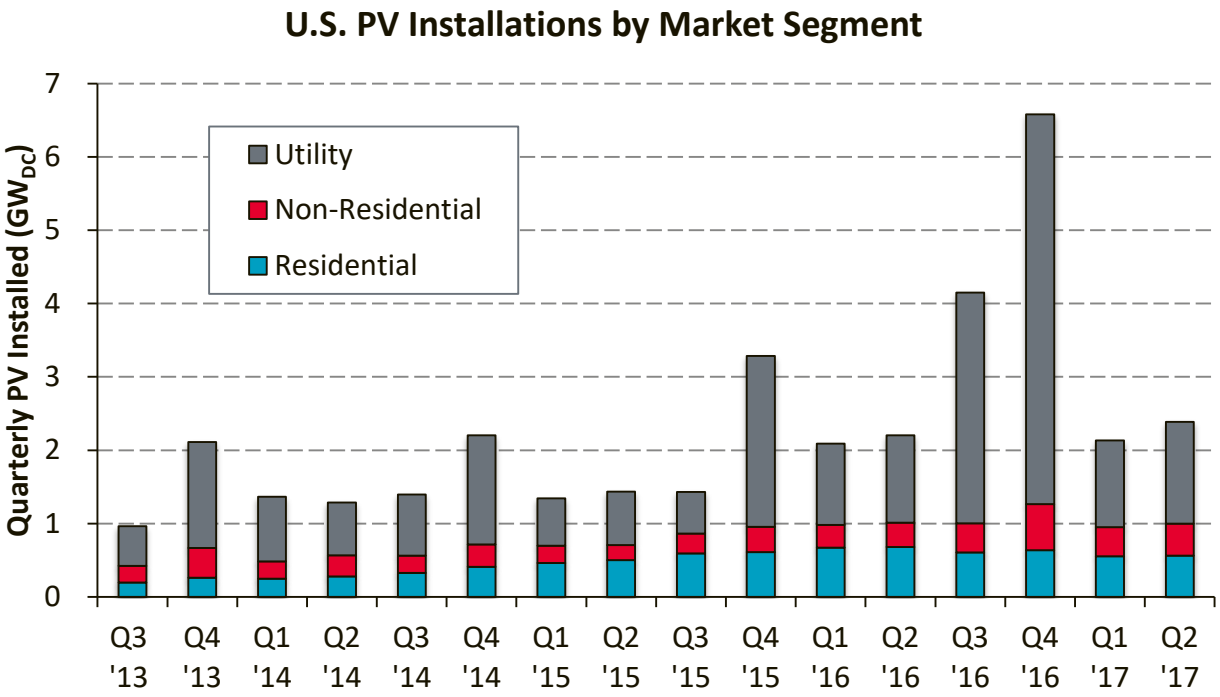
U.S. PV Demand

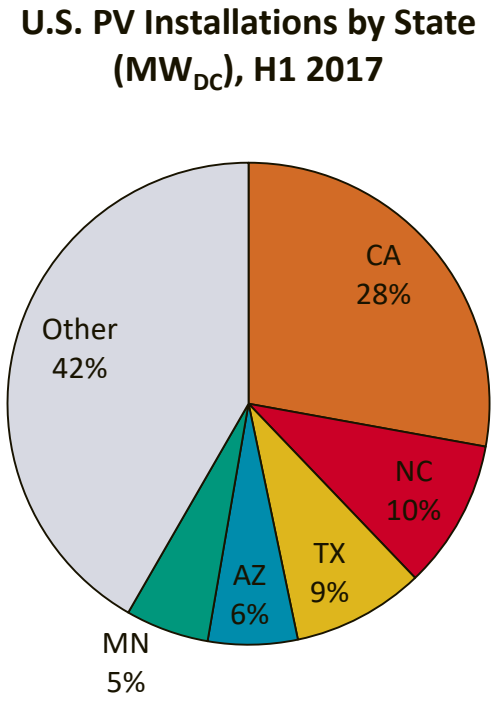


- Analysts project that U.S. PV installation levels from 2018 to 2021 will largely depend on whether there is a U.S. tariff and, if so, the size of the tariff. Estimates of total four-year deployment range from 27 GW to 64 GW.
  - Under a 20¢/W tariff , the median analyst projection indicates a ~15% reduction in demand from 2018 to 2021, with distributed and utility-scale deployment being affected roughly the same.
  - Under a 40¢/W tariff, the median analyst projection indicates a 36%–43% reduction in demand from 2018 to 2021, with utility-scale being most affected (40%–49%), followed by commercial scale installations (36%–44%).
  - In addition to a tariff, analysts believe that U.S. PV demand would also be affected by a cap on imports or minimum module-sales price.
- New PV activity in the United States is already being affected, as projects without a guaranteed module supply are being put on hold until there is a resolution in the trade case—many module suppliers are sold-out through 2018.

Note: P = projection. Bar represents median projection. Error bars represent high and low projections
Sources: 2013–2016 data from GTM Research(October 2017); 2017-2021 data displayed represents the median figures from the following sources: BNEF (10/18/17); GTM Research (October 2017); IHS Markit, Technology Group, PV Integrated Market Tracker, October, 2017.

U.S. Installation Breakdown





- The United States installed 4.5 GW_{DC} of PV in H1 2017 (up 5% y/y) —cumulative capacity reached 45.4 GW.
  - Q2 2017 represents the 15th-straight 1 GW+ quarter and 7th-straight 2 GW+ quarter.
  - The 17% reduction in residential PV installs in H1 2017 was compensated for by the 30% and 12% increase in non-residential and utility-scale PV installations, respectively.
- In H1 2017, the top five states represented 58% of the market (63% in 2016)—24 states installed more than 25 MW, 10 states had more than 1 GW of cumulative PV capacity.

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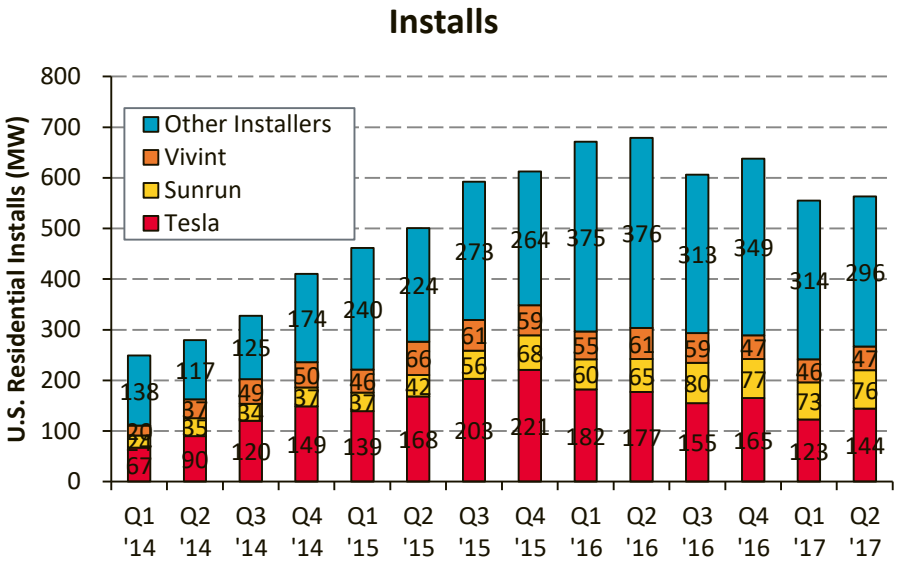
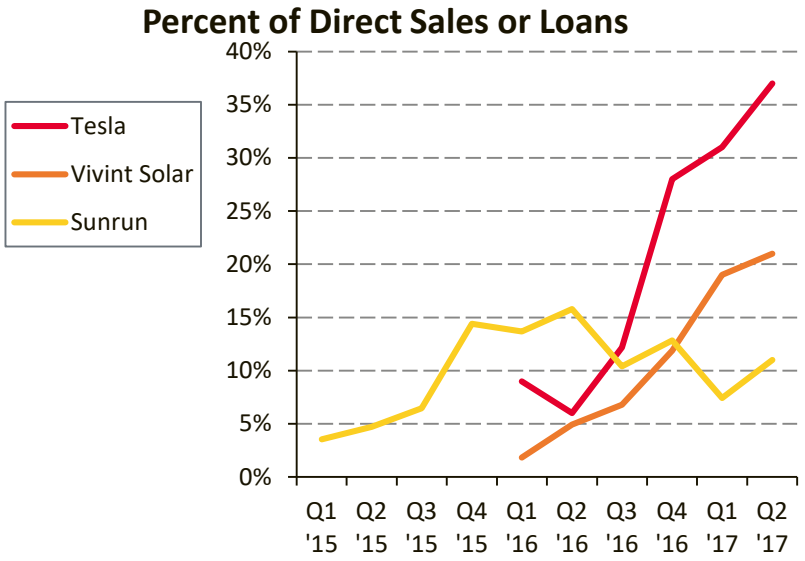
Source: GTM Research/SEIA : U.S. Solar Market Insight Q3 2017.

Tesla, Vivint Solar, and Sunrun Residential Market Share





- Leading residential PV integrators are losing market share and diversifying sales.
- In 2014 and 2015 the leading three residential integrators more than tripled their quarterly installations.
- Since then, these companies' installations have stagnated or shrunken.
  - Large integrators are pursuing profitability over growth. Tesla has stopped door-to-door sales.
- Starting in 2015 and 2016, Tesla, Vivint Solar, and Sunrun are deploying a significantly higher proportion of direct sales or loans versus their traditional PPA and lease offerings .
- Tesla and Sunrun are also expanding product offerings through PV+storage.
  - Tesla has installed 255 MWh of storage in the past three quarters.
- In 2017, the U.S. residential market has contracted due to customer acquisition challenges, large integrators' pursuit of profitability, and challenges in leading markets, such as California.
  - H1 '17, U.S. residential PV installs are down overall y/y; however, they are still much larger than they were in all years preceding 2016.

Source: Corporate filing, GTM/SEIA Solar Market Insight Q3 2017.

Note: Tesla Q4 2016 through Q2 2017 residential deployment are assumed to have the same percentage of total deployment that occurred in Q3 2016.

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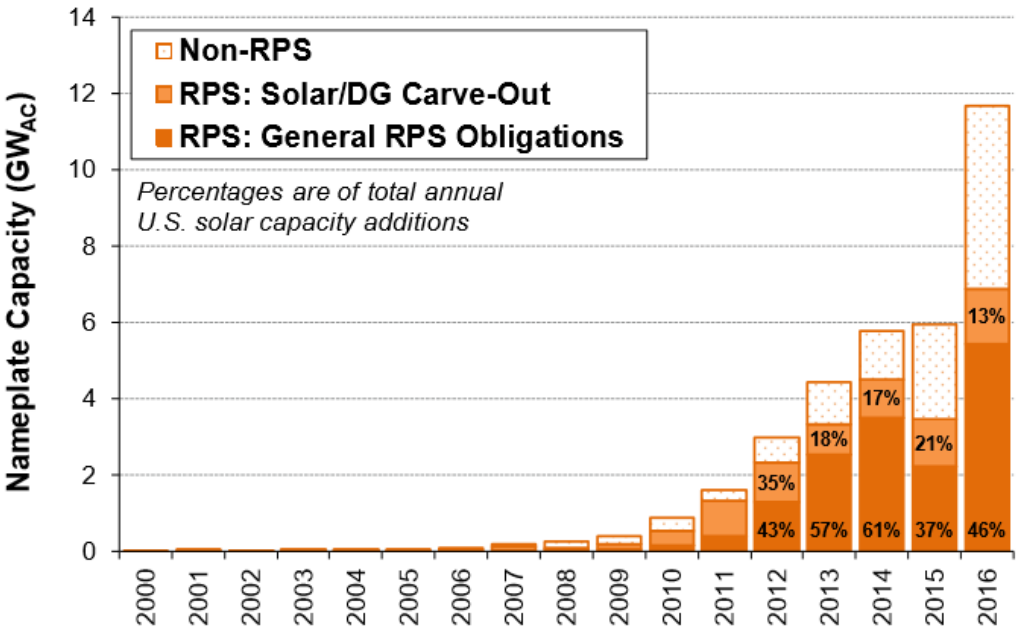
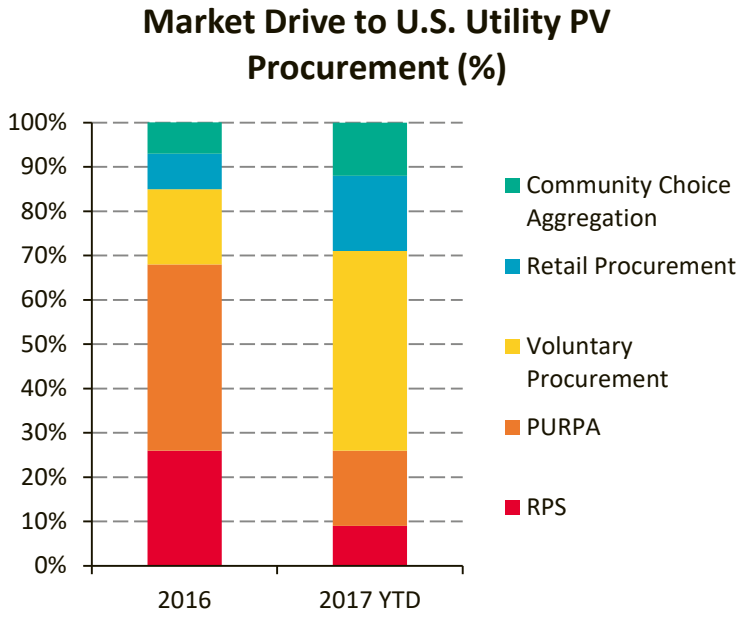
RPS No Longer Driving Solar Demand





- Historically, RPS requirements have driven the majority of U.S. solar deployment; however, as of June 2017, 64% of projects in development were driven by non-RPS mechanisms.
- Due to significant reductions in cost, utility-scale U.S. PV deployment is being driven by other factors.
- In 2016, PURPA* was the largest driver of utility PV procurement; however, recent reforms in key markets may minimize the impact of PURPA in the future.
- SEIA and GTM Research expect voluntary procurement to be the largest driver of utility procurement in the near future, with utilities outlining 11 GW of additional PV planned non-RPS procurement.

*PURPA is a U.S. federal law passed in the 1970s which requires electric utilities to purchase electricity from "qualified facilities", such as solar PV, at the "avoided cost" of energy. It's up to states to implement PURPA and each state has different standards as to the value of avoided cost, the length of procurement, and the maximum system size.

Sources: G. Barbose. "U.S. Renewables Portfolio Standards 2017 Annual Status Report." LBNL. GTM Research and SEIA. "U.S. Solar Market Insight: Q2 2017."

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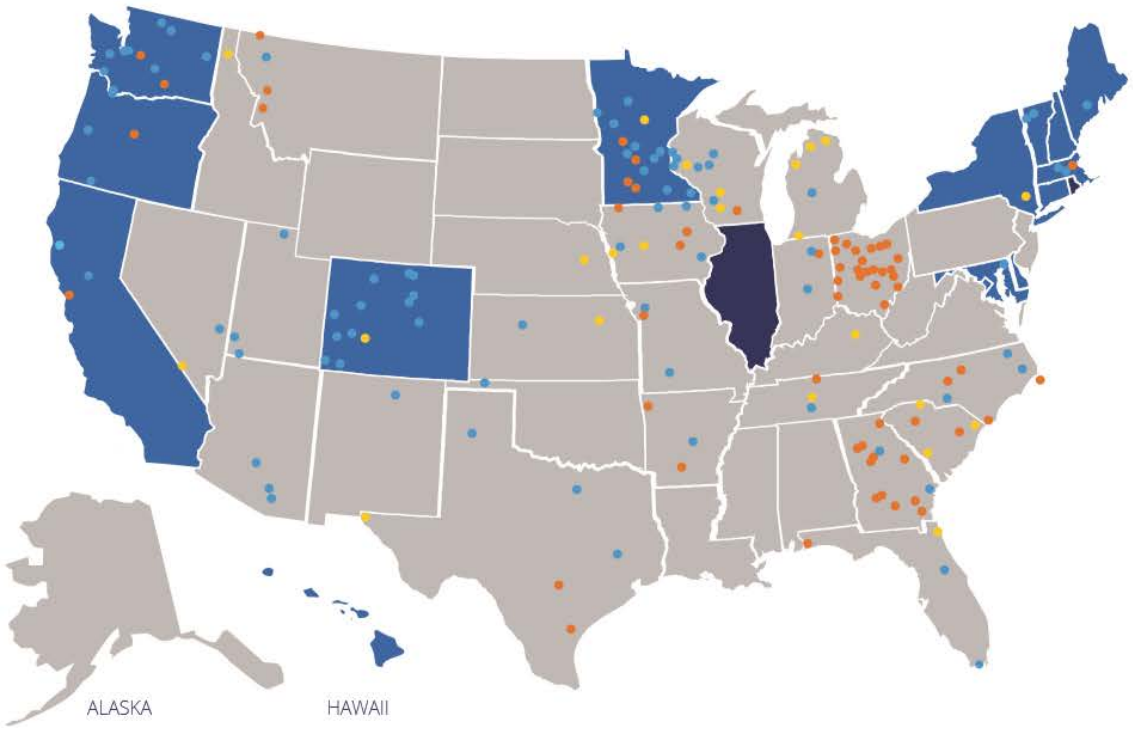
Community Solar Programs in the U.S.

- **171 utilities** have active programs
- **311 MW** are online
- **Over 300 MW** in the pipeline
- **16 states and the District of Columbia** have enacted community solar policies

Source: Smart Electric Power Alliance, 2017. Numbers updated as of June 15, 2017.



- Community solar programs are active across the United States and are one of the fastest growing PV market segments.
- SEIA and GTM Research report that the non-residential market will be the only segment to grow in 2017 in part due to the strength of community solar and other offsite PV deployment strategies.

MW = megawatts AC
Source: SEPA, "2017 Utility Solar Market Snapshot."

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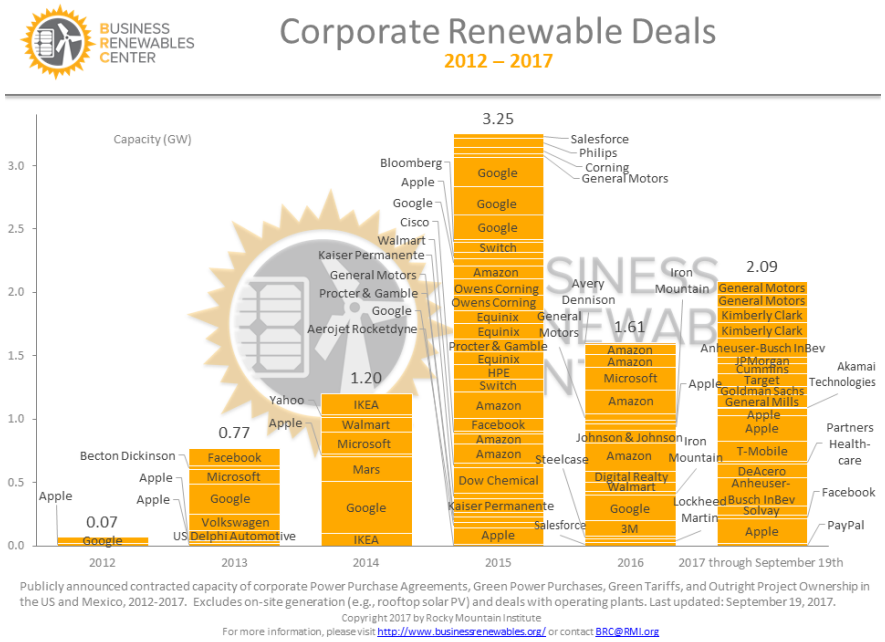
Offsite Corporate Procurement of PV

- Offsite corporate procurement is an innovative business solution that has become a driver of large-scale PV deployment.
- The Rocky Mountain Institute (2017) found that all corporate renewable deals rose from 50 MW in 2012 to 1.48 GW in 2016. This trend appears to be continuing with over 2 GW of deals completed in the first nine months of 2017.
- There are several advantages of offsite corporate procurement:
  - Many corporations (e.g., data centers) use a lot of energy, have limited onsite resources, and have aggressive sustainability goals.
  - With the reduction in cost, investment in PV assets can offer an additional source of profitability.
  - Long-term energy contracts can limit their exposure to energy price volatility.



Source: Rocky Mountain Institute 2017

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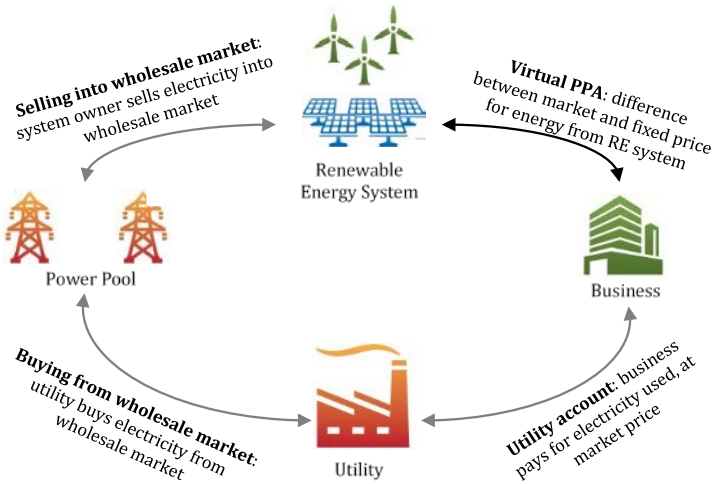
Offsite Corporate Procurement Contracts

There are several methods for contracting offsite corporate procurement, which depend on market structure and customer preference.

- **Virtual PPAs** (e.g., "fixed-for-floating swap", "contract for differences") allow PV developers and businesses to hedge against the electricity market without actually selling each other electricity.
  - Virtual PPAs rely on a wholesale market and are not contracted with the utility.
  - Typically, the closer the PV system is to the company's load, the better the hedge.

Summary of Virtual PPA transactions



- **Sleeved PPAs** (e.g., utility green tariff, back-to-back PPA) are three-way contracts between the corporation, the corporation's electric utility, and the PV system owner.
  - Two PPAs: one between the customer and the utility and one between the utility and the PV system owner.
- While they can be complicated, time-consuming and costly to set up, there are many benefits of sleeved PPAs
  - Corporations lock-in a price hedge without any wholesale market risk.
  - Developers often have an easier time financing the PV project due to a stronger credit profile.
  - Electricity service providers lock in electricity load.

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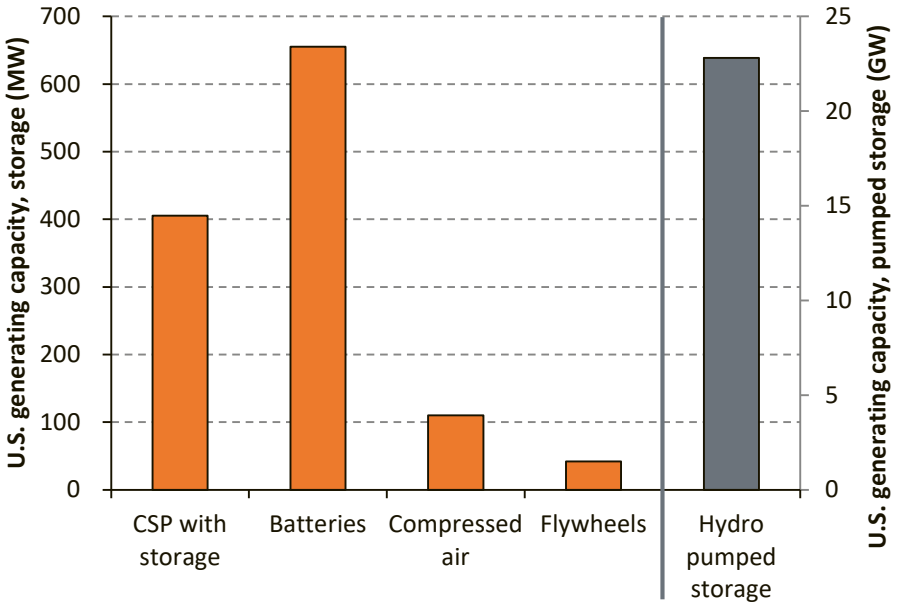
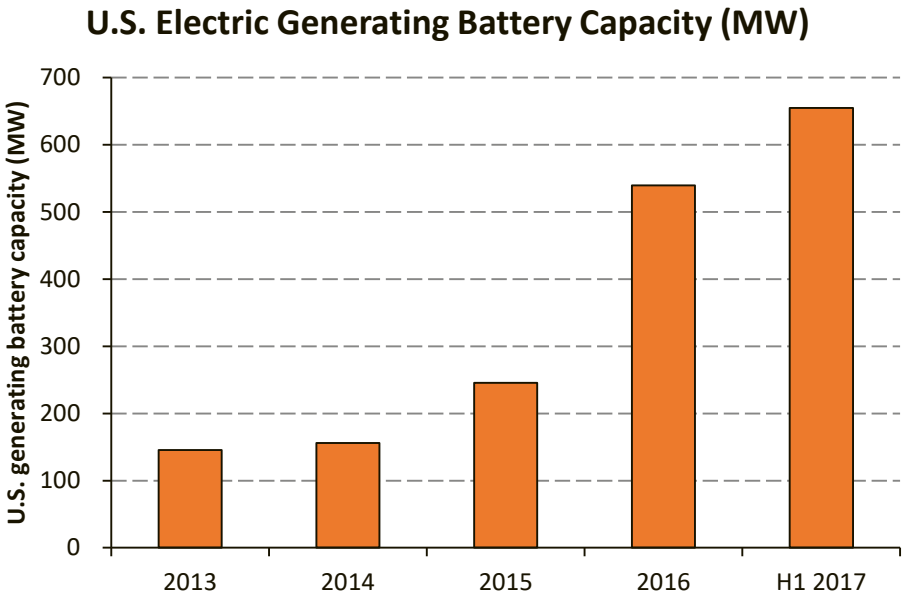
Source: Schwabe et al. "Wind Energy Finance in the United States: Current Practice and Opportunities." NREL. August 2017.

Batteries are a small but growing tool to help utilities and customers manage variable generation.

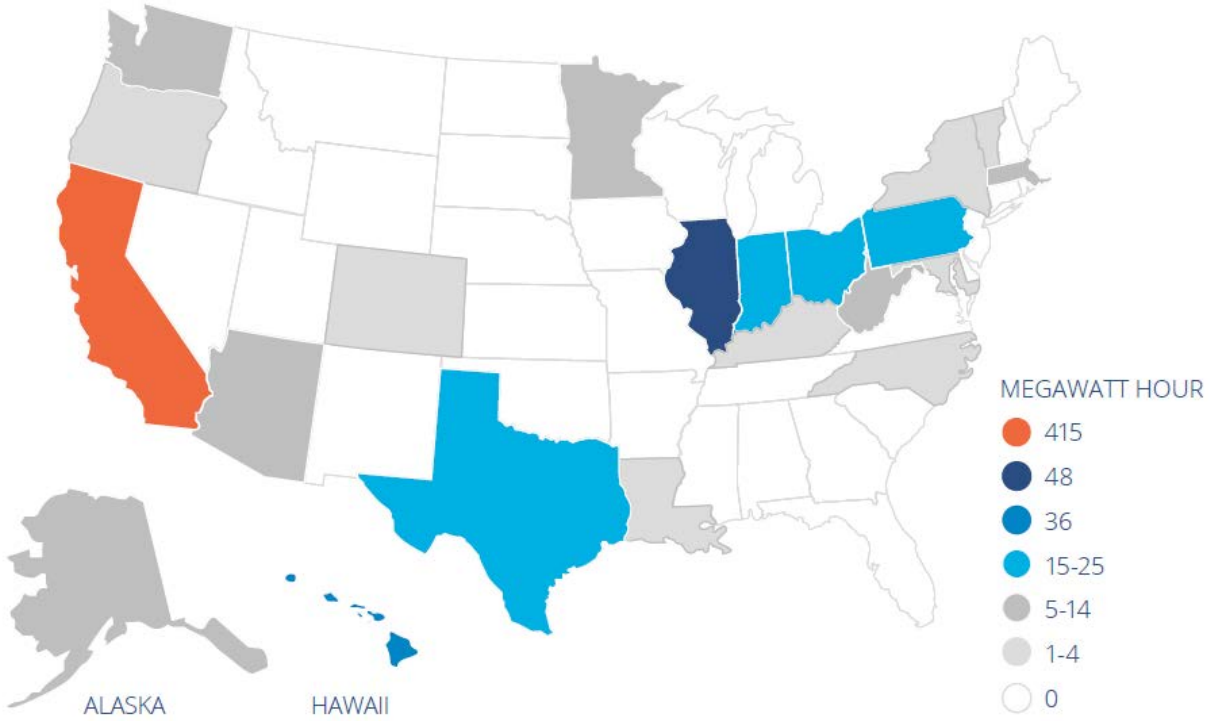


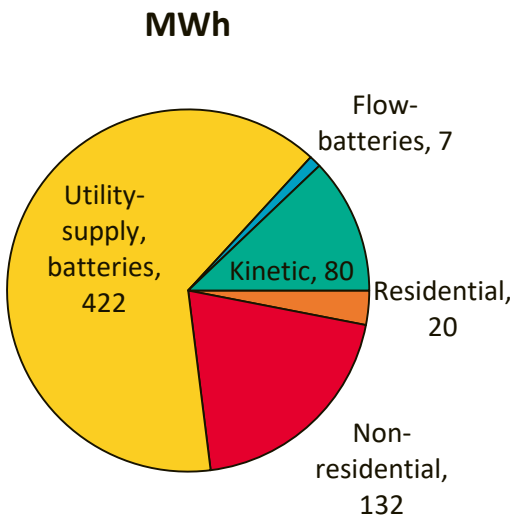


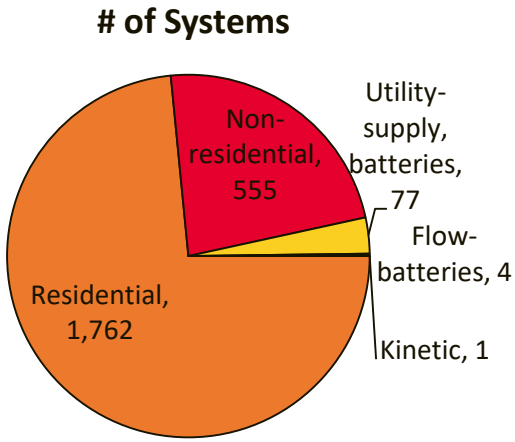
- Pumped-hydro continues to be the largest source of energy storage in the United States by an order of magnitude; however, a significant amount of batteries have been added to the grid over the past few years due to the rise in renewable capacity and the reduction in battery costs.
- Tesla and Sunrun are also expanding product offerings through PV + storage.
  - Tesla has installed 255 MWh of storage in the past three quarters.
  - Sunrun has announced 20 MWh of orders received for energy PV + storage. “Storage and other advanced technologies add greater value than solar alone and are best addressed with monthly billing models from a dedicated service provider [Sunrun].”

Source: EIA “Electric Power Monthly,” Table 6.1. Electric Generating Summer Capacity Changes (MW).

Cumulative U.S. Energy Storage Deployment, 2016







- SEPA reports there were 661 MWh (622 MW*) of battery storage in the United States at the end of 2016, approximately one-third of which was installed that year.
- In 2016, 71 different utilities had at least one energy storage installation, 31 of which employed their first energy storage project in 2016.

*SEPA reports slightly higher U.S. battery capacity than EIA (540 MW in 2016) due to different datasets and assumptions.
Source: Smart Electric Power Alliance (SEPA), "2017 Utility Energy Storage Market Snapshot," September 2017.

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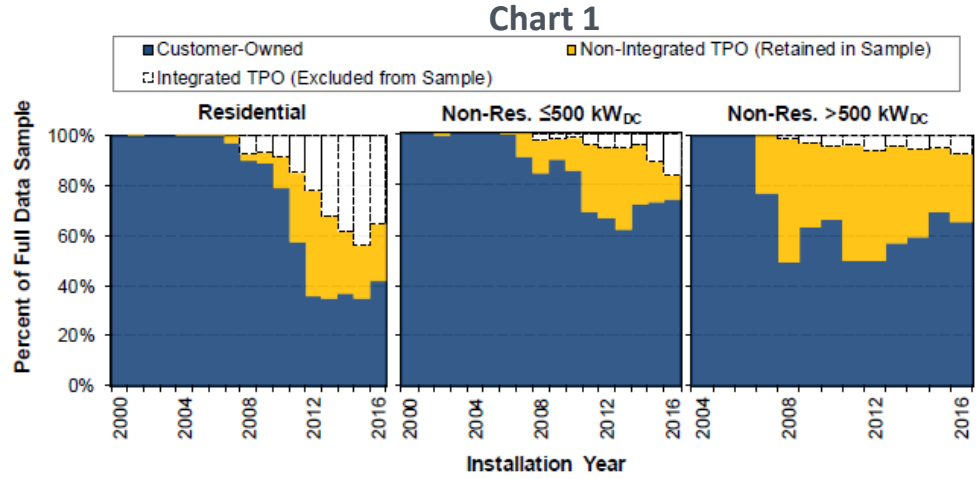
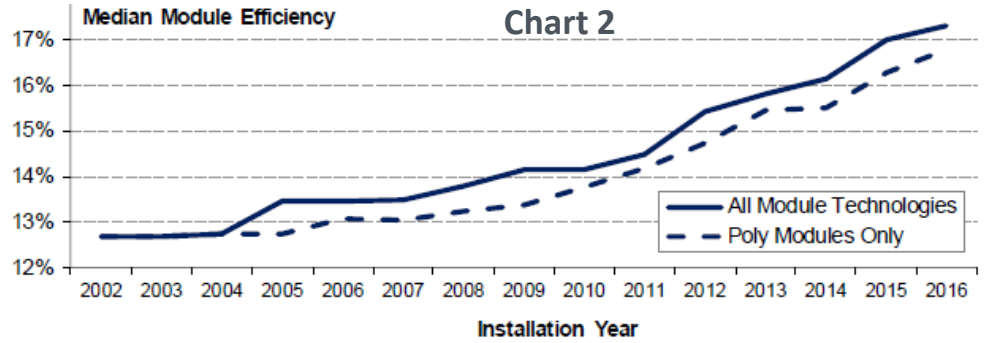
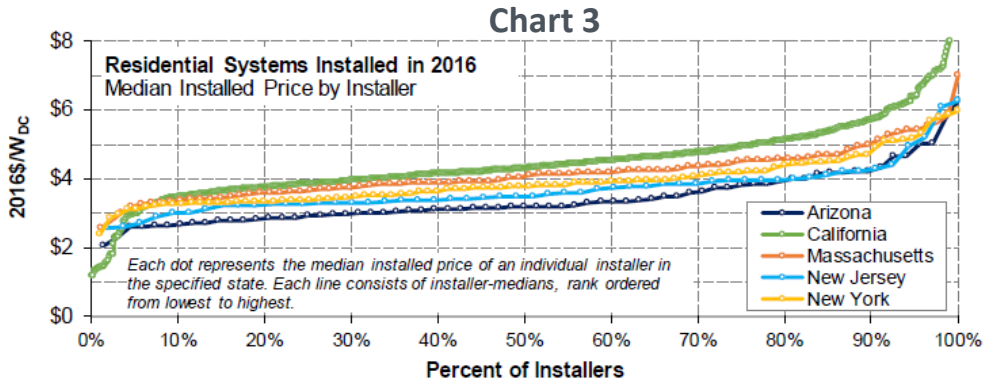
Five New Things to Know from *Tracking the Sun X*







1. TPO share of U.S. installs dropped to 58% in 2016, reflecting broader market trends back toward customer ownership (Chart 1).
2. Despite the smaller system size and premium modules, PV systems installed in new construction offer a significant price advantage.
3. The median efficiencies for modules installed in residential U.S. PV systems grew from 12.7% to 17.3% from 2002 to 2016 (Chart 2).

   Increasing module efficiencies and system sizes are together responsible for roughly a $1.0/W reduction in residential system costs over the long term (12% of the total decline in residential installed prices).
4. Within each of the five states shown in Chart 3, installer-level median prices differ by $0.7/W to $1.4/W between the 20th and 80th percentiles (and by more across the full set of installers).
5. In general, there is little price difference and no consistent directional trend based on installer volume.

Source: Barbose, G. and N. Dargouth. 2017. *Tracking the Sun X The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States*. LBNL. Sept. 2017

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Five New Things to Know from *Utility-Scale Solar 2016*

Chart 1

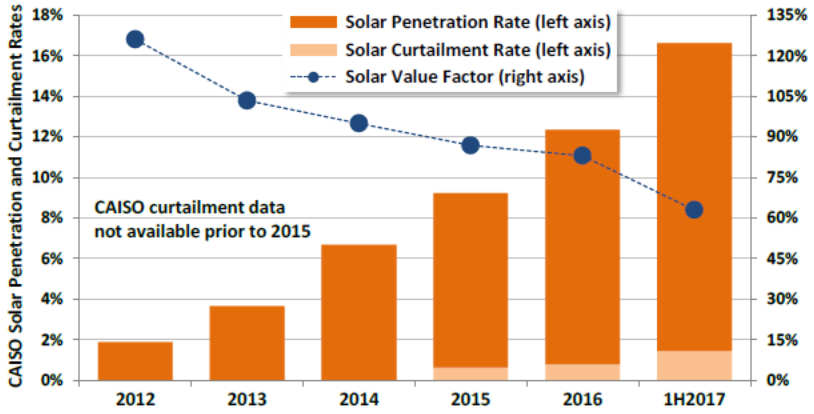


Chart 2

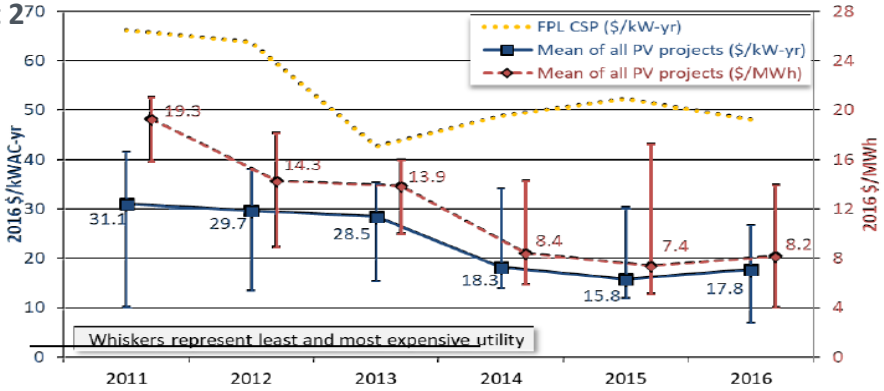
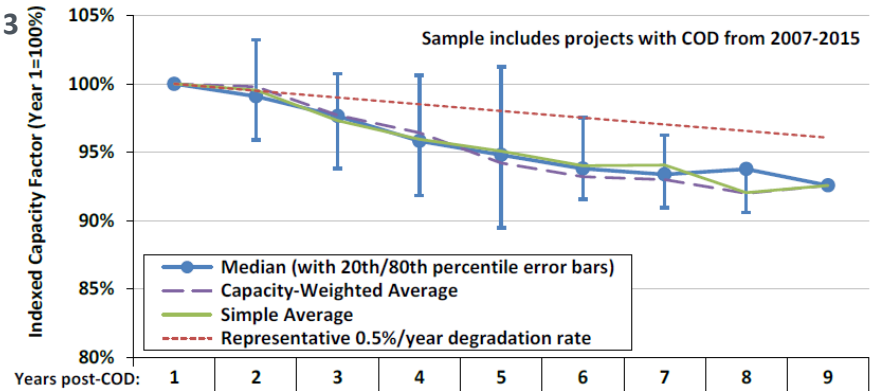


Chart 3



1. With increasing solar penetration in California, solar curtailment has increased while solar's wholesale energy value has declined (Chart 1).

   In 2012, when solar penetration was ~2%, solar earned 126% of the average wholesale power price; in 2016, with solar penetration at ~12%, solar earned just 83% of the average wholesale power price.

2. O&M costs appear to be declining, over the long-term, to $17.8/kW-year in 2016 (Chart 2).

3. Fleet-wide PV capacity degradation appears to exceed the 0.5%/year benchmark commonly assumed in PPAs and pro forma models (Chart 3).

4. Utility-scale PV projects with tracking increased in dominance (79% of newly installed capacity) relative to fixed-tilt projects (21%) in 2016, offering higher production with a price premium of only $0.15/W. With lower module prices, developers have oversized the DC array capacity relative to the AC inverter capacity (i.e., the ILR) to enhance revenue.

5. There is a strong percentage growth in PV deployment outside the established markets in place such as Georgia, Florida, and Texas.

Source: Bolinger, M. , J. Seel. 2017, K. H. LaCommare. *Utility-Scale Solar 2016: An Empirical Analysis of Project Cost, Performance, and Pricing Trends in the United States*. LBNL.

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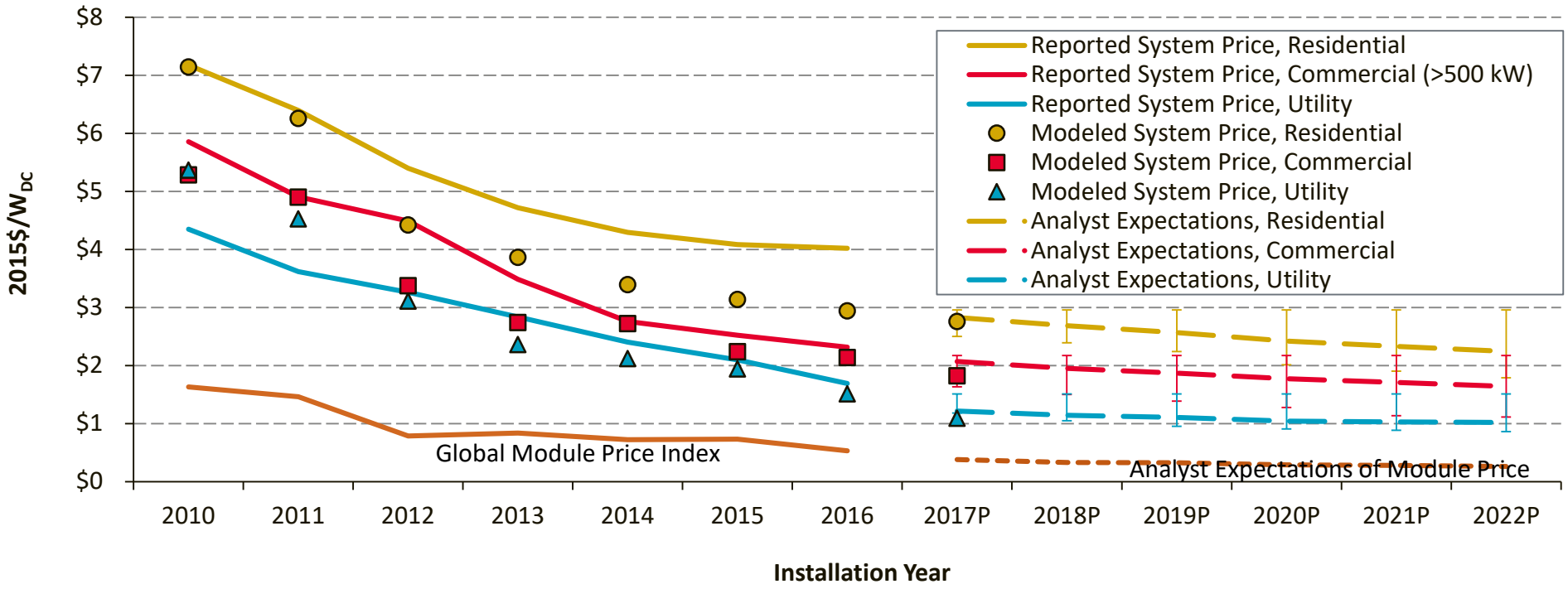
Agenda

- State and Federal Updates
- Global PV Deployment
- U.S. PV Deployment
- PV System Pricing
- Global Manufacturing
- Component Pricing
- Market Activity

U.S. PV System Pricing

- Most data suggest that PV system pricing, across market segments, continues its downward trajectory.
- There are a variety of ways that U.S. PV system pricing, or costs, are estimated and quoted, including:
  - Reported price (backward-looking)
  - Reported costs (backward-looking and may not include profit, unless incorporating "value")
  - Developer quotes (forward-looking)
  - Bottom-up cost benchmarking (forward-looking).
- In 2016, the range in *average* U.S. PV system pricing across methods was reported to be:
  - $2.78/W to $4.61/W for residential
  - $1.62/W to $3.46/W for non-residential
  - $1.06/W to $1.69/W for utility-scale.
- In the first half of 2017, the range in *average* U.S. PV system pricing across methods was reported to be:
  - $2.55/W to $4.47/W for residential
  - $1.53/W to $2.98/W for non-residential
  - $0.96/W to $1.64/W for utility-scale.

Reported, Bottom-Up, and Analyst-Projected Average U.S. PV System Prices over Time

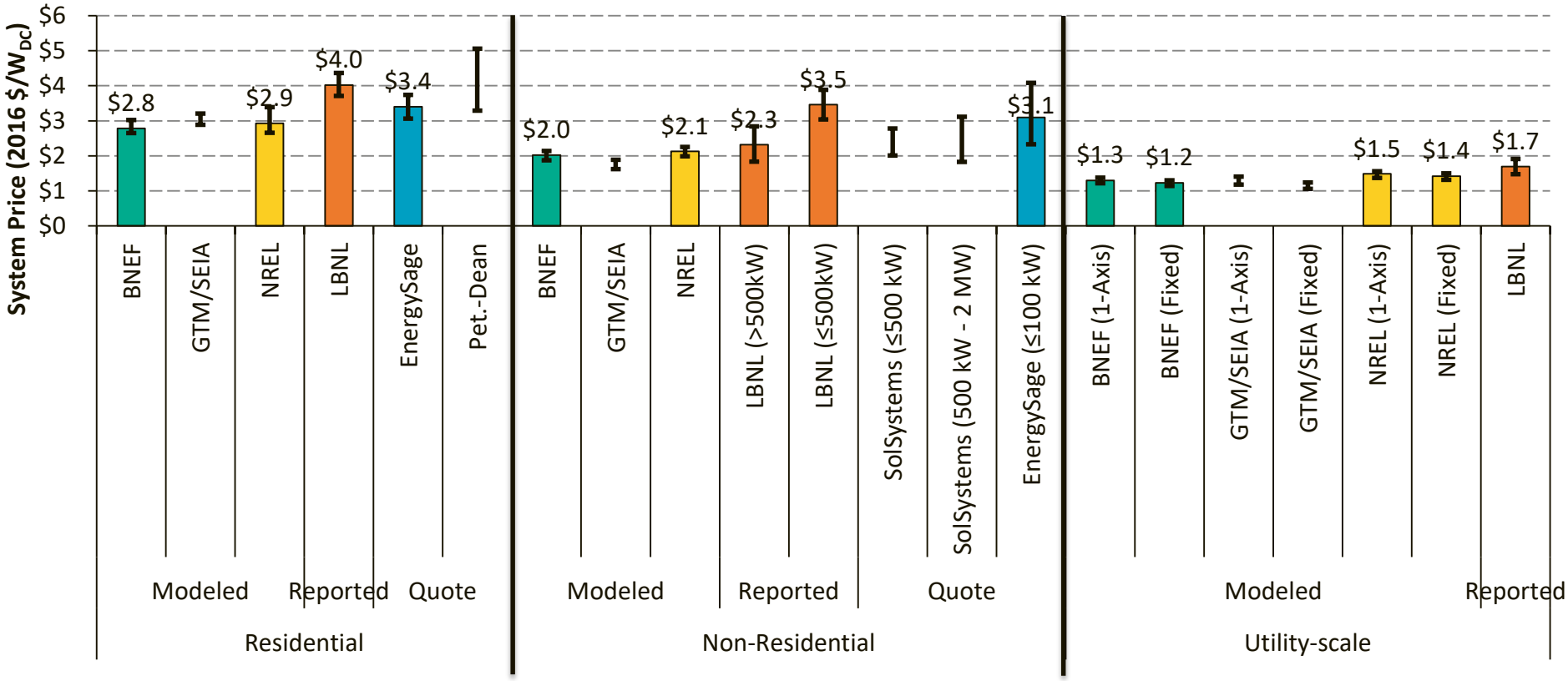


- All methodologies show a downward trend in PV system pricing.
- Historically, reported pricing and modeled benchmarks had similar results; however, residential PV system price estimates have recently diverged over time.
- Analysts expect system prices to continue to fall with commercial PV approaching, and utility-scale PV exceeding, SunShot targets by 2022.

Note: Reported prices represent the median national U.S. averages. Error bars represent the high and low analyst expectations.

Sources: Reported residential and commercial system prices (Barbose and Dargouth 2017); reported utility system prices (Bolinger, Seel , LaCommare 2017); modeled system prices (Fu et al. 2017); analyst expectations (Cole et al. 2017); The Global Module Price Index is the average module selling price for the first buyer (P. Mints SPV Market Research); analyst expectation of module price (see Slide X).

2016 Modeled, Reported, and Quoted System Price from Various Sources



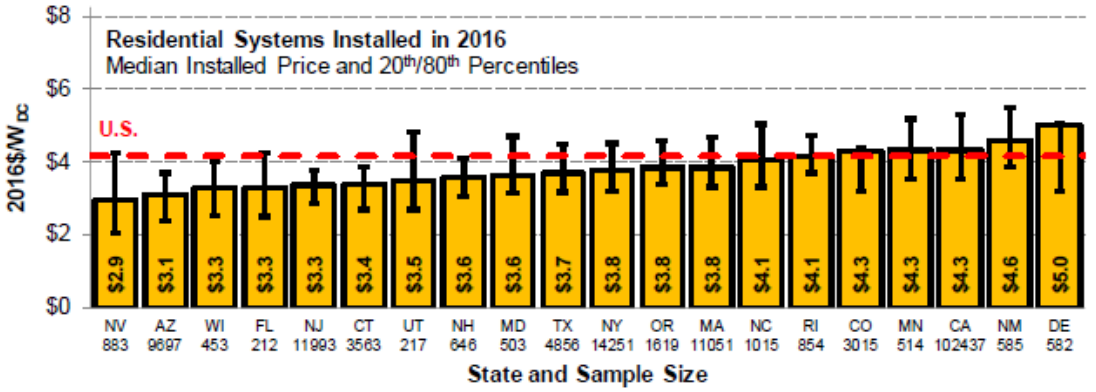
- NREL and LBNL PV system pricing figures are consistent with other sources.
- Across various sources, reported system pricing is generally higher than modeled system pricing.

Note: Some sources only report a range, which is represented by the error bars.
Sources: Barbose and Darghouth, "Tracking the Sun X," 2017; Bolinger, Seel, and LaCommare, "Utility-Scale Solar 2016," 2017; BNEF, "H1 2017 US PV Market Outlook," June 2017; Fu et al., "Q1 2017 Benchmarks"; GTM Research and SEIA, "Solar Market Insight 2016 year-in-review," March 2017.

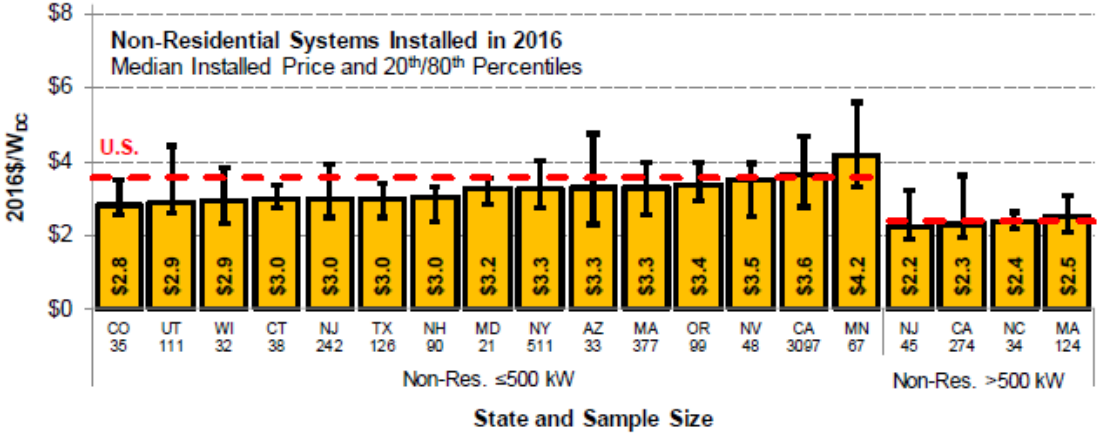
Variation in Reported Price by State:
Residential and Non-Residential PV Systems in 2016

- Some of the largest markets (California, Massachusetts, and New York) are relatively high-priced, pulling overall U.S. median prices upward.
- Pricing in most states is below the national median.
- Cross-state variation may reflect differences in installer competition and experience, retail rates and incentive levels, project characteristics particular to each region, labor costs, sales tax, and permitting and administrative processes.
- A high degree of variability also occurs within states.

Residential Systems



Non-Residential Systems



Source: Barbose, G. and N. Dargouth. 2017. *Tracking the Sun X The Installed Price of Residential and Non-Residential Photovoltaic Systems in the United States*. Berkeley, CA: Lawrence Berkeley National Laboratory. September 2017.

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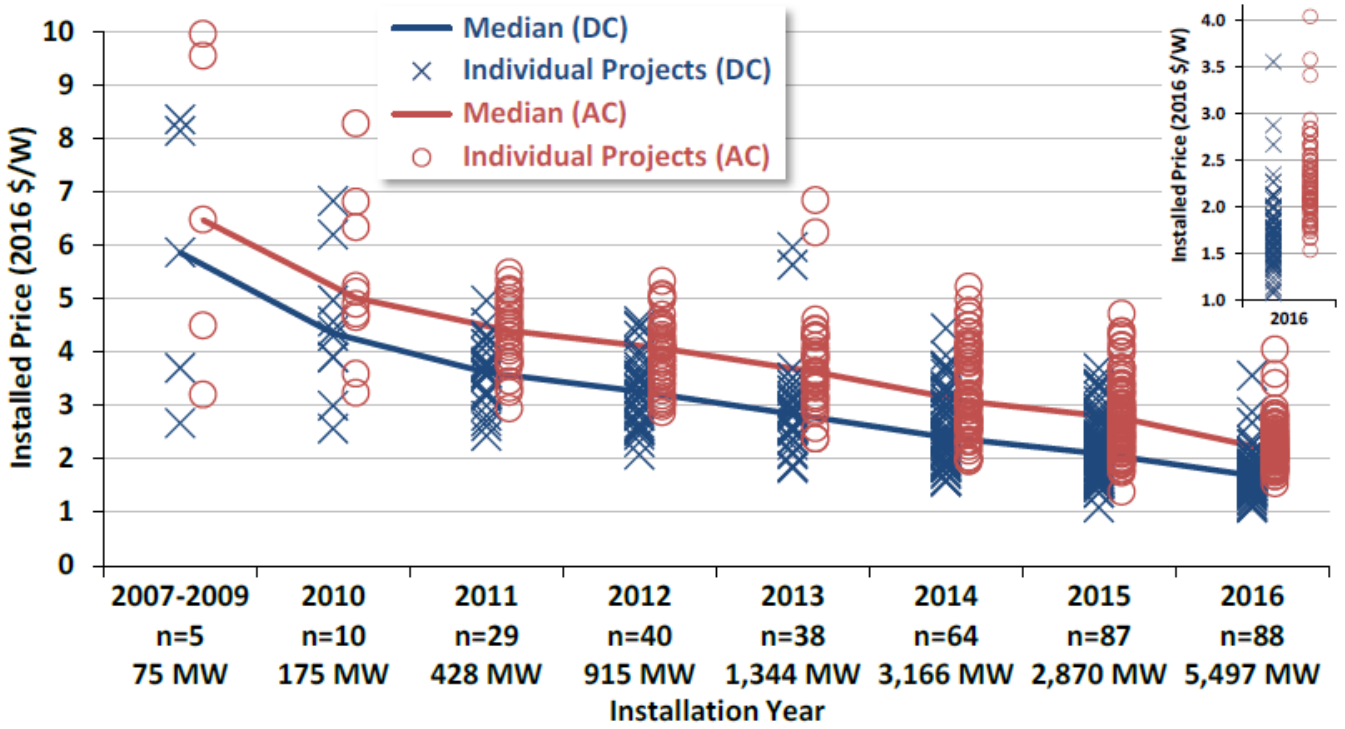
Reported Price of Utility-Scale PV Projects over Time



- Since 2007-2009, the median installed price of utility-scale PV has fallen steadily, by over 65%, to around \$2.2/W_{AC} (\$1.7/W_{DC}) in 2016.
  - From 2015 to 2016, the median installed price of utility-scale PV fell 22% (19% in \$/W_{DC}).
- 80% of reported utility-scale PV system prices in 2016 were below \$2.53/W_{AC} (\$1.91/W_{DC}).
- This sample is backward-looking and may not reflect the price of projects built in 2017–2018.

Source: Bolinger, M. , J. Seel, K. H. LaCommare. 2017,*Utility-Scale Solar 2016: An Empirical Analysis of Project Cost, Performance, and Pricing Trends in the United States*. Berkeley, CA: Lawrence Berkeley National Laboratory.

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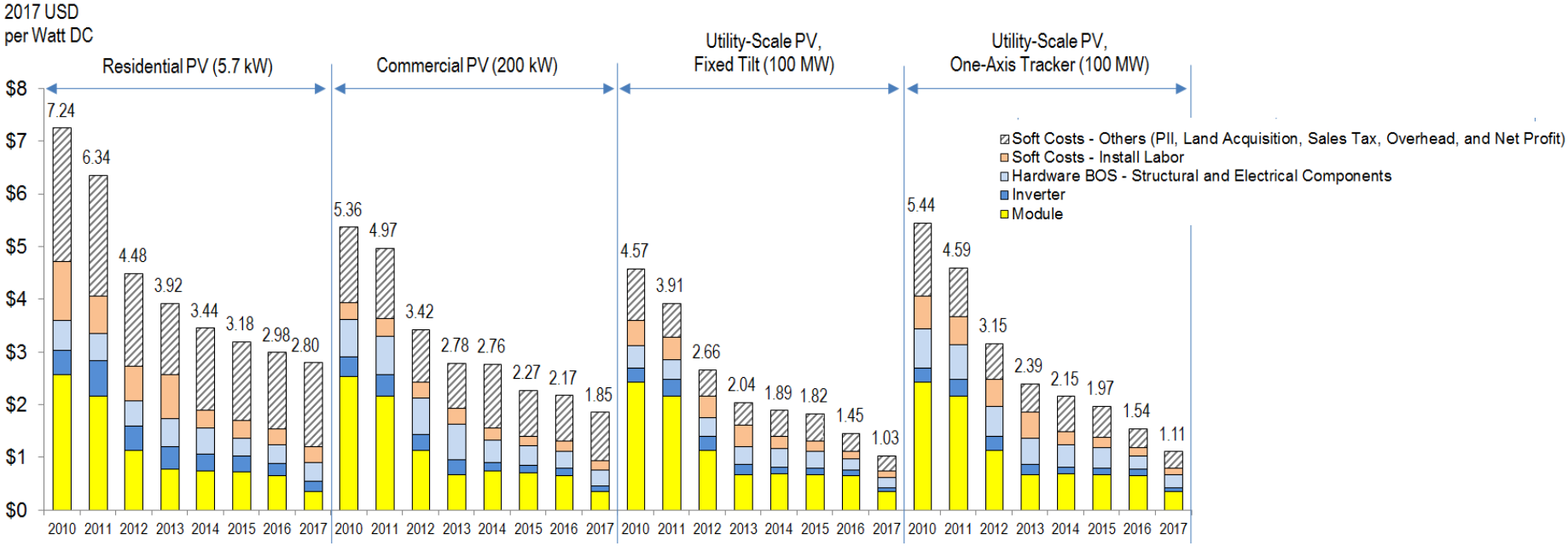
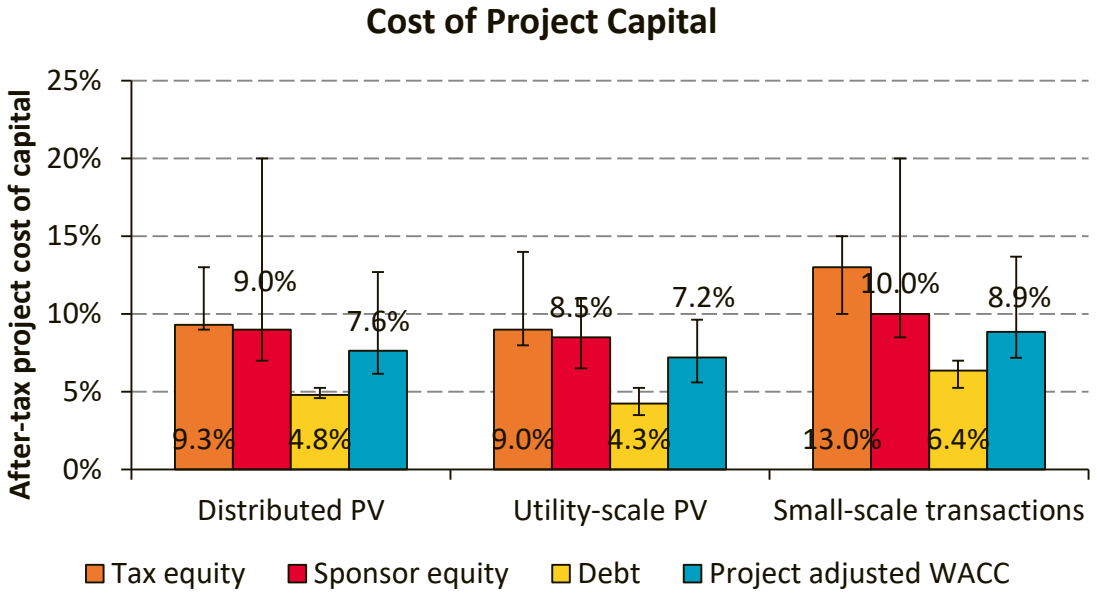
Bottom-Up Modeled System Price of PV Systems by Sector, 2010–2017

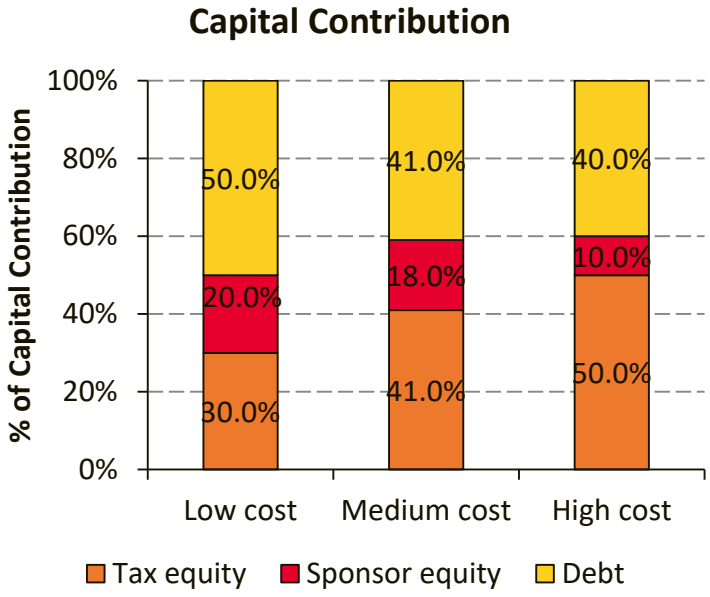


- From 2010 to 2017, modeled system prices fell 15%–26% per year.
  - 48%–62% of reduction attributed to module price reductions
- From 2016 to 2017, modeled system prices fell between $0.18/W and $0.43/W, or 6%–29%.
  - Modeled residential system price reductions in 2017 were not as great as in commercial and utility-scale markets due to increased soft costs related to module supply chain, such as historical inventory.
- Modeled soft costs are generally increasing as a proportion of the total price for distributed PV systems.
  - 59% and 68% of modeled system price for commercial and residential systems respectively
- The Q1 2017 bottom-up modeled residential system *costs* of $2.80/W is consistent with leading residential installers' costs, such as Sunrun's ($2.92/W) and Vivint's ($2.98/W) reported Q1 2017 costs.

Source: Fu, R., D. Feldman, R. Margolis, M. Woodhouse, and K. Ardani, 2017. *U.S. Photovoltaic (PV) Prices and Cost Breakdowns: Q1 2017 Benchmarks for Residential, Commercial, and Utility-Scale Systems*. Golden, CO: National Renewable Energy Laboratory.

Financing Cost Benchmarking

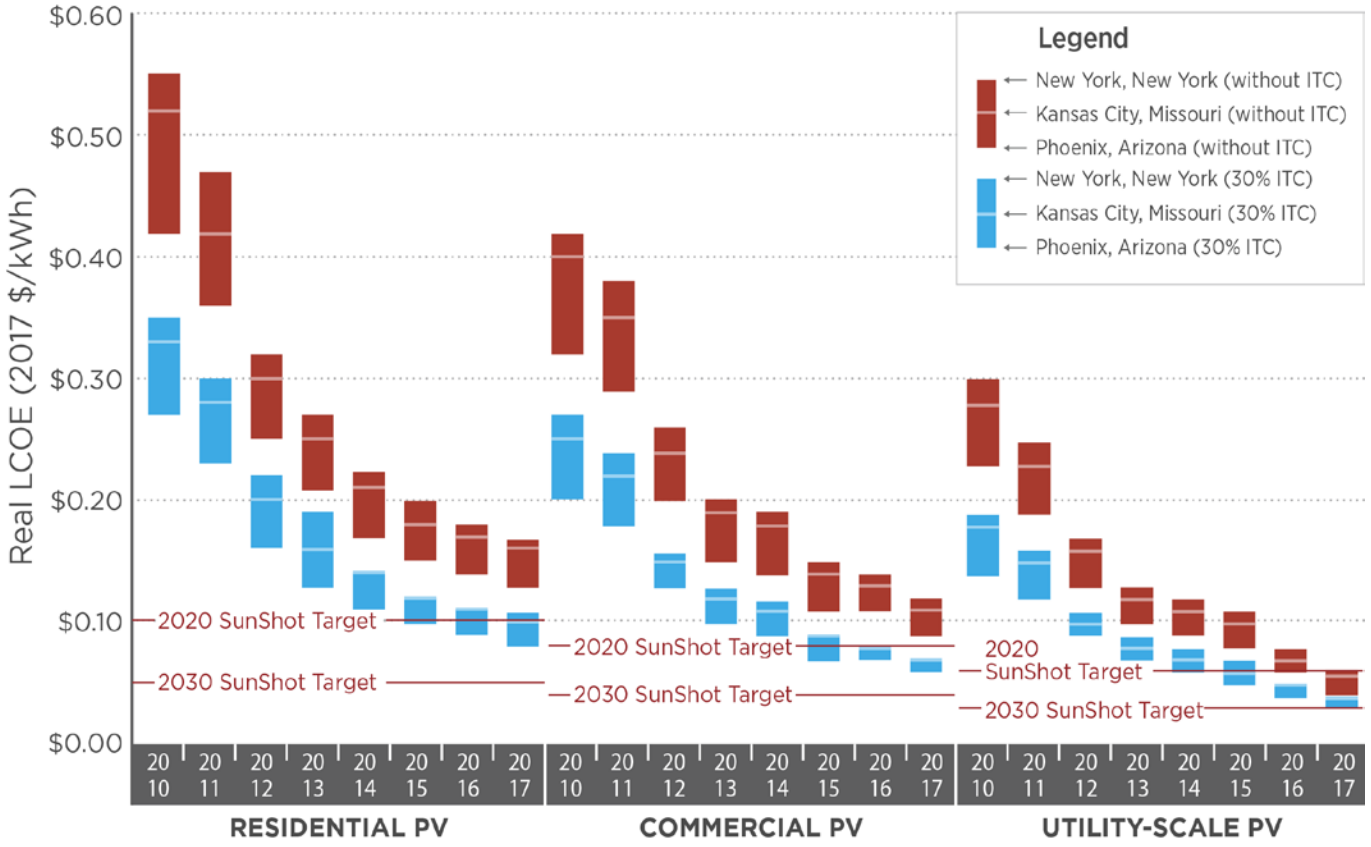




- NREL estimates that in 2017 the cost of capital for large projects, or portfolios of projects (large and distributed), averages 7.2% and 7.6% respectively.
  - Tax equity is currently the most expensive source of capital, with the exception of some sources of sponsor equity, while debt is the least expensive.
- Smaller-scale transactions have higher WACCs that average in the range of 7.2% to 13.7%.
- The cost of capital is not the only cost of financing borne by a project. NREL found that in addition to bearing the cost of capital, projects may also incur set-up costs averaging $1.1 million.

Source: D. Feldman and P. Schwabe. 2017. *Terms, Trends, and Insights PV Project Finance in the United States, 2017.* Golden, CO: National Renewable Energy Laboratory.

Bottom-Up Modeled LCOE of PV Systems by Sector, 2010–2017



The reductions in total capital cost, along with improvements in operation, system design, and technology have resulted in significant reductions in the cost of electricity. U.S. residential and commercial PV systems are 86% and 89% toward achieving SunShot's 2020 electricity price targets, and U.S. utility-scale PV systems have achieved their 2020 SunShot target three years early.

Note: The analysis uses the fixed-tilt systems for LCOE benchmarks from 2010-2015 and then switches to one-axis tracking systems from 2016 to 2017 to reflect the market share change in the utility-scale PV sector.

Source: Fu, R., D. Feldman, R. Margolis, M. Woodhouse, and K. Ardani, 2017. *U.S. Photovoltaic (PV) Prices and Cost Breakdowns: Q1 2017 Benchmarks for Residential, Commercial, and Utility-Scale Systems*. Golden, CO: National Renewable Energy Laboratory.

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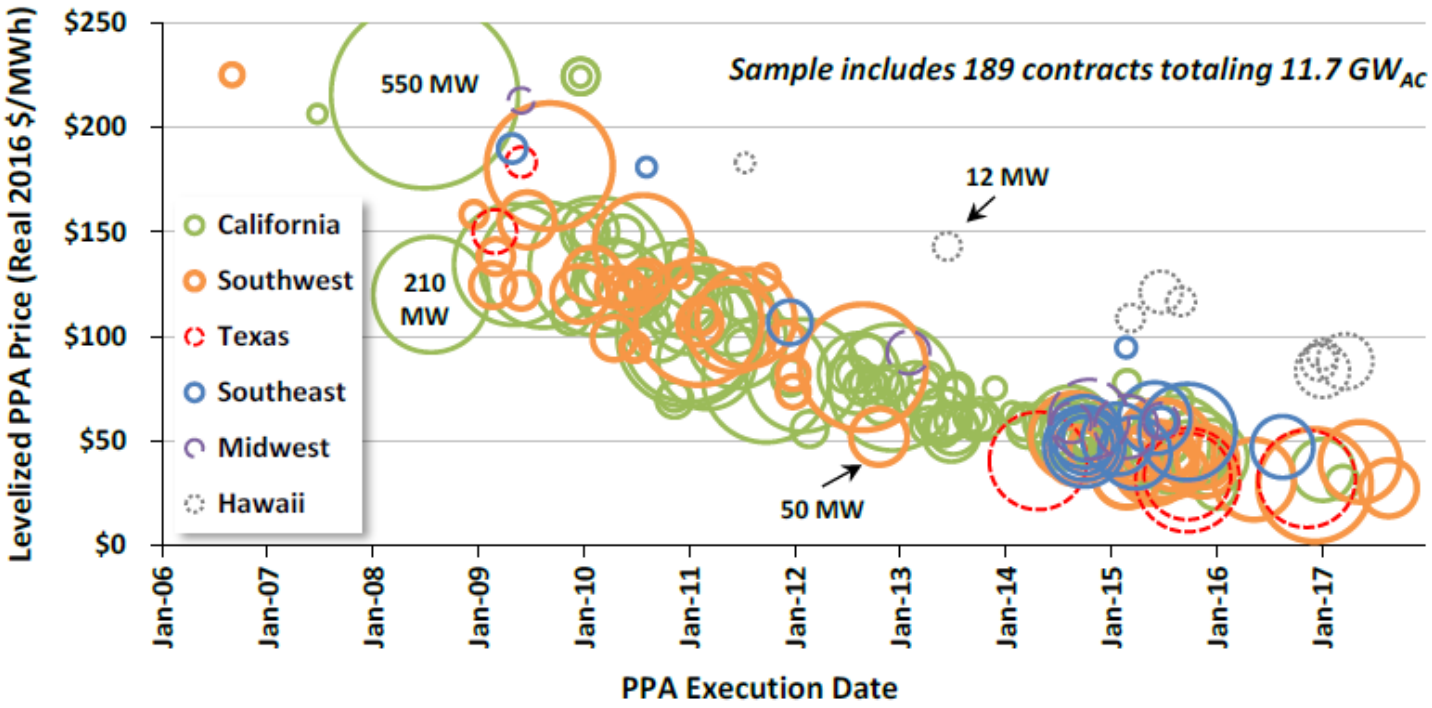
U.S. PV pricing has rapidly dropped in recent years.



- There has been a strong, steady downward PPA price trend since 2006, with an average levelized price signed in 2016 of ~$35/MWh.
  - The median unsubsidized LCOE of utility-scale PV projects built in 2016 was below the DOE SunShot target of 6 cents/kWh.
- California and the Southwest dominate the sample, but 2014–2016 saw a broadening of the market to Texas, Arkansas, Alabama, Florida—and even Minnesota and Michigan.
- Three PPAs featuring PV plus long-duration battery storage do not seem to be priced at a prohibitive premium to their PV-only counterparts.

Source: Bolinger, M. , J. Seel, K. H. LaCommare. 2017. *Utility-Scale Solar 2016: An Empirical Analysis of Project Cost, Performance, and Pricing Trends in the United States*. Berkeley, CA: Lawrence Berkeley National Laboratory.

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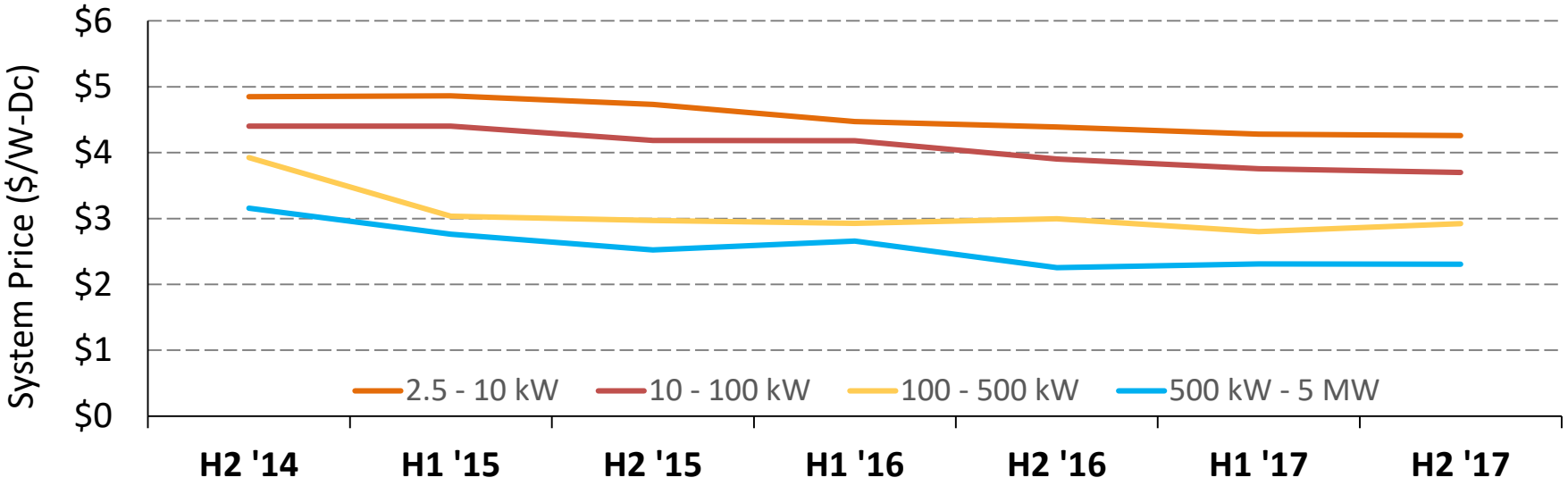
System Pricing from Select States



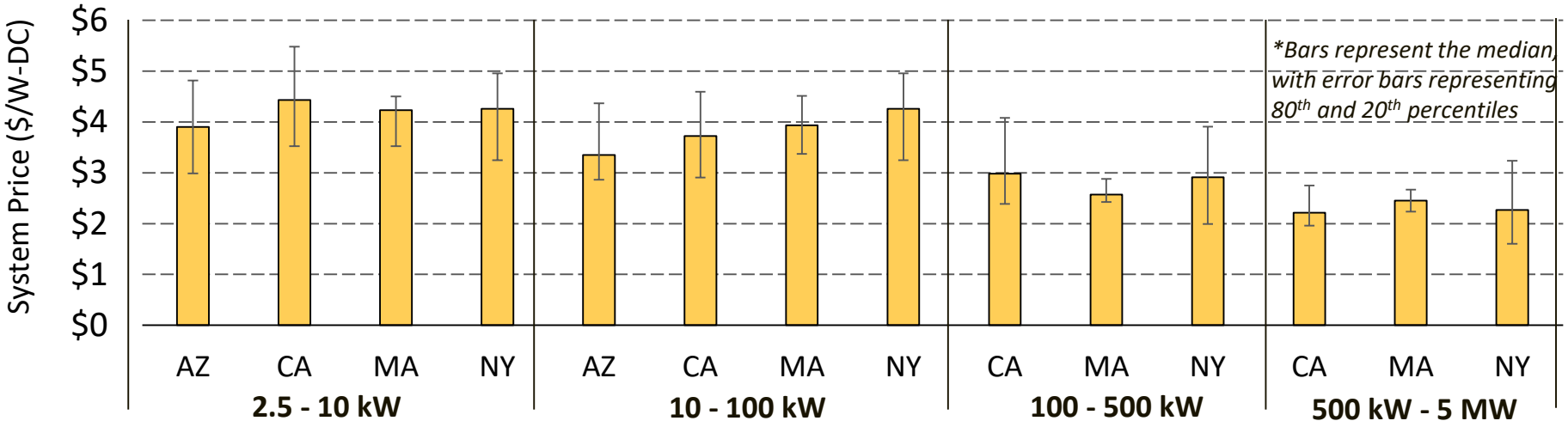
- From H2 2016 to H2 2017, the median reported system price for PV systems in Arizona, California, Massachusetts, and New York:
  - Fell 3% to $4.26/W, for systems 2.5 kW–10 kW
  - Fell 5% to $3.70/W, for systems 10 kW–100 kW
  - Fell 3% to $2.92/W, for systems 100 kW–500 kW
  - Increased 2% to $2.30/W, for systems 500 kW–5 MW.
- In H2 2017, the median reported system price for PV systems 2.5 kW–10 kW was 85% higher than the median price for systems 500 kW–5 MW
  - From H2 2014 to H2 2017, the median price of systems 2.5 kW–10 kW fell 12%, while the median price of systems 500 kW–5 MW fell 27%.

H2 2017 MW: AZ (2); CA (24); MA (3); NY (8).

Note: California pricing data before 2015 are collected from the California Solar Initiative database. CA NEM data have only been reported through July 2017.

Sources: CA NEM database; MA SREC program; Arizona Public Services and Salt River Project; NY PV Incentive Program. All programs accessed 10/02/17.

System Pricing from Select States, H2 2017



- In addition to price differences based on system size, there is also variation between states and within individual markets.
  - In H2 2017, the median price of a small system in Arizona was about 12% less than the median price in California.
  - In H2 2017, the 20th and 80th percentile prices in California for a system 100 kW–500 kW were $4.08/W and $2.39/W respectively.

H2 2017 MW: AZ (2); CA (24); MA (3); NY (8).

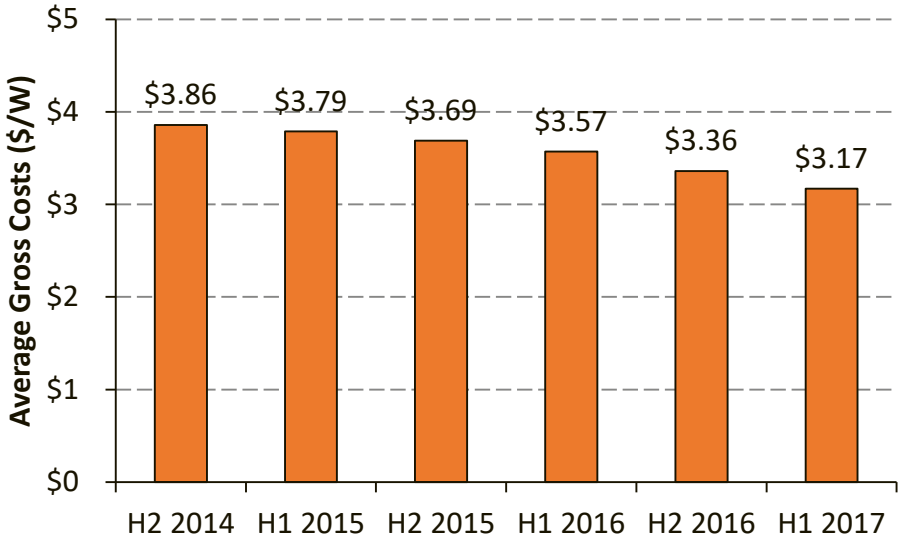
Note: California pricing data before 2015 are collected from the California Solar Initiative database. CA NEM data have only been reported through July 2017.

Sources: CA NEM database; MA SREC program; Arizona Public Services and Salt River Project; NY PV Incentive Program. All programs accessed 10/02/17.

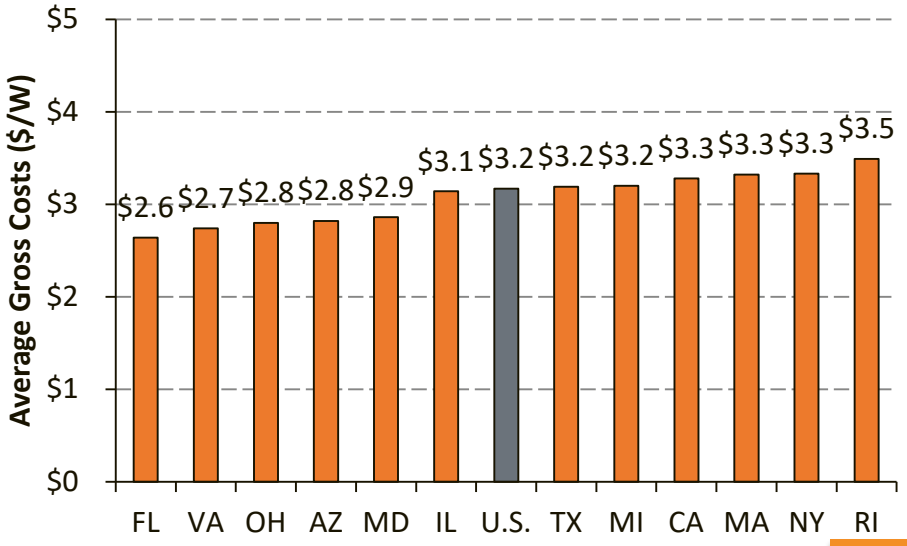
System Price Quotes Reported by EnergySage

- EnergySage reported an 11% reduction in the average gross costs of a residential system from H1 2016 to H1 2017 .
  - The standard deviation of PV system quotes in H1 2017 was $0.47/W.
  - EnergySage quotes also reported an average system payback period of 7–8 years.
- Residential system quotes varied by state. In H1 2017, the average gross cost of a residential system in Rhode Island was 32% higher than the average gross cost of a residential system in Florida.

Cost over Time



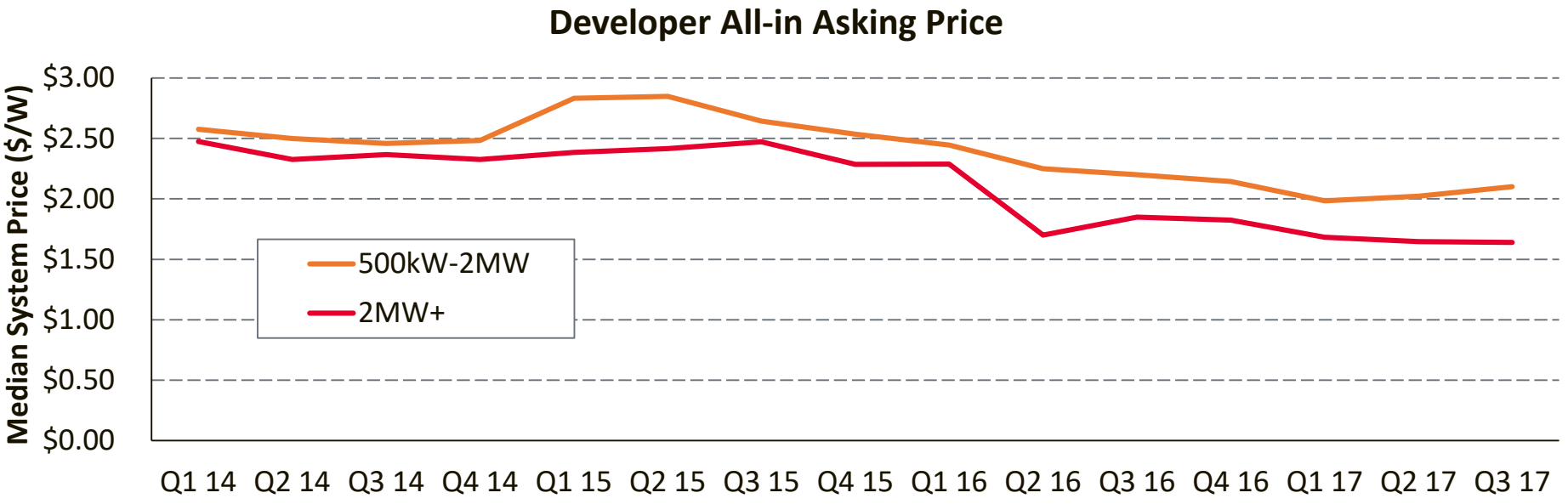
Cost by State, H1 2017



Sources: EnergySage "Solar Market Place Intel Report H2 2016 – H1 2017."

System Prices from Sol Systems

500 kW–2 MW and 2 MW+

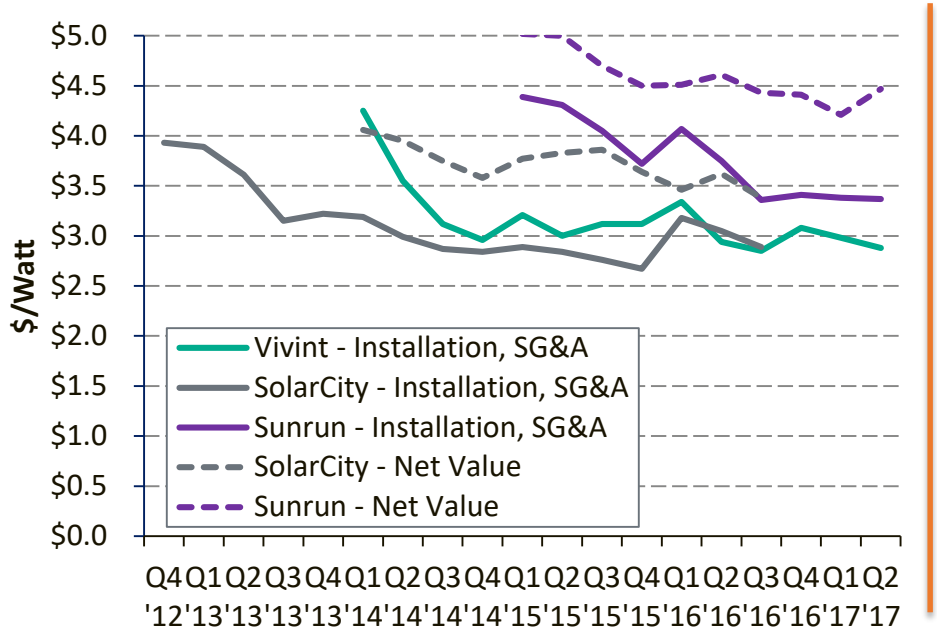


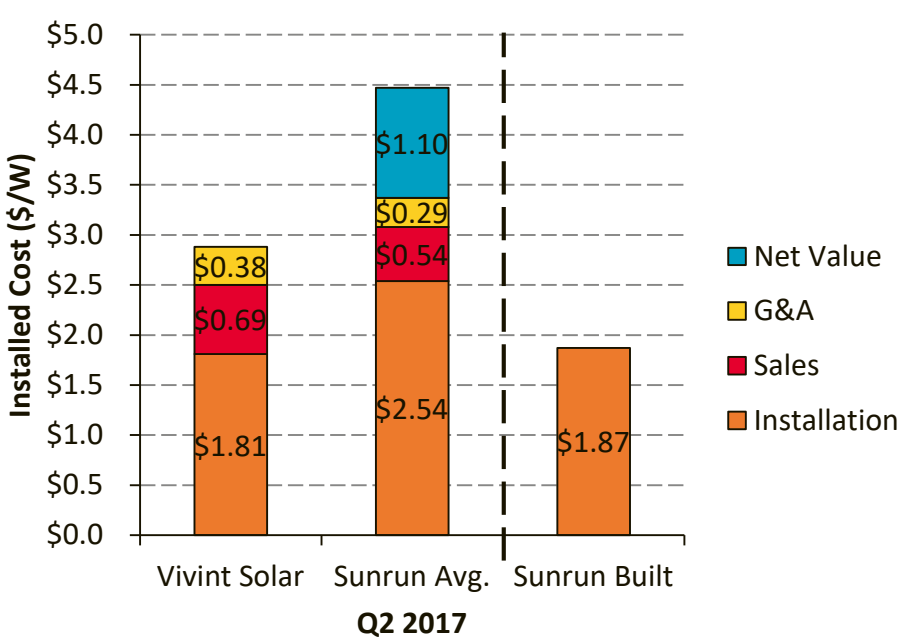
Sol Systems reports than from Q4 2016 to Q3 2017 the median all-in asking price for systems 500 kW–2 MW fell approximately 2%, and the median all-in asking price for systems greater than 2 MW fell 10%.

Sol Systems reports values on a monthly basis. Values for each quarter from Q2 2016 to Q3 2017 represent the average of the three monthly medians reported each quarter. Prior to Q2 2016 Sol Systems only reported a high and low value for each market segment; values prior to Q2 2016 represent the midpoint between the reported high and low value.

Sources: Sol Systems, "The Sol Source," March 2014—September 2017.

SolarCity, Vivint Solar, and Sunrun Cost and Value

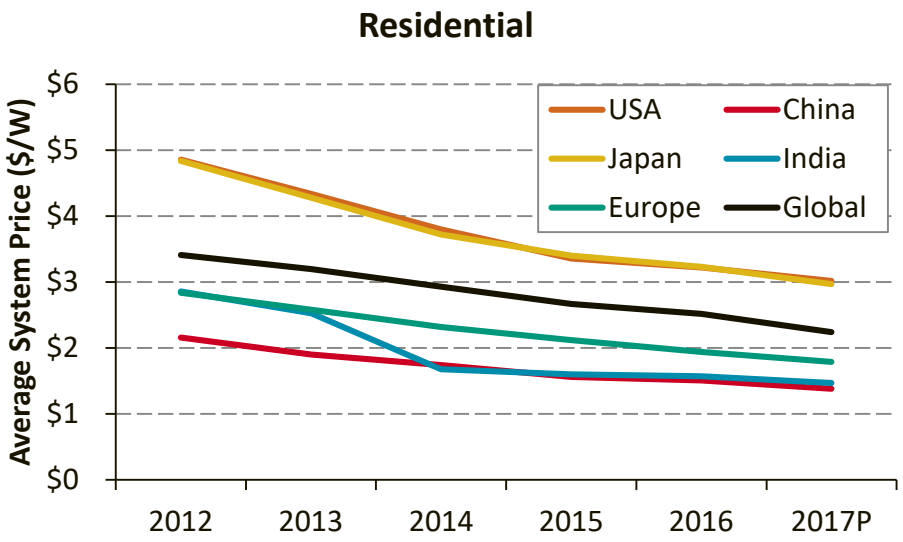


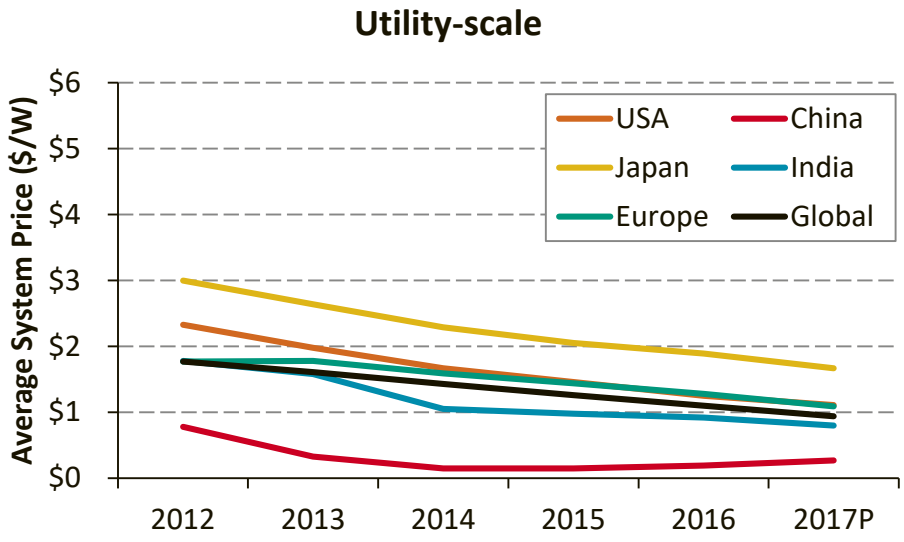


- From Q2 ‘16 to Q2 ’17, Vivint Solar and Sunrun systems total costs decreased 2% and 10% respectively.
  - Vivint Solar’s and Sunrun built installation costs decreased 15% and 18% y/y respectively to between $1.8/W and $1.9/W.
  - Vivint Solar’s overhead costs increased from $0.81/W to $1.07/W over that time, while Sunrun’s overhead costs decreased from $1.19/W to $0.83/W. Vivint Solar’s quarterly installation levels have decreased while Sunrun’s quarterly installation levels have increased.

Source: Corporate filings

Residential and Utility-Scale System Prices by Region

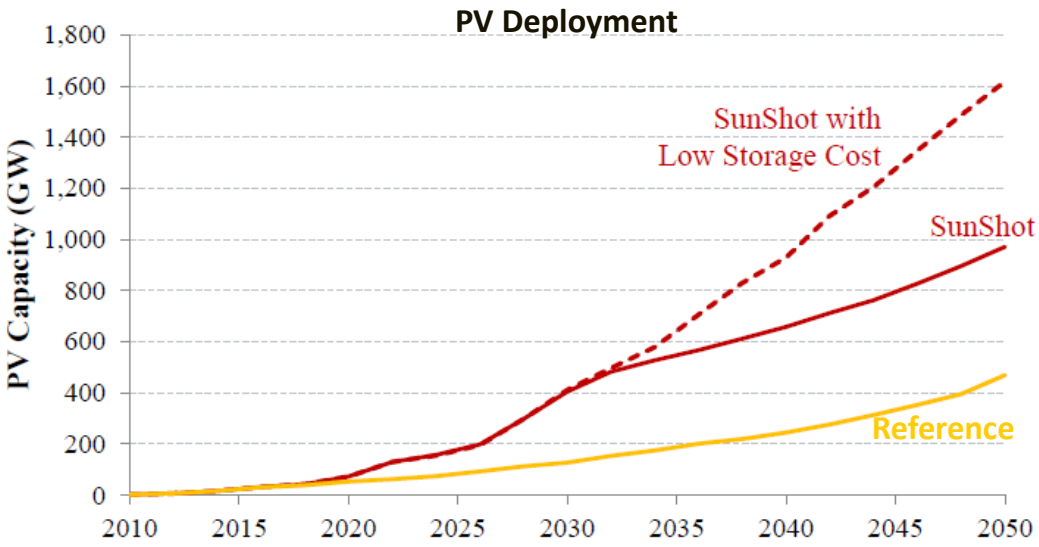


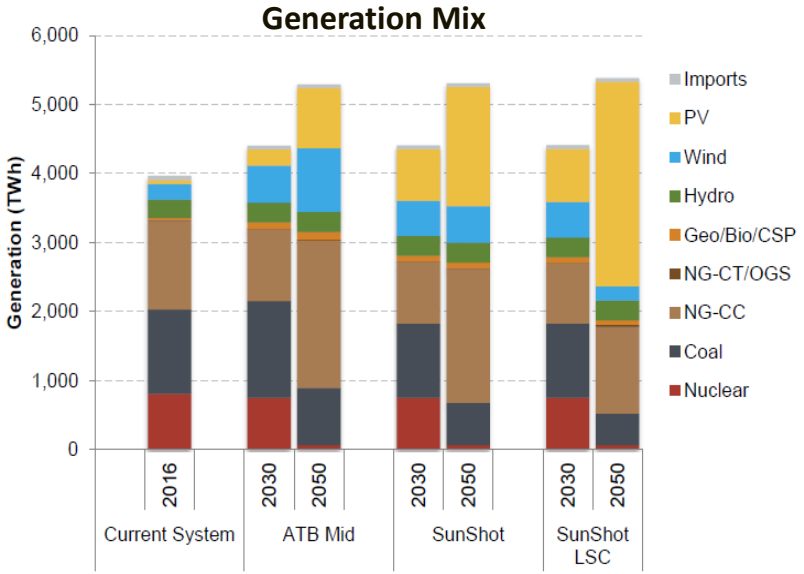


- The price of residential systems in the United States remains higher than in much of the world, including other developed regions.
  - An LBNL report cited non-hardware costs as the primary difference in distributed PV system pricing, owing to differences in market size, incentive levels and incentive design, solar industry business models, demographics and customer awareness, building architecture, systems sizing and design, interconnection standards, labor wages, and permitting and interconnection processes.
- While U.S. utility-scale projects are higher than global averages, the gap is much smaller than it is in the residential sector.

Sources: IHS Markit, Technology Group, PV Demand Market Tracker, September, 2017; Barbose and Darghouth, "Tracking the Sun X," 2017.

Report Analyzes Impact of SunShot 2030





- A recent NREL study analyzed the impact that the SunShot 2030 targets[1] would have on the United States and how its results would change with low-storage cost (LSC).[2]
- It is estimated that if the SunShot 2030 cost targets are achieved, 405 GW of PV will be deployed by 2030 and 971 GW will be deployed by 2050 (33% of total generation).
  - With the addition of low-cost storage, PV is estimated to continue to achieve significant growth post-2030, resulting in 1,618 GW of PV by 2050—accounting for factors such as supply-chain constraints and changes in natural gas price, deployment could range from 1,148 GW to 1,923 GW.
- By 2050 electricity prices are projected to be 2% lower under the SunShot scenario, and 12% lower under the SunShot + LSC case.

[1]SunShot 2030 targets: 3¢/kWh for utility-scale PV, 4¢/kWh for commercial PV, 5¢/kWh for residential PV
[2] Low-cost storage: ~$130/kWh, for an 8-hour battery, by 2030

Source: Cole et al. *SunShot 2030 for Photovoltaics (PV): Envisioning a Low-cost PV Future*. NREL/TP-6A20-68105. September 2017.

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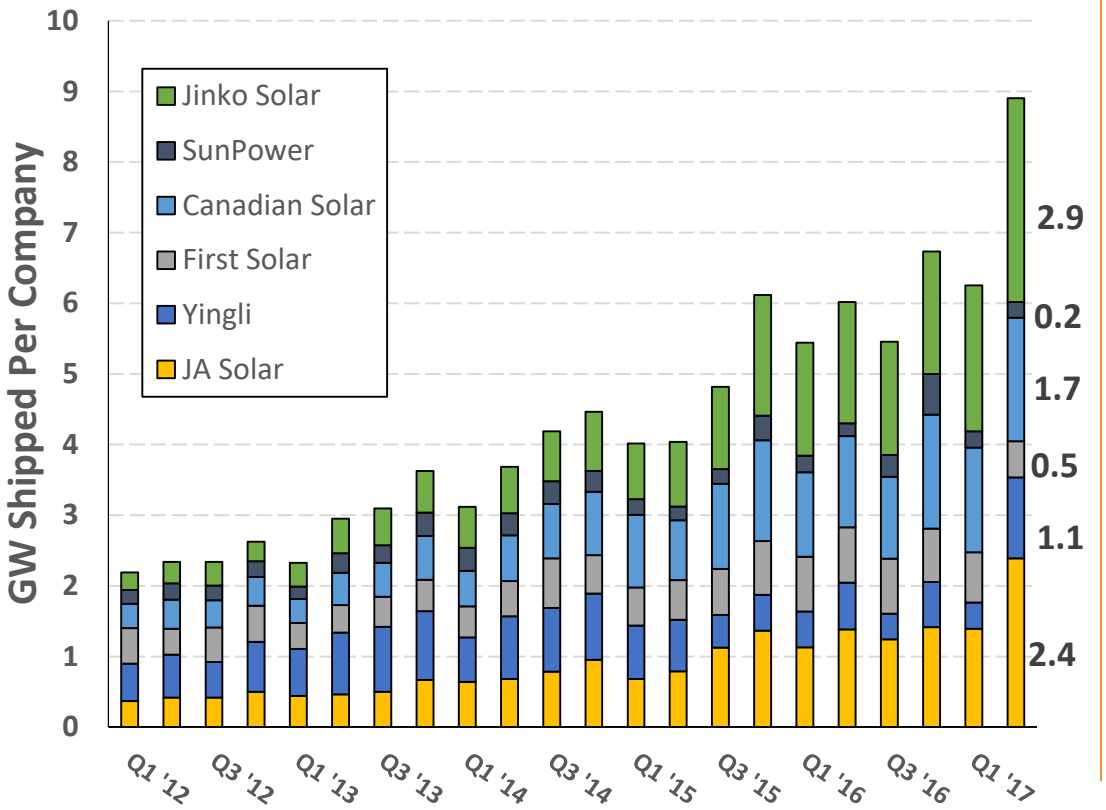
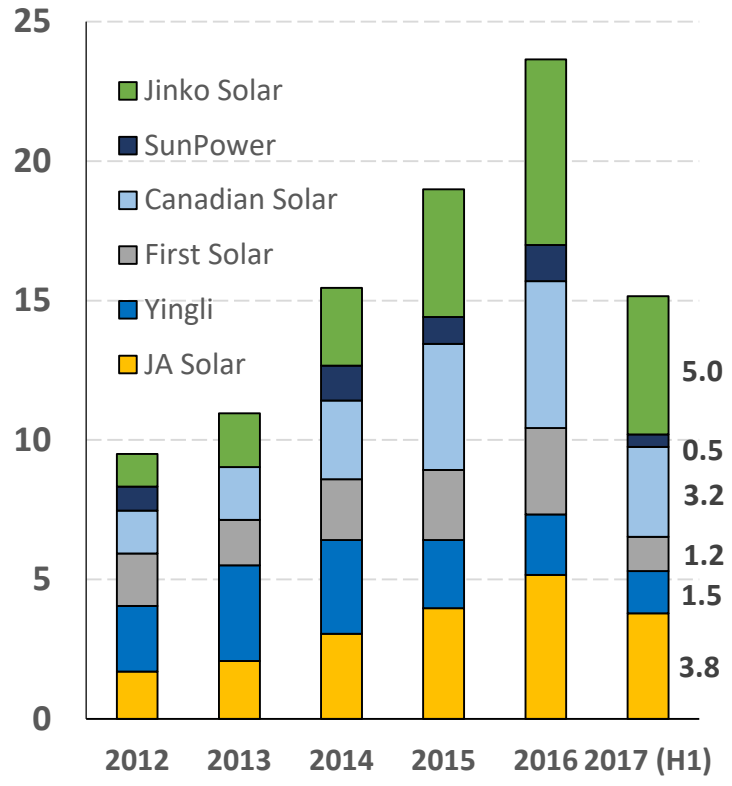
Manufacturers' Shipments

Publically Traded Cell/Module Manufacturers

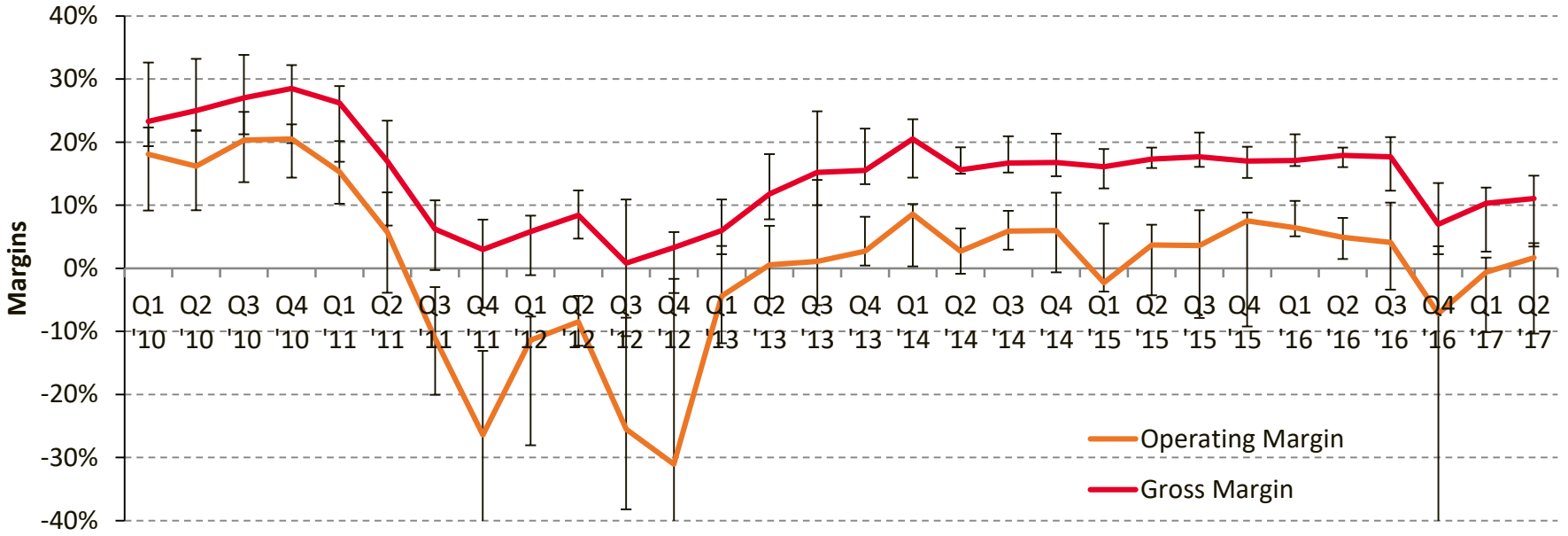




- In the first half of 2017, the tracked companies shipped 15.2 GW, 32% more than were shipped in the first half of 2016.
  - In Q2 '17, the tracked companies shipped 8.9 GW.
  - Jinko once again reported the largest shipments, with 5 GW shipped in H1 '17.

Note: First solar reports production, not shipments.
Sources: Company figures based on Q2 2017 (and previous) SEC filings by the respective companies.

PV Manufacturers' Margins



**Line represents the median, with error bars representing 80th and 20th percentiles for the following companies: Canadian Solar, First Solar, Hanwha Q Cells, JA Solar, Jinko Solar, SunPower, and Yingli Solar.*

- Margins improved slightly in Q2 2017, continuing their recovery after a significant fall in Q4 2016, when companies faced a significant decline in module prices and several went through restructuring.
  - The median gross margin was 11% and the median operating margin was 2% for the above seven companies in Q2 2017.

Sources: Company figures based on Q2 2017 (and previous) SEC filings by the respective companies.

Privatization of PV Manufacturers

Since 2015, and especially in the past year, several PV manufacturers have gone private, although most of the top manufacturers continue to be public companies.

Analyst Explanations

- Low valuations have made it difficult for public solar companies to raise capital.
- Some analysts believe solar stocks on the New York stock exchange are undervalued, especially those for Chinese solar manufacturers. There is speculation that Trina and ReneSola will eventually re-list on an Asian stock exchange.
- ReneSola was at risk of being forced out of the New York Stock Exchange because of its low market capitalization. Shedding most of its debt should allow its downstream arm to continue being listed.

Key Events

Company	Status
ReneSola	went private Q2 2017
JA Solar	offered buyout to shareholders Q2 2015, then again in Q2 2017
SolarWorld	entered bankrupcy in Q2 2017, emerged as private company
Trina Solar	went private Q1 2017
REC Solar	went private Q2 2015

Sources: Fillings and earning calls from relevant companies. Analyst reactions from SeekingAlpha.com, PV-Magazine.com, and PV-Tech.com

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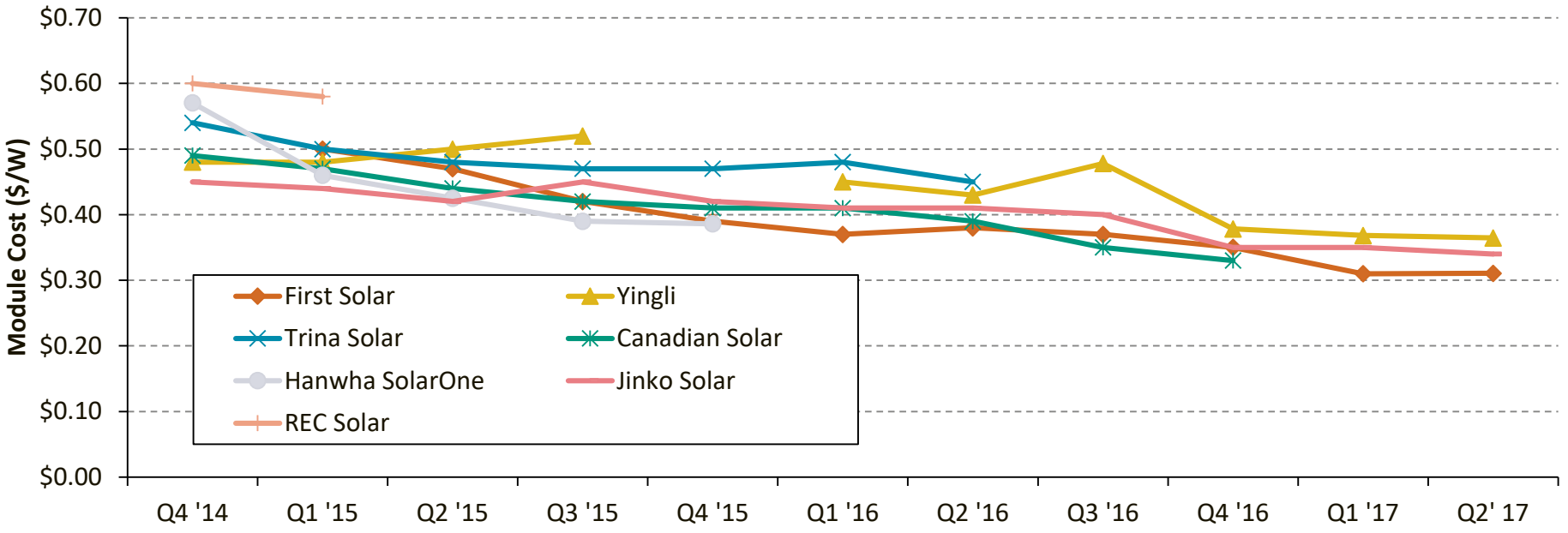
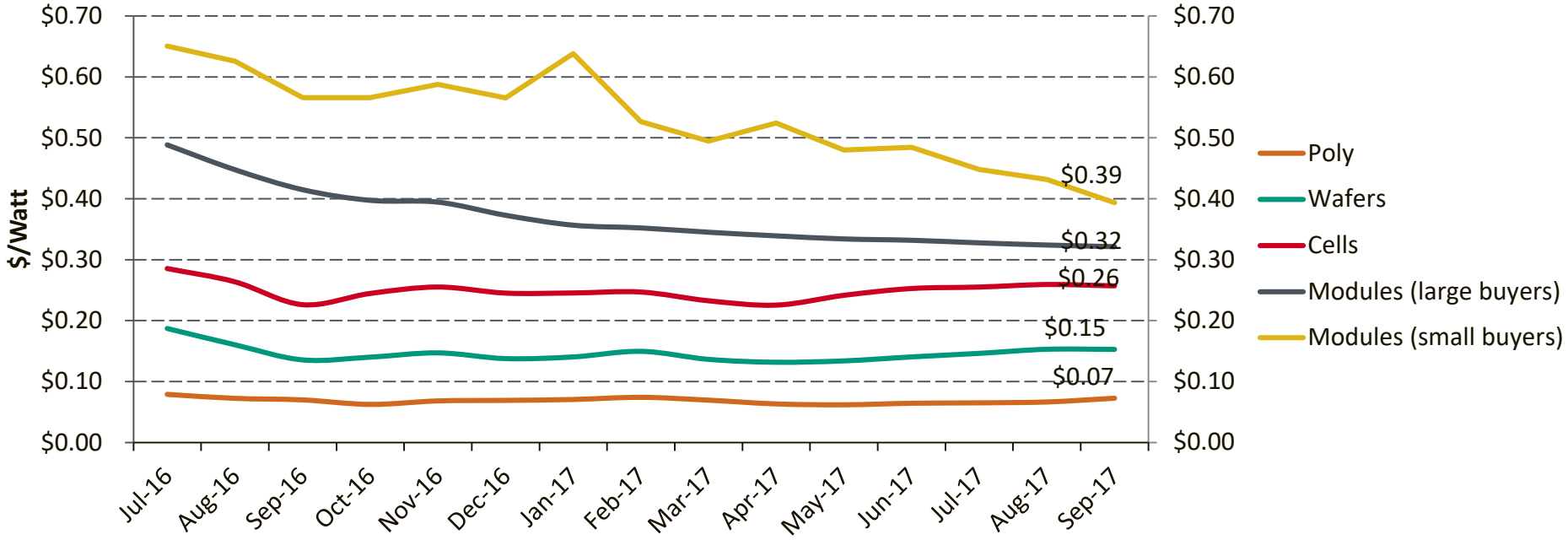
PV Manufacturers' Cost



- In Q2 '17, module costs were reported to be between $0.31/W and $0.36/W.
  - Q2 '17 costs for First Solar, Jinko Solar, and Yingli Solar were, on average, 17% less than Q1 '16, though these three companies may not be representative of the industry as a whole.
- As prices have come down, fewer companies are publicly reporting manufacturing costs.

Sources: Company figures based on Q2 '17 (and previous) SEC filings by the respective companies. Deutsche Bank (07/18/17)

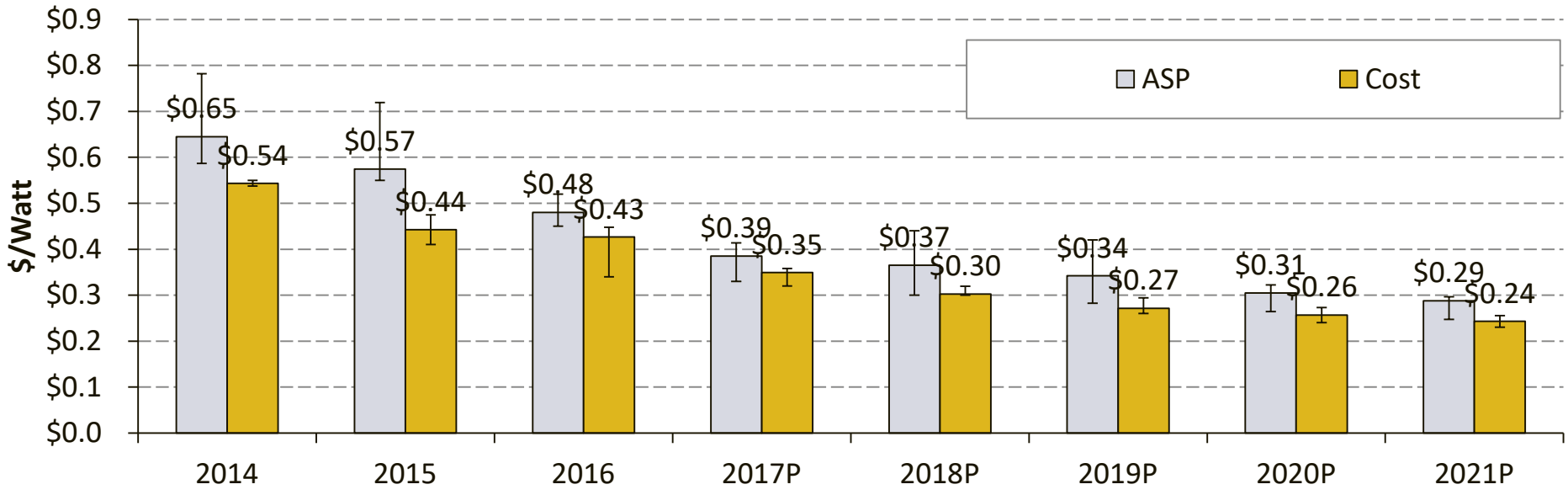
Module, Cell, Wafer, and Polysilicon Price



- Strong demand for PV in China and the stockpiling of modules in the United States due to the Section 201 filing by SolarWorld and Suniva have eliminated the glut of supply and stabilized pricing.
- From January 2017 to September 2017, module prices for larger and small buyers fell 10% and 38%, while over the same period, poly, wafer, and cell prices increased 3%, 9%, and 5% respectively.
  - In Q3 2017, poly pricing varied from $13/kg to $16/kg, making it harder for PV manufacturers to determine whether they can hit their cost-roadmap targets.
  - BNEF and GTM Research report U.S. module prices have increased approximately $0.10/W since the beginning of 2017, due to trade case fears.

Sources: "Modules (large buyers)" from PVInsights, accessed 10/13/17. U.S. module pricing from GTM Research (October 2017). Remaining pricing data from BNEF Solar Spot Price Index (10/13/17). Kilogram to Watt conversion: 4.78 grams per watt (2016); 4.73 grams per watt (2017), from Cowen & Co. (05/11/17); Deutsche Bank (07/19/17).

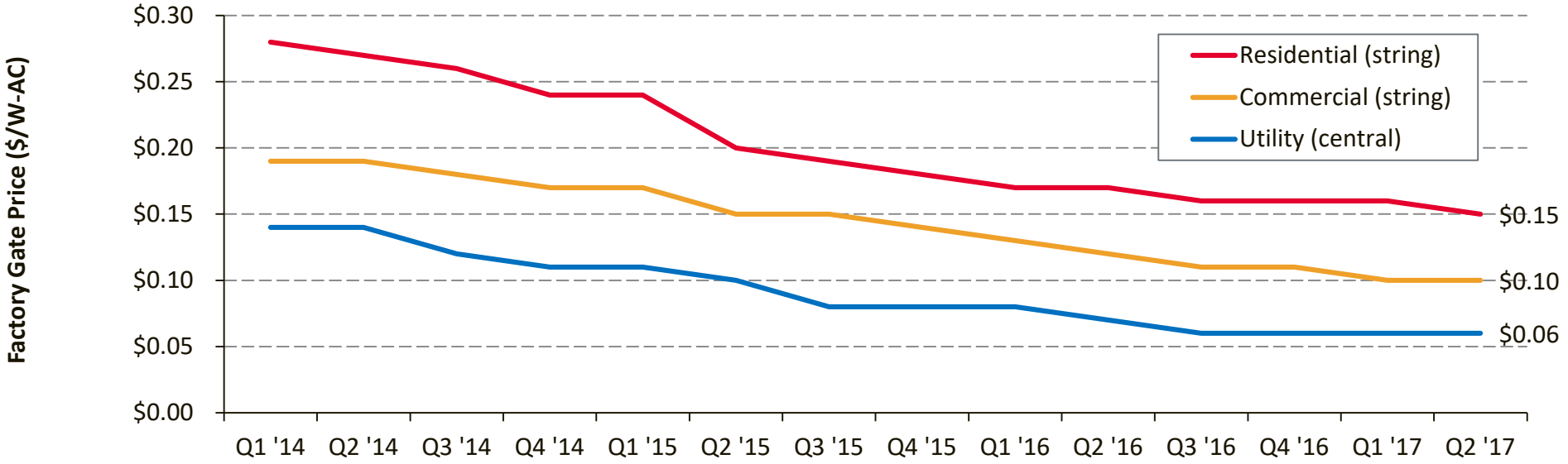
Near-Term Module Price/Cost Projections



- Recent analyst reports indicate *global* module prices and costs are expected to continue to drop in the next few years, with some analysts expecting prices below $0.3/W and costs below $0.25/W by 2020.
- Regional module preferences and tariffs could impact actual pricing in the United States, Europe, India and elsewhere.

Sources: Lines represent the median estimates, and error bars represent the maximum and minimum, ASP and costs for First Solar and industry averages from the following analysts: BNEF (08/18/17); Deutsche Bank (09/20/17, 10/03/17); Goldman Sachs (05/09/17); GTM Research (June 2017); IHS Markit, Technology Group, PV Integrated Market Tracker, October, 2017; Navigant Research (03/29/17).

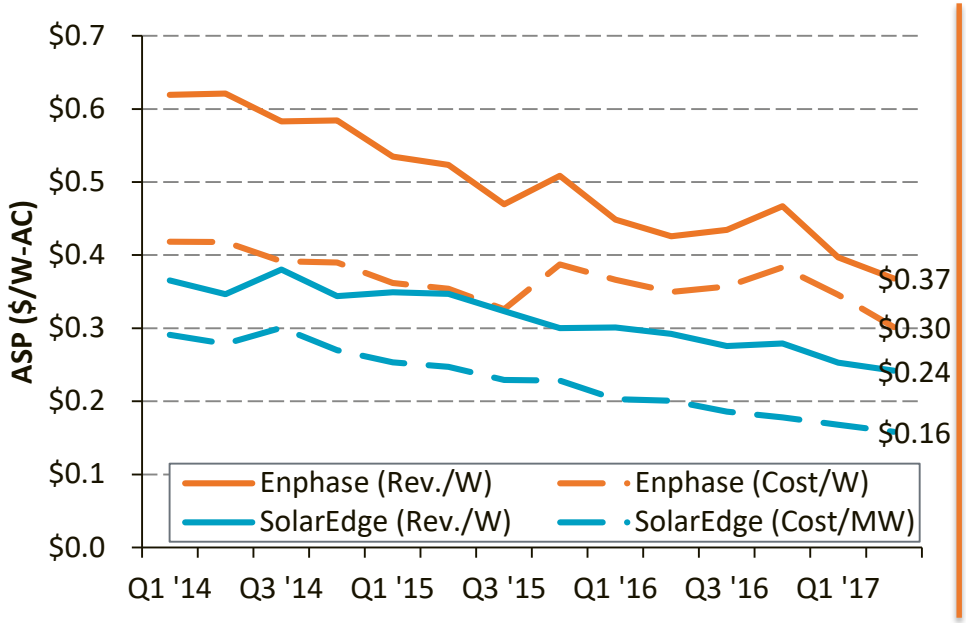
Inverter Pricing

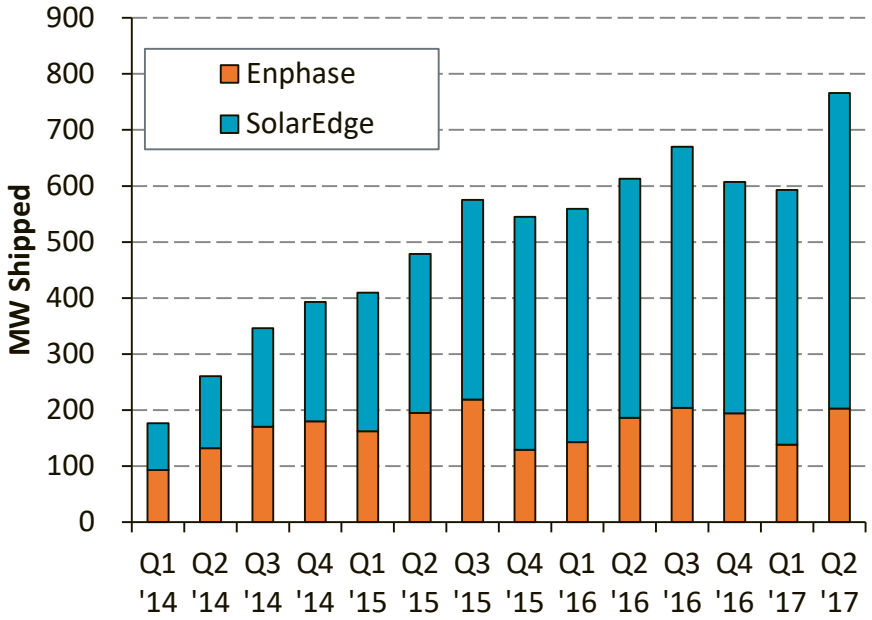


- Since Q3 2016, the decrease in inverter price has slowed.
  - In Q2 2017, utility and commercial inverter pricing was flat Q/Q, while residential inverter pricing fell 6% over the same period
  - Central and string inverter prices have dropped 46%–57% since Q1 2014
  - As prices have dropped, manufacturers have included new standards and features.
  - GTM Research expects price reductions to continue due to the ongoing introduction of high-power string inverters and increasing adoption of 1,500-volt systems.

Source: GTM Research/SEIA "Solar Market Insight Q3 2017."

Enphase Microinverters and SolarEdge DC-Optimized Inverter Systems





- Module-level power electronics (MLPE) price and costs are at historic lows and shipments are at historic highs—companies are expanding into new markets, growing shipments but also growing competition
- From Q2 '16 to Q2 '17, Enphase and SolarEdge MLPE prices fell 14% and 17% respectively.
  - Enphase and SolarEdge MLPE costs also decreased by 14% and 21% respectively over the same period.
  - These companies have also cut operating costs and are transitioning to more advanced technologies to better compete in this highly competitive marketplace.
- In Q2 2017, SolarEdge achieved record shipment levels, growing 32% y/y, propelling them to record levels of revenue (despite continued reduction in price). Enphase shipments rebounded in Q2 2017, growing 9% y/y
  - Some of the new MLPE products have not achieved significant penetration in the U.S. market yet.

Sources: Enphase/SolarEdge public filings.

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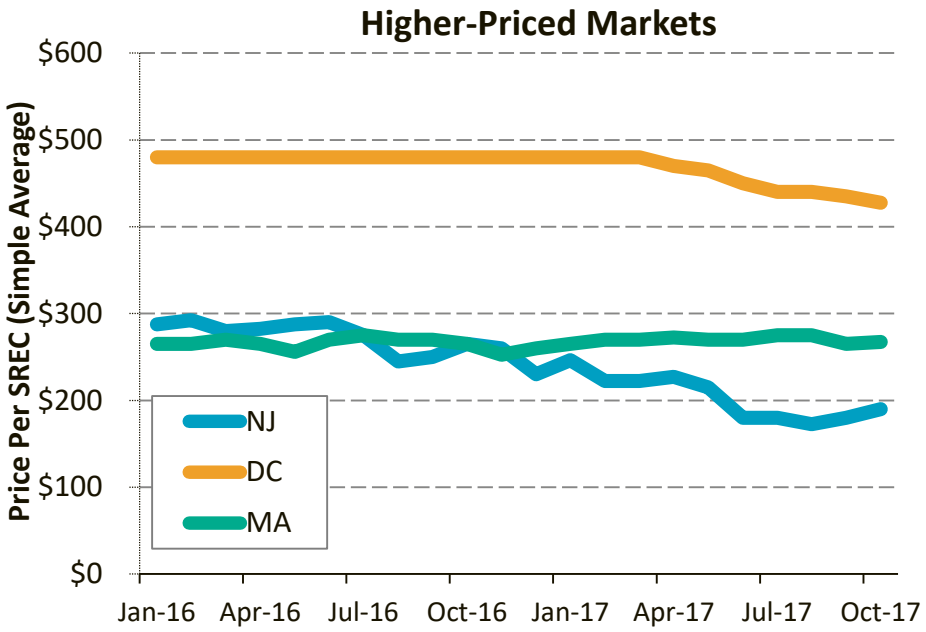
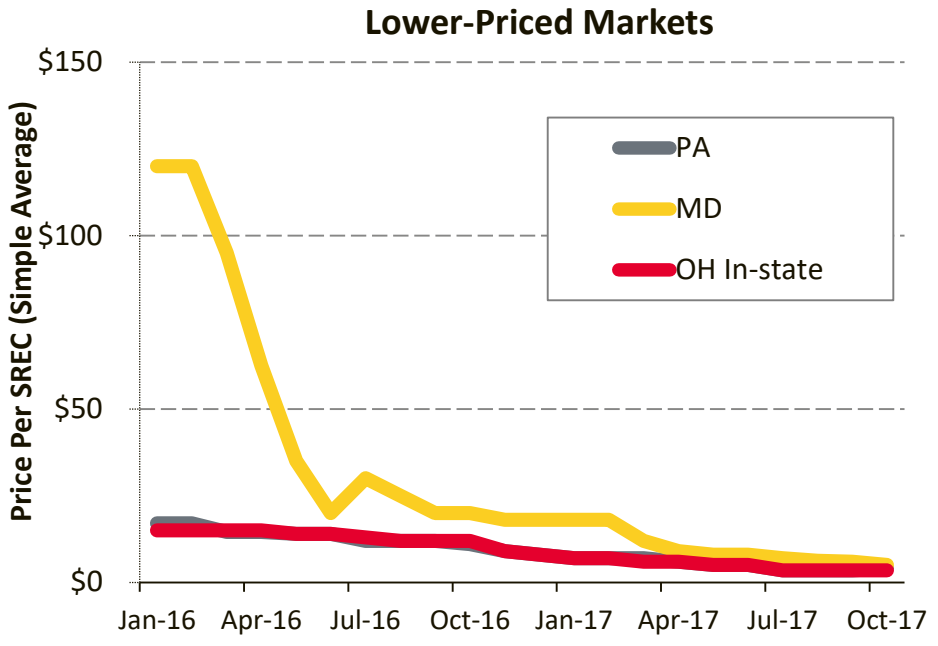
SREC Pricing



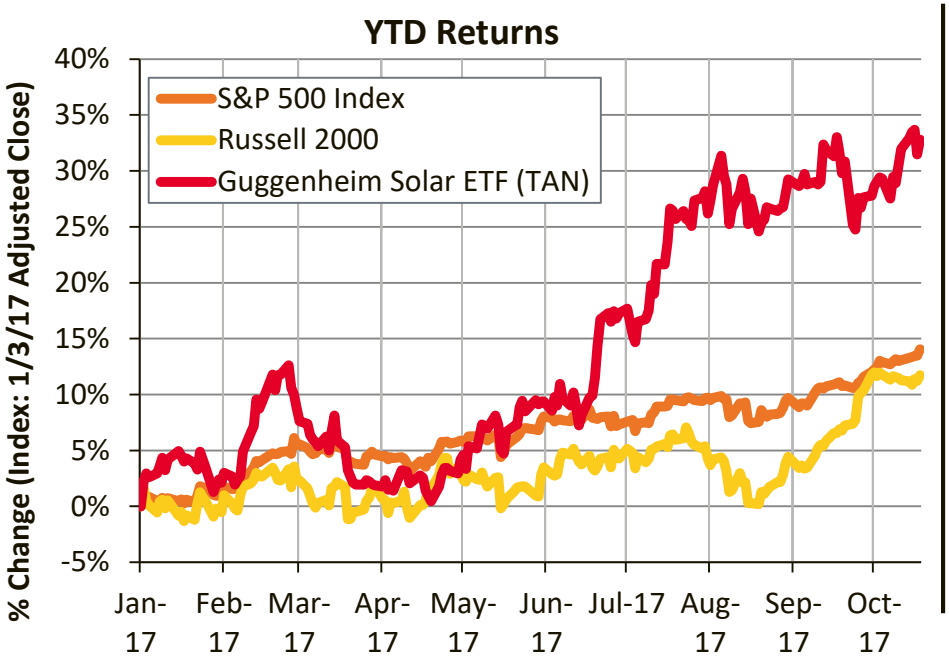


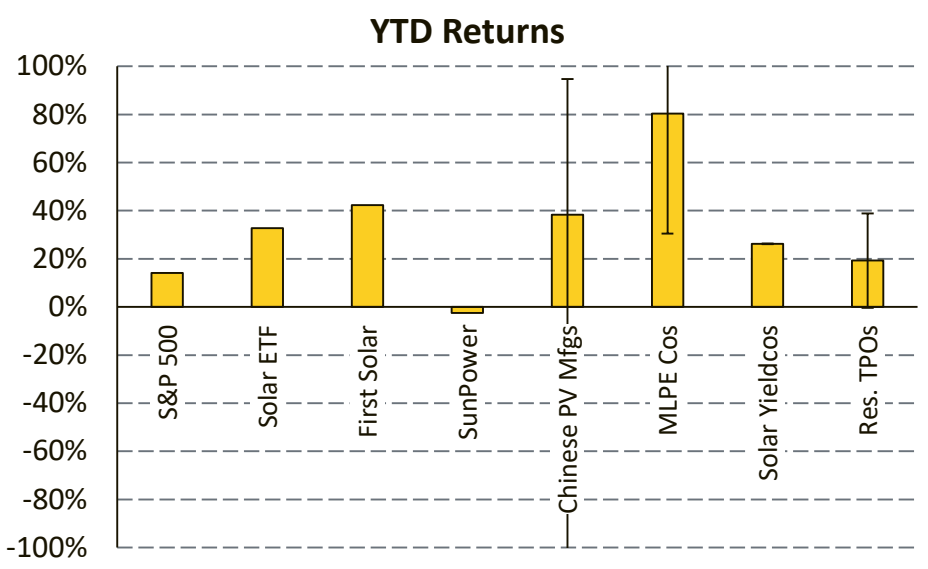
SREC pricing in higher-priced markets have decreased $0–$60/MWh in 2017 (0%–23%) and $3–$14/MWh in lower-priced markets.

Source: Blog, SRECTrade, www.srectrade.com (accessed 10/20/17).

Stock Market Activity

- Solar stocks made significant gains in 2017—up 33% from the beginning of the year, compared to 14% from the S&P500.
- While public companies in the solar space have performed well in 2017, overall there is wide variety by market segment and company.
  - First Solar and SunPower, which received 83% and 85% of their net sales in 2016 from the U.S. market respectively, and which both produce the majority of their modules abroad, would experience drastically different outcomes if the Section 201 tariffs are put in place in the United States.
  - While Chinese PV manufacturers' margins have been damped by low pricing, their largest market (China) has experienced larger than expected growth.





Notes: Average market cap. of securities in TAN was $9.8 billion (12/31/16), Russell 2000, $1.6 billion (6/27/16).
Sources: Stock market: Yahoo Finance (07/28/17).

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Thank You

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List of Acronyms and Abbreviations

AC	alternating current
AD	antidumping duty
ASP	average selling price
BNEF	Bloomberg New Energy Finance
CSP	concentrating solar power
CVD	countervailing duty
DC	direct current
DG	distributed generation
ETF	exchange traded fund
FIT	feed-in-tariff
G&A	general and administrative expenses
GW	gigawatt
kW	kilowatt
kWh	kilowatt-hour
ILR	inverter loading ratio
LBNL	Lawrence Berkeley National Laboratory
LSC	low-cost storage
MFG	manufacturing
MLPE	module-level power electronics
MW	megawatt
MWh	megawatt-hour
NEM	net energy metering
O&M	operation and maintenance
PPA	power purchase agreement
PURPA	Public Utility Regulatory Policies Act
Q/Q	quarter over quarter
ROW	rest of world
SG&A	selling, general and administrative expenses
SHS	solar home system
SREC	solar renewable energy certificate
TPO	third-party owned
USITC	United States International Trade Commission
W	watt
WACC	weighted average cost of capital
y/y	year over year
YTD	year to date