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U.S. Department of Energy

Q4 2016/Q1 2017
Solar Industry Update

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April 25, 2017

NREL/PR-6A20-68425

Executive Summary

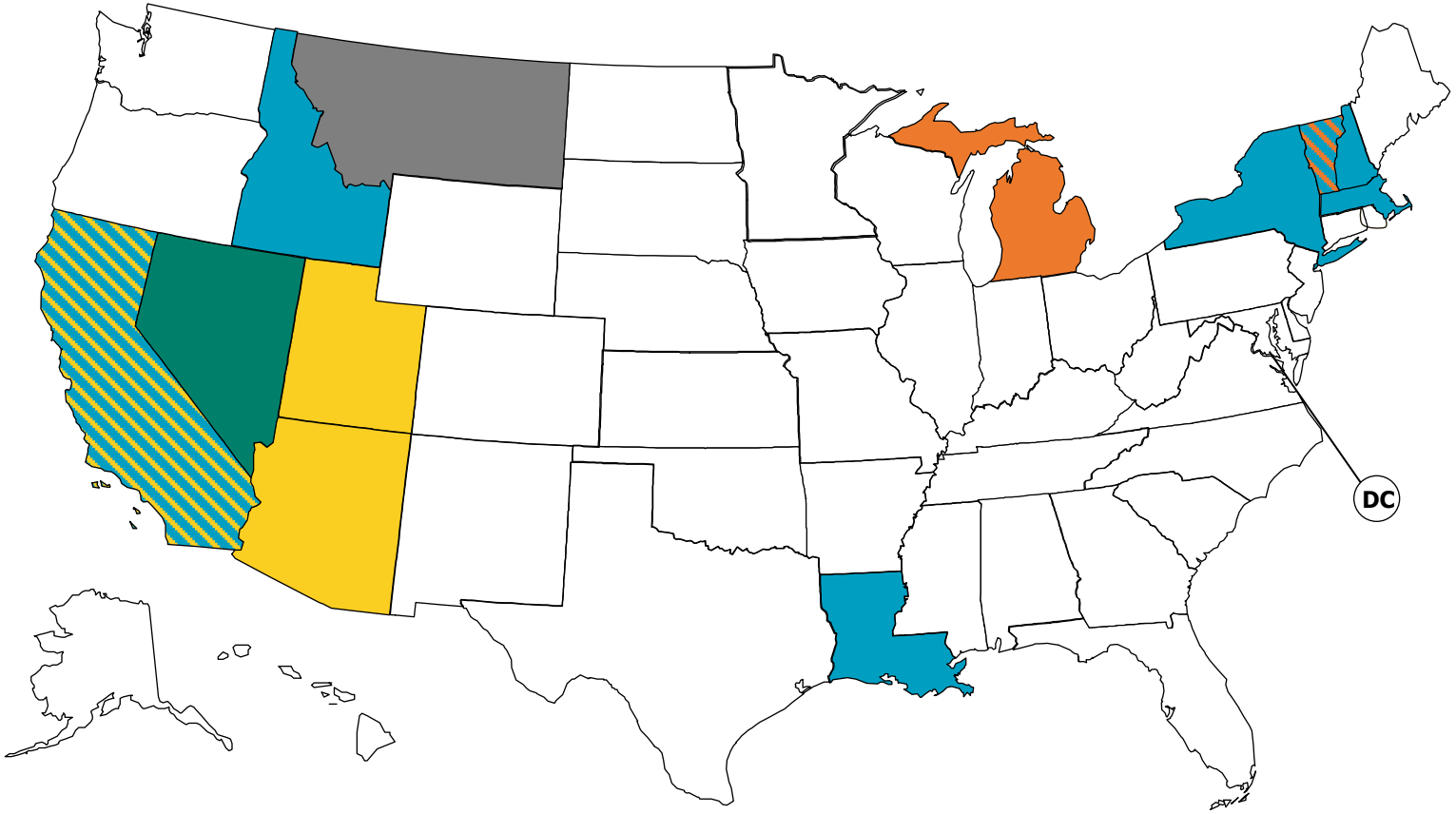
- The United States installed 14.8 GW_{DC} of PV in 2016, an increase of 97% from 2015, representing ~$30 billion in deployed capital, along with another $2.2 billion in U.S.-manufactured PV products.
  - The United States ranked 2nd globally in annual PV installations behind China.
  - Cumulatively the United States had installed 40.4 GW_{DC} at the end of 2016 and has installed over 1.25 million PV systems.
  - 1.4% of electricity generated in the United States in 2016 came from solar facilities.
  - While composing only 3% of U.S. installed electric generation capacity, solar compromised the largest share of electric generation capacity additions in 2016 (~40%).
- China installed approximately 34 GW of solar in 2016, 77 GW cumulatively, and now has more solar capacity than the second largest market, Japan, by 34 GW.
- In 2015, three states enacted net metering changes that lowered exported energy credit to below retail rates; however, seven states increased their net metering cap—there are now 22 states with NEM regulations, studies or proceedings pending.
- In Q4 2016 residential installation costs (excluding SG&A) for two of the leading firms was around $2.05/W with total costs ranging from $3.0/W to $3.5/W.
- PV modules continue their sharp decline in price from the second half of 2016 with many analysts estimating module ASP to be around $0.35/W.
  - These low prices caused global module manufacturers to have their sharpest decline in gross margin since 2012.

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

Agenda

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

Legislative/Regulatory Action for Net-Metering Effecting PV Enacted in 2016



- NEM Cap Increased (7 States)
- NEM Legislation Passed (2 States)
- NEM Rule Or Process Changes (4 States)
- NEM Restored (1 State)
- Solar credited between wholesale and retail rate (3 States)
- Solar Credited at Wholesale Rates or Below (0 States)

Source: Meister Consultants Group, *50 States of Solar: Net Metering Quarterly Update* (Q4 2016).

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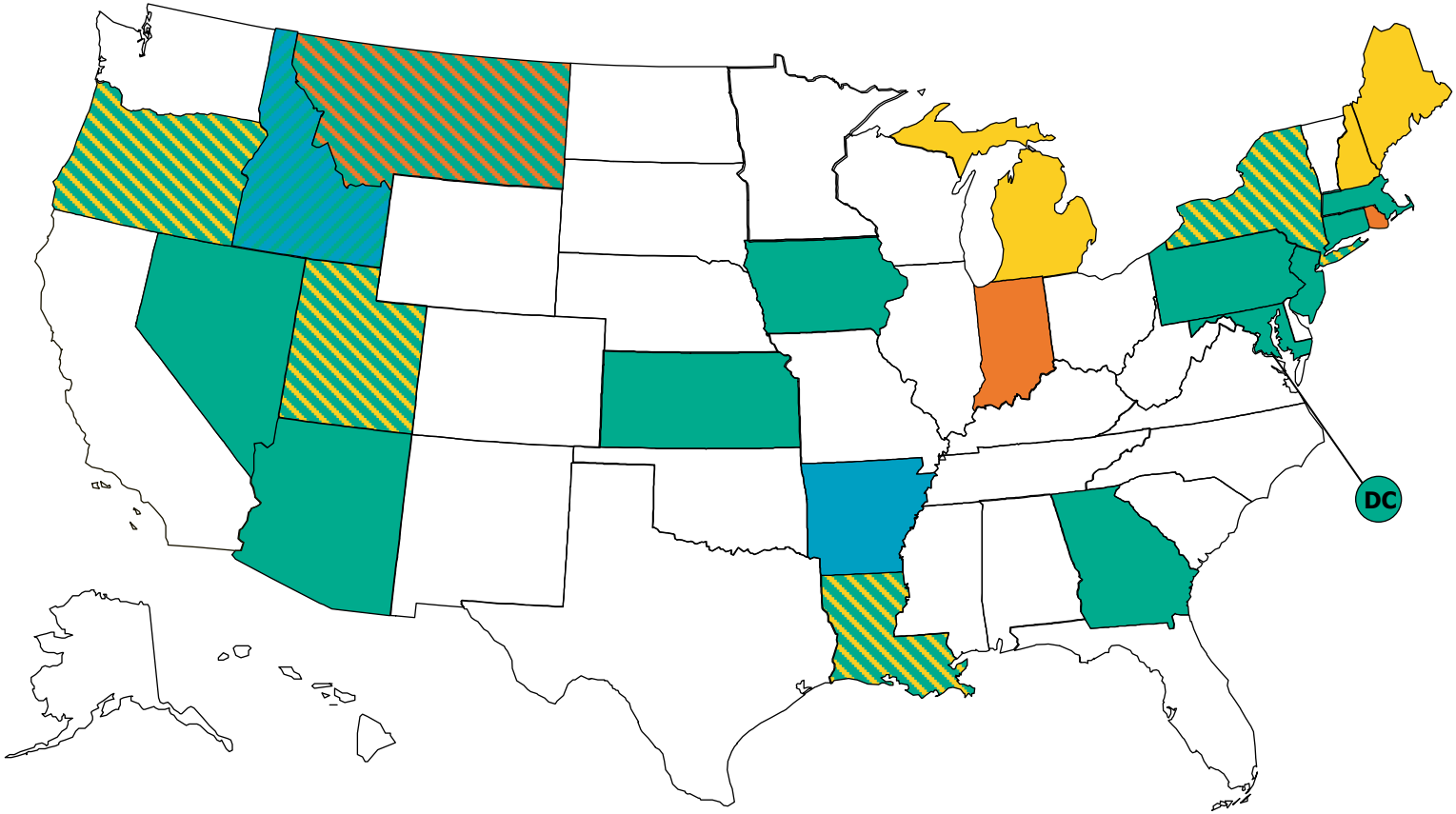
States with Pending NEM Regulations, Studies or Proceedings



Pending NEM Legislation (2 States)

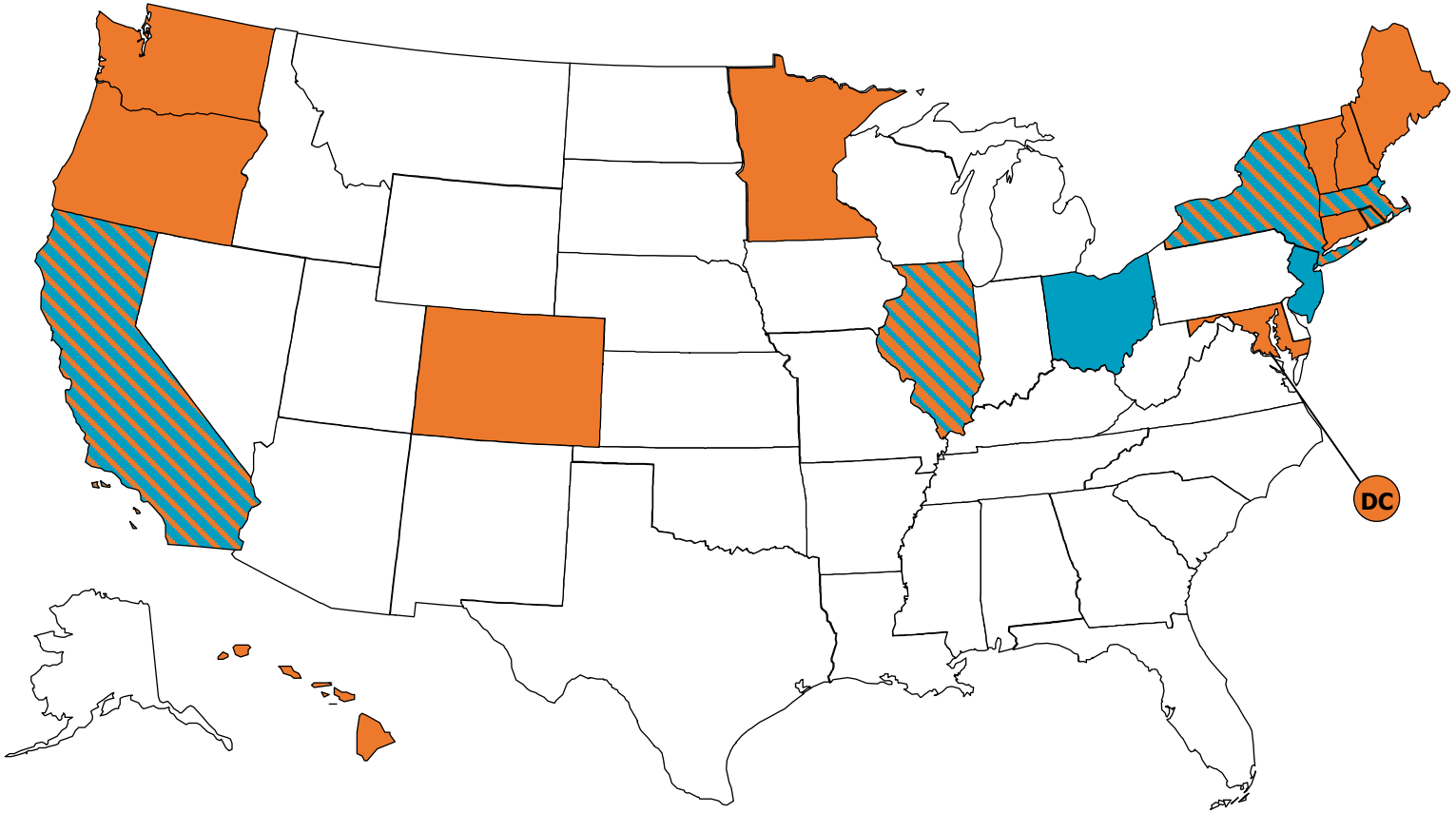
Active NEM Bill in State Legislature (3 States)

Pending Commission Proceeding or Docket (7 States)

DG Solar Valuation Study in 2016 (16 States)

Source: Meister Consultants Group, *50 States of Solar: Net Metering Quarterly Update* (Q4 2016).

Community Solar and Community Choice Aggregation



Community Solar Enabled (15 States)

Community Choice Aggregation (7 States)

Source: Meister Consultants Group, *50 States of Solar: Net Metering Quarterly Update* (Q4 2016)., National Council of State Legislatures.

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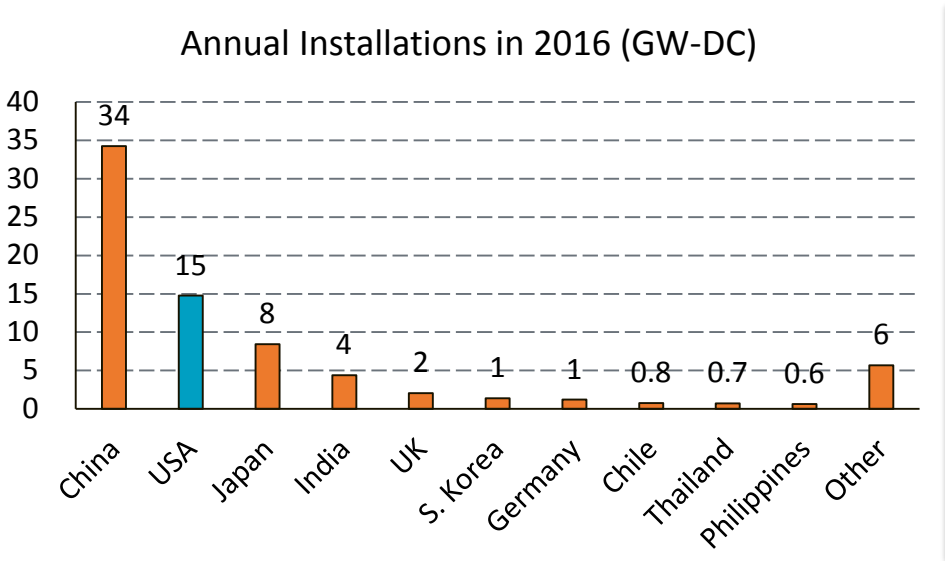
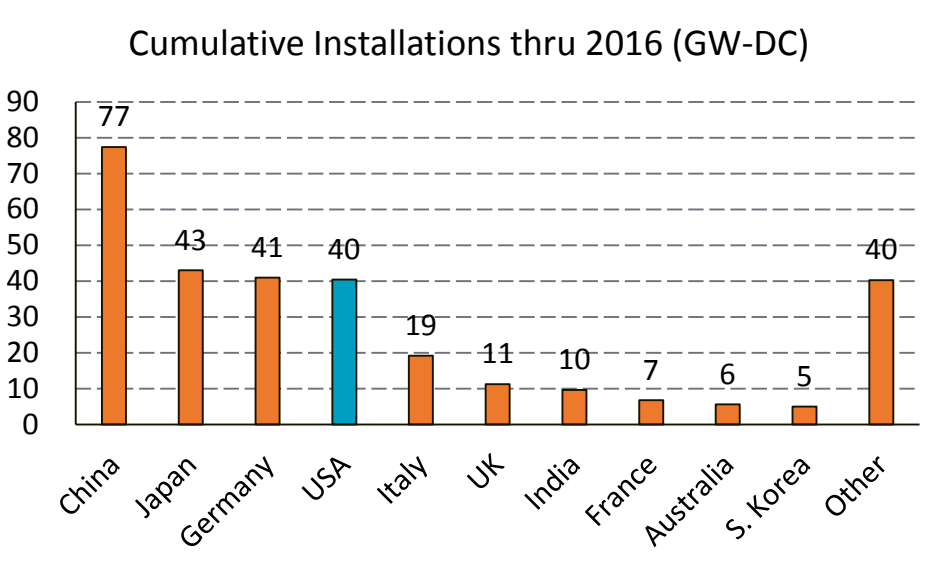
Top Ten PV Markets by Country





- At the end of 2016, global PV installations reached 299 GW_{DC}, up from 225 GW_{DC} in 2015.
  - An annual increase of 74 GW_{DC}
  - In 2001, there was only 1 GW of cumulative installations; the industry has thus grown by a factor of 298.
- Globally, the United States installed the second most PV capacity in 2016 and is now one of the top four markets in cumulative capacity—including CSP, it is nearing the second largest global solar market.
- The top ten markets represented 92% of annual PV installations in 2016.
  - China represented 46% of annual global installations in 2016.
- Despite a large concentration of installs in a few markets, many new markets are expanding around the world
  - From 2012 to 2016, Asian countries (other than China, Japan, and India) installed 8.6 GW, African countries installed 2.1 GW and South American countries installed 1.8 GW.

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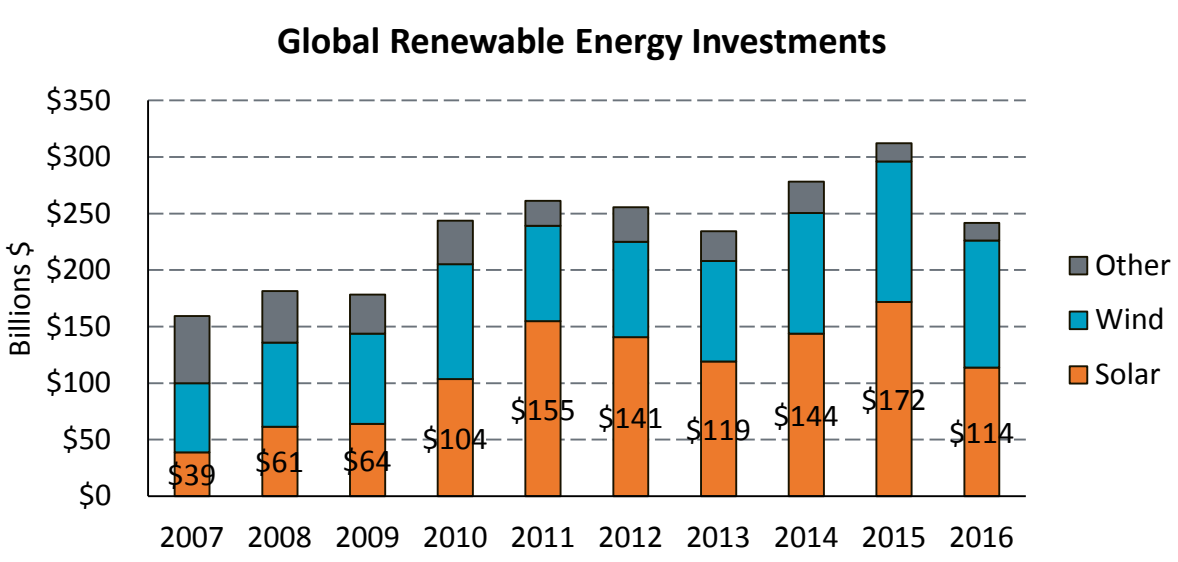
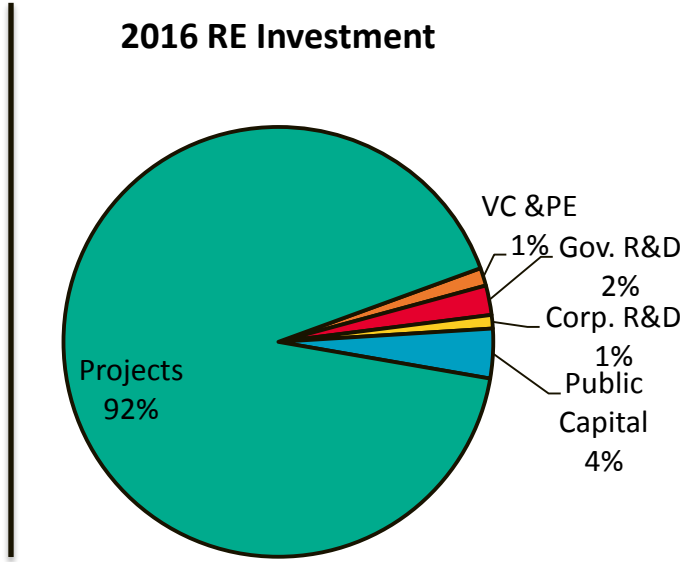
Source: All statistics from: IRENA "Renewable Capacity Statistics 2017," except United States from (GTM Research & SEIA: SMI 2016 Year-in-Review," and Japan from RTS Corporation.

Global Renewable Energy Investment





- $242 billion of investments were made in the renewable energy industry in 2016, down 23% y/y.
  - Approximately $114 billion of investments went into the solar industry, down 34%.
- The drop in investments belies the fact that there was a record level of renewable power capacity added in 2016 (~140 GW).
  - Renewable energy project costs dropped by more than 10% in 2016.
  - Many of the projects installed in 2016 were financed in 2015 and there was a slowdown in investments in China, Japan, and the developing world.
- The vast majority of investments dollars went to projects, rather than company development and R&D.
- Solar R&D investment fell 20% to $3.6 billion ($1.6 billion from corporate R&D, $2.0 billion from government R&D) mostly due to a 39% reduction in corporate R&D.

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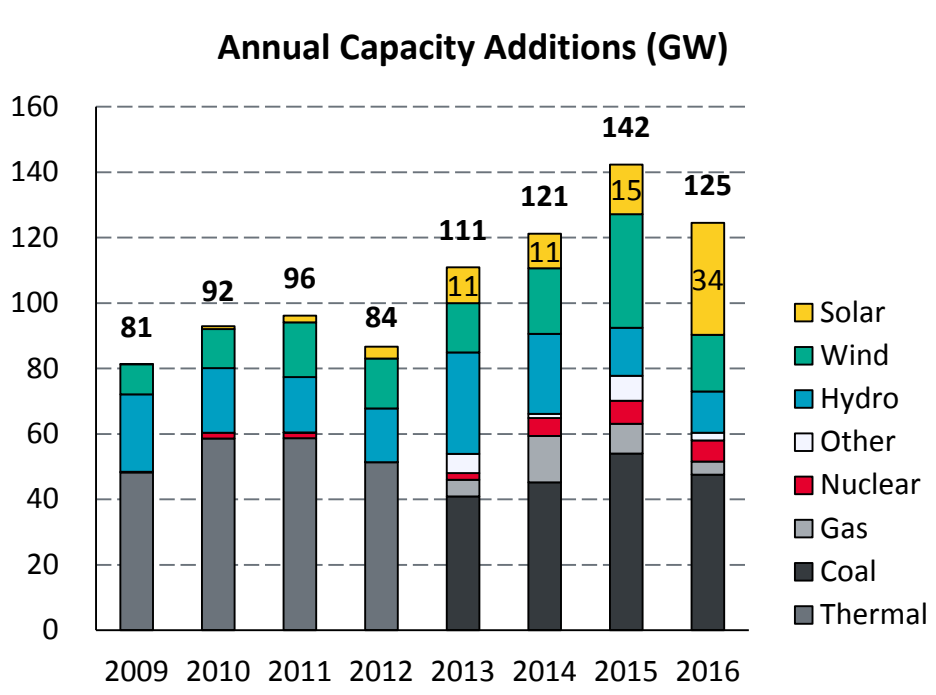
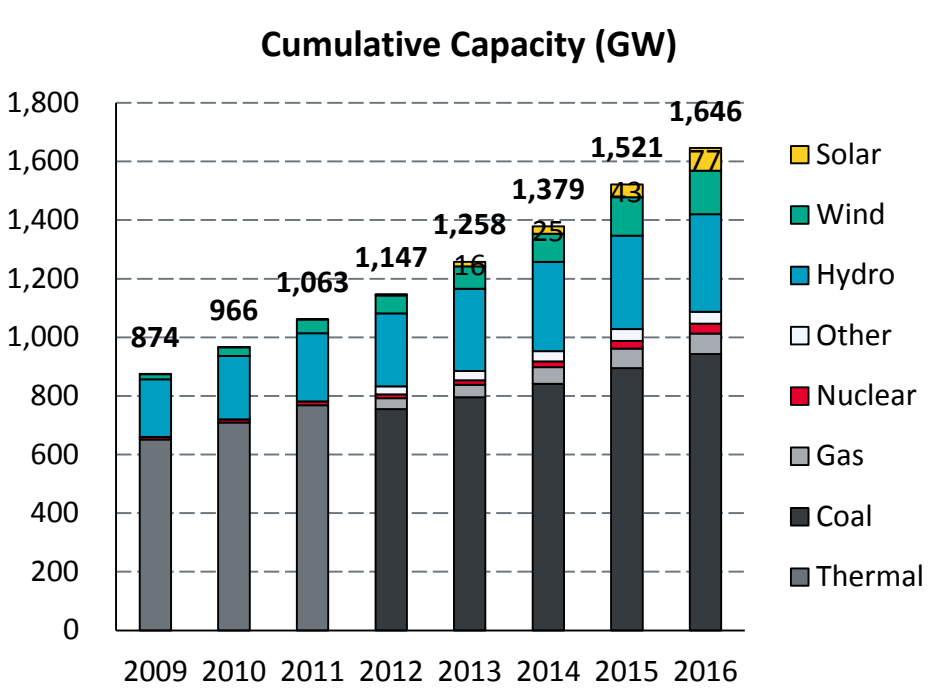
Source: Global Trends in Renewable Energy Investment: 2017. FS-UNEP Collaborating Centre/BNEF.

Chinese Generation Capacity Additions by Source





- In 2016, solar contributed 28% to new generation capacity in China (34 GW) and 5% of cumulative capacity (77 GW).
- Since 2009 China has doubled its installed electric generation capacity, and at the same time reduced the percentage of total thermal capacity, from 76% to 64%.
  - From 2010 to 2016, new thermal generation capacity as a percent of total new capacity was reduced from 63% to 43%.

Source: China Electric Council, accessed 04/11/17.

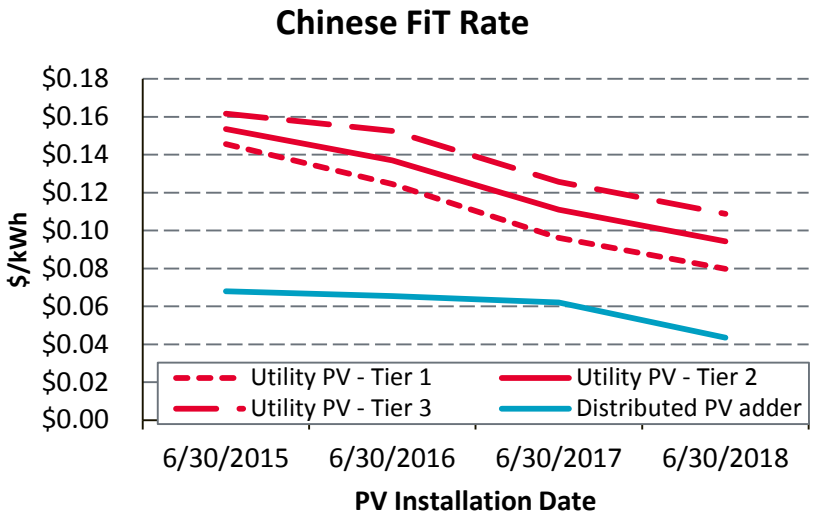
China Update

- China reported installing 34 GW of PV in 2016, compared to 15 GW in 2015, bringing its cumulative total installed PV capacity to 77 GW.
  - In 2016, 30 GW of installations came from power stations and 4 GW from distributed PV systems—representing a similar proportion to previous years.
- China reduced its five-year plan PV installation target to 105 GW (from 150 GW), leaving 30 GW to be installed by 2020; however, the previous target was seen as a ceiling and the new target is viewed as a floor.
  - China also has a target of 5 GW of CSP by 2020; however, unlike PV, it has fallen short of previous CSP targets.
  - In December 2016, China also revised its 105 GW target which previously included a 60 GW DG PV target; thus far the majority of PV installations in China have been utility-scale.
  - Not included in the installation target are the Top-Runner and Poverty Alleviation Programs:
    - The Poverty Alleviation Program has the goal of installing solar panels on the roofs of 2 million poor families by the end of 2020.
    - The Top-Runner program aims to accelerate PV technology improvement by setting module efficiency standards.
  - Analyst projections of 2017 Chinese PV deployments range from 15 GW to 30 GW, which would still make it the largest PV market by a wide margin.

Note: Some analysts believe that a portion of the 34 GW of reported installations in 2016 were actually built in 2015.
Source: BNEF (03/30/17); CleanTechnica (12/09/16); Digitimes (03/28/17); Mercom (01/23/17); UBS (03/27/17).

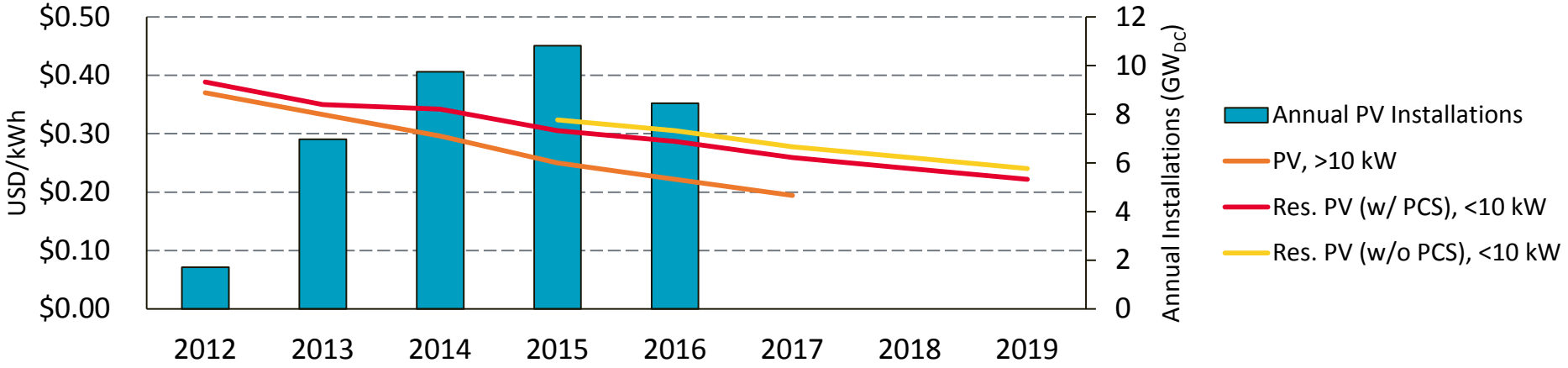
China Update (cont.)

- 22 GW of the 34 GW of PV projects built in 2016 were installed in the first half in order to qualify for a higher FiT; Chinese deployment picked up again in 2016 with the announcement of a 13%-19% FiT cut set to take effect in July 2017, as well as the reduction in module pricing.
  - In 2017, some installers are expected to interconnect PV systems in H1 before all of the system is built to receive the higher FiT.
- China is introducing a voluntary REC program for which PV projects can register; they will decide in 2018 whether to make it mandatory.
  - Under the program projects receive payments for RECs for energy, in lieu of FiT payments, which cannot exceed FiT rates. Currently, project owners often wait two years to receive FiT payments, so the REC program may actually improve project cash flow.
- Chinese developers are focusing on projects closer to population centers for easier interconnection; however, they face higher land costs, including taxes on agricultural land.



Source: BNEF (03/30/17); CleanTechnica (12/09/16); Digitimes (03/28/17); Mercom (01/23/17); UBS (03/27/17).

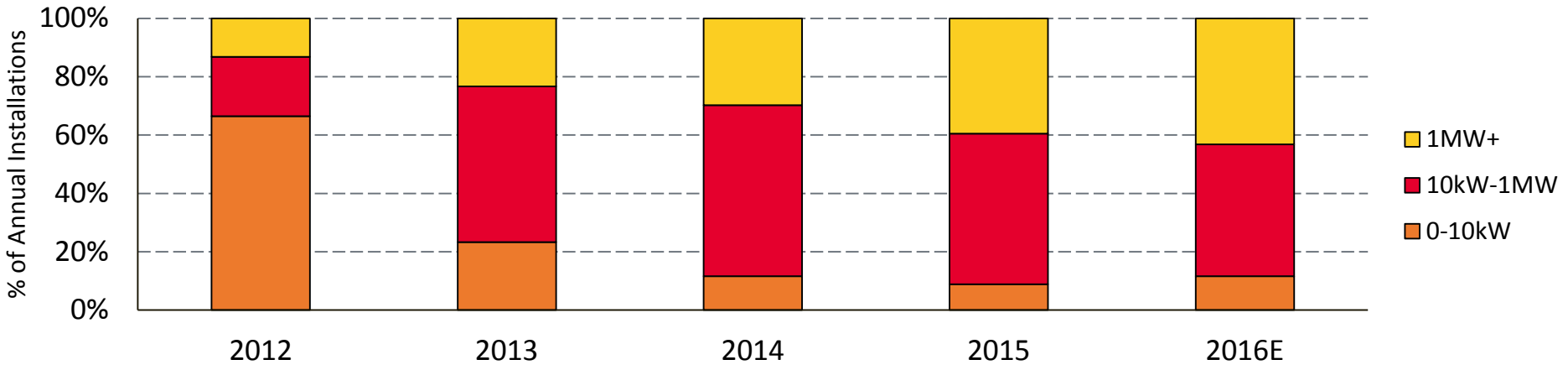
Japan Update



- Japan installed approximately 8.5 GW_{DC} of PV in 2016, compared to 10.8 GW_{DC} in 2015, surpassing Germany as the country with the second highest total PV capacity, with 43 GW.
  - PV represented 4.3% of electricity production in 2016 in Japan—up from 2.7% in 2015.
  - PV installations are expected to fall again in 2017 to ~7.5 GW.
- In March 2017 Japan announced revisions to its FiT program:
  - 10-year FiT for residential systems < 10 kW and without power controlling systems (PCS) will drop from JPY31(~$0.26) to JPY28 (~$0.24) in EY 2017, JPY26 in EY 2018, and JPY24 in EY 2019.
  - 20-year FiT for systems >10 kw began at JPY42 (~$0.36)/kWh in 2012 and fell to JPY24 (~$0.20)/kWh in April 2016 will drop to JPY21 (~$0.18) in April 2017 (when energy year starts).
  - Starting in EY 2018, Japan will have an auction mechanism for PV systems above 2 MW in size.
  - There have been far fewer FiT applications with the lower FiT rates; however, there are still over 45 GW of non-commissioned PV projects.

Notes: Japanese energy year starts in April. Values of feed-in-tariff (FiT) in chart are representative of energy year (EY); installations are representative of calendar year. In EY 2015 the FiT for Japanese PV systems larger than 10 kW was 29 JPY/kWh from April to June. JPY/USD exchange rate is held at 0.00925 for all years.
Sources: BNEF (01/30/17; 02/17/17); EnergyTrend (03/22/17); IEA PVPS NSR Japan (September 2016); Mercom (12/26/16; 01/23/17).

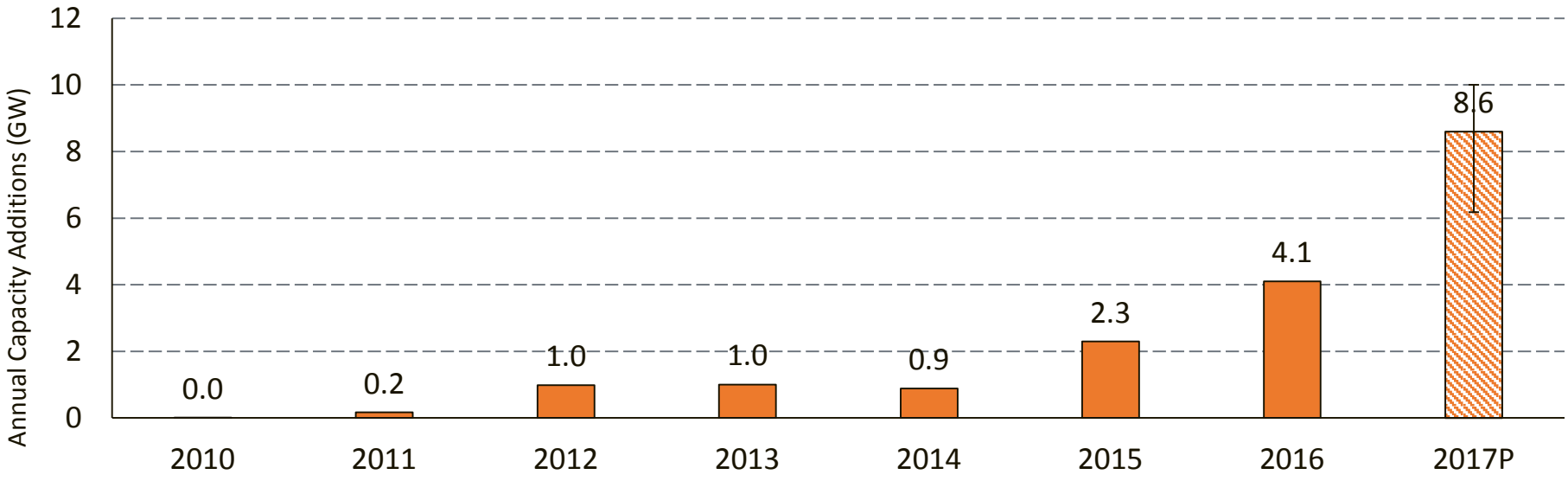
Japan Update (cont.)



- Japan's PV market consisted of primarily residential systems before the FiT; however, it has since transitioned to installing larger-sized plants.
- Japanese PV developers have expressed concern over high system prices and the risk of energy curtailment.
  - To date, curtailment has only occurred in two places—both islands—and typically on holidays with low-levels of demand.
  - In April 2017, Japan announced a plan to lower the cost of batteries installed with solar on home-rooftops by as much as 70% by 2021.
- Japanese PV manufacturing has fallen since 2013, from approximately 3.6 GW to approximately 2.7 GW in 2016.

Sources: BNEF (01/30/17; 02/17/17); EnergyTrend (03/22/17); Mercom (12/26/16; 01/23/17); SPV Market Research (April 2017).

India Update



- India has substantially increased PV deployment after years of uneven growth.
- The country installed roughly 4.1 GW of solar in 2016 (up from 2.3 GW in 2015).
  - Capacity additions have doubled every year since 2014, and analysts expect it to double again in 2017.
  - Solar currently represents about 1% of the nation's electricity load.
- The country is working to create a more effective policy environment, with analysts projecting between 6 GW and 10 GW of deployment in 2017.

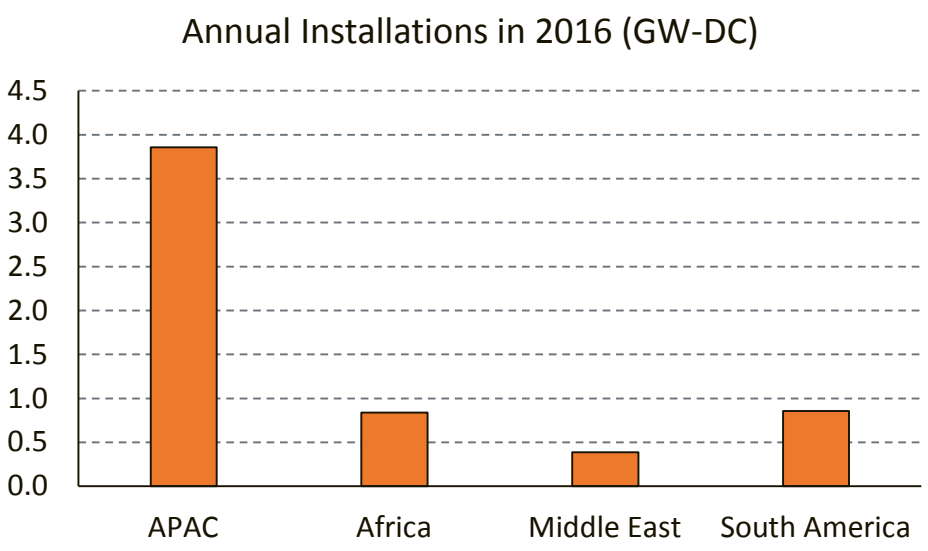
Sources: Mercom (1/2/17; (2/24/15); 2017 analyst projections from slide 18.

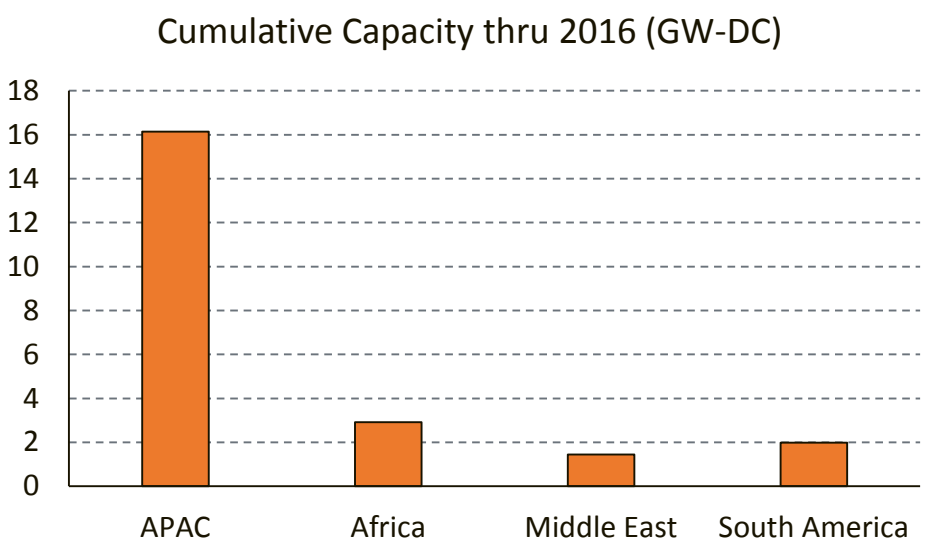
India Update

- **India has set aggressive targets for solar, but has had difficulty meeting interim goals.**
  - The country has a goal to deploy 100 GW of PV by 2022, but had only installed 10 GW of total capacity at the end of 2016.
  - Developers have indicated that frequently changing policies have inhibited growth in the short term.
- **India has looked toward a variety of methods to incentivize solar deployment.**
  - Utility scale deployment has also been driven by solar parks (right of way zones with transmission access). The government has set a goal of 40 GW (recently doubled from 20 GW) of utility scale PV deployment in solar parks.
    - India was one of the first countries to use tenders (reverse auctions) to facilitate PV deployment.
  - The nation has relatively generous SRECs that were priced between $86 and $52/SREC in 2016; these prices are expected to decrease substantially in 2017.
  - Some states are also providing subsidies for net metered rooftop systems, and the national government has set a goal of 40 GW of rooftop PV by 2022.
  - India has indicated that while it will incentivize PV deployment, it will not subsidize domestic manufacturing.
- **PV deployment targets are closely tied to economic development targets.**
  - Electricity demand could quadruple by 2040, as the country's population and economy expand.
  - As over 300 million Indians do not have access to the electricity grid, the strategy of employing both centralized and DG PV is seen by the government as a way to electrify rural communities while curbing pollution in urban centers.

Sources: Mercom (3/30/17; 3/24/17; 3/10/17; 3/6/16), World Bank (6/30/16); PV Tech (6/2/15), CleanTechnica (2/30/17); Sivaram, "The Global Warming Wild Card"

Emerging Market Update





- PV Deployment continues to be driven by a few nations, but some smaller countries have reached GW levels of deployment.
- South Korea has set ambitious goals for PV, announcing $28 billion of investment into renewables by 2020; 5 GW of PV capacity were installed in 2016.
- Chile remains the market leader in South America, and it has begun construction on the largest solar park in the Americas, a 754-MW set of projects that will begin generating in 2018.
- Nigeria has signed over 1 GW of PPAs for solar projects, that are beginning construction in 2017.
- Saudi Arabia issued tenders for 700 MW of solar and wind projects, as part of a $50 billion push to cut oil consumption.

Source: All statistics from: IRENA "Renewable Capacity Statistics 2017," Bloomberg (4/17/17); CleanTechnica (4/17/17), PV Magazine (7/7/16).
Note: APAC includes all listed IRENA countries in Asia and Oceana, except China, India, and Japan.

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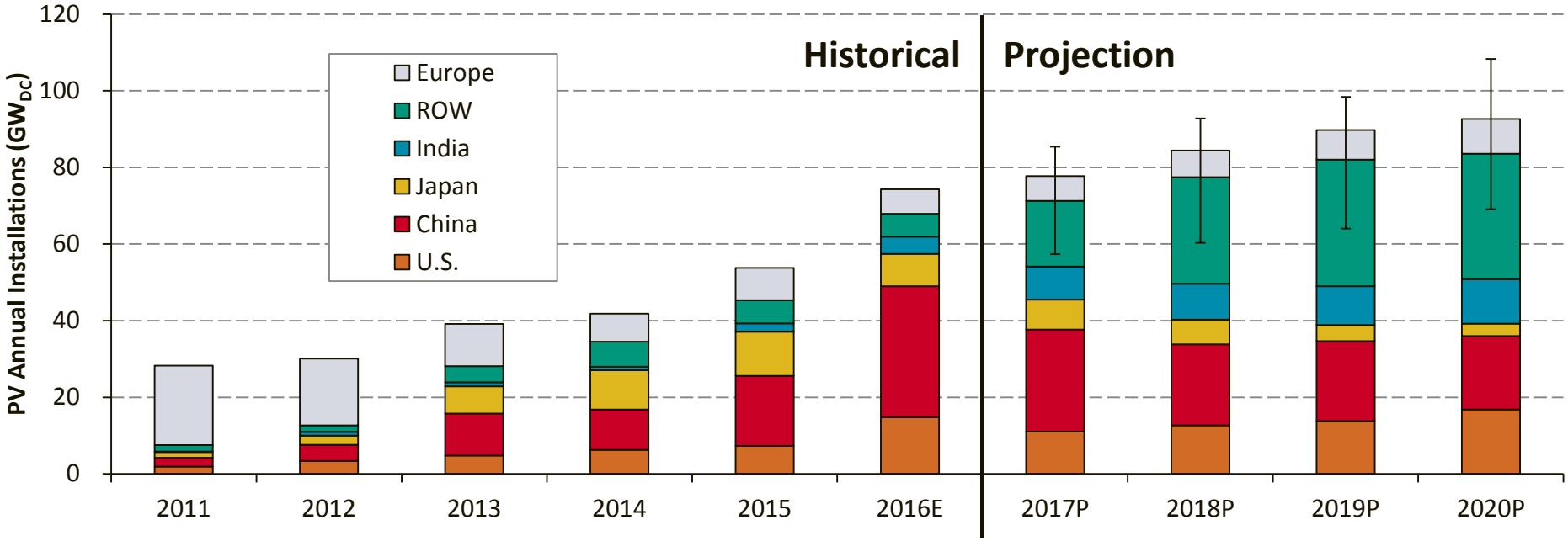
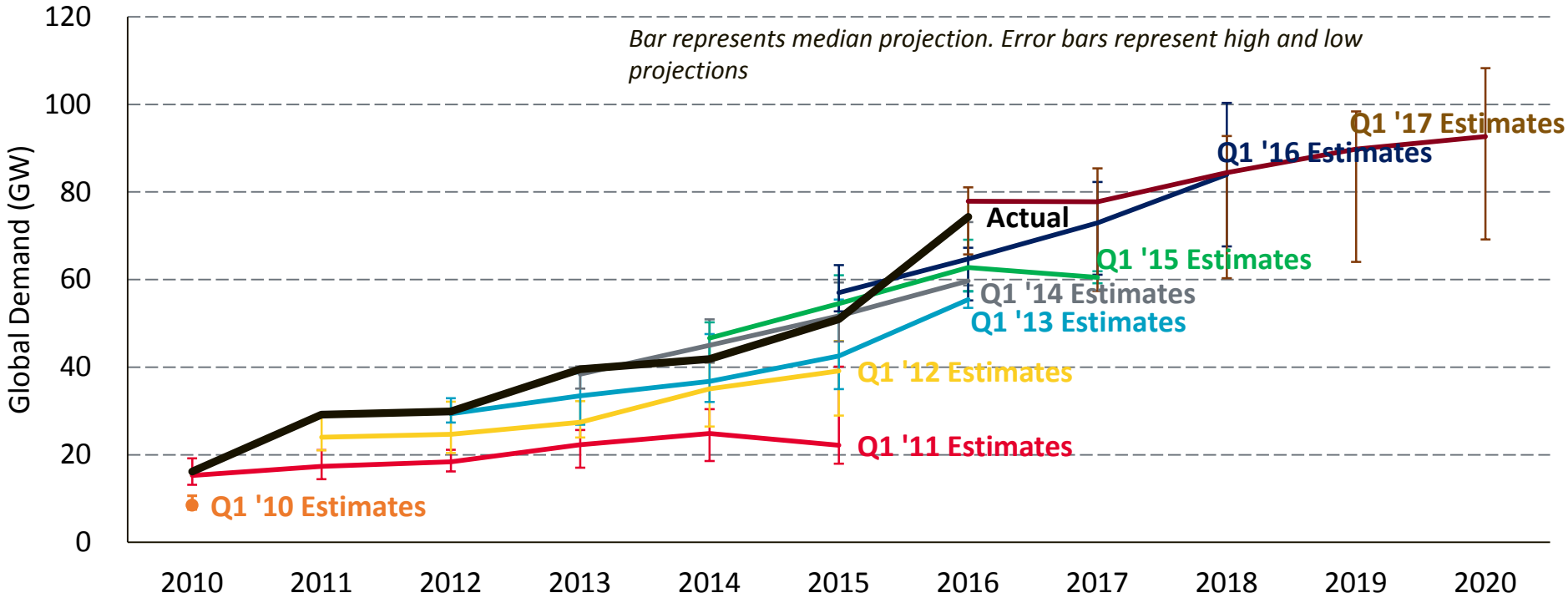
Annual Global PV Demand



- Analysts recently estimated that approximately 75 GW of PV was installed globally in 2016 (54 GW in 2015), bringing the cumulative total to ~300 GW.
  - China (~34 GW) and the United States (~15 GW) were the two largest markets in 2016.
- Annual global installations are projected to grow to be 69 GW–109 GW by 2020.
  - The median analyst figures estimate that 380 GW of PV will be installed globally from 2017 to 2020, more than doubling current installed capacity.
  - The majority of the growth is expected to come from emerging markets (ROW).

Note: E = estimate. P = projection. Bar represents median projection. Error bars represent high and low projections.
Sources: 2016 figures from slide 8. Other data displayed represent the median figures from the following sources: BNEF (02/17/17); Cowen & Co. (10/16/16); Deutsche Bank (04/24/17, 03/09/17, 10/19/16); Goldman Sachs (01/02/17), GTM Research (January 2017); IHS Technology (03/31/17); UBS (January 2017).

Historical Projections vs. Actual Global PV Deployment



- Analysts have historically underestimated future PV deployment, particularly in years with large changes in deployment (e.g., 2011, 2016) and for longer-term projections.
  - The median analyst projection, made in Q1 2011, for global deployments in 2015 was 22 GW and the highest projection that period was 40 GW—actual deployment was approximately 50 GW in 2015.

Notes: Analyst projections may vary due to differing methodologies of projecting ***installations*** or ***shipments***. Median, maximum, and minimums may also vary because of the differing set of analyst projections for each year. Q1 estimates also include estimates made in Q4 of the previous year.
Sources: 56 separate estimates from 20 institutions.

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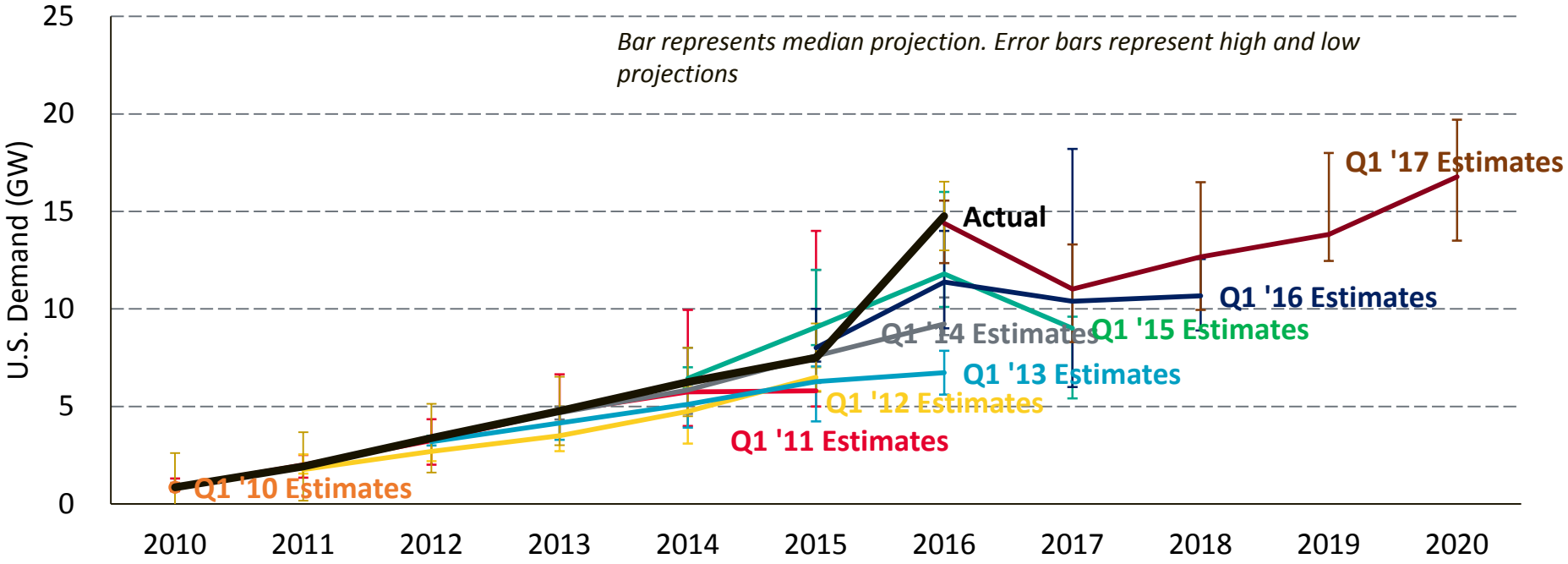
Historical Projections vs. Actual U.S. PV Deployment



- Due to relatively stable federal policies in the United States, the median projections were relatively close to actual deployment.
- Despite knowing of the potential expiration of the ITC in 2016 most analysts historically underestimated PV deployment in that year.

Notes: Analyst projections may vary due to differing methodologies of projecting ***installations*** or ***shipments***. Median, maximum, and minimums may also vary because of the differing set of analyst projections for each year. Q1 estimates also include estimates made in Q4 of the previous year.
Sources: 56 separate estimates from 20 institutions.

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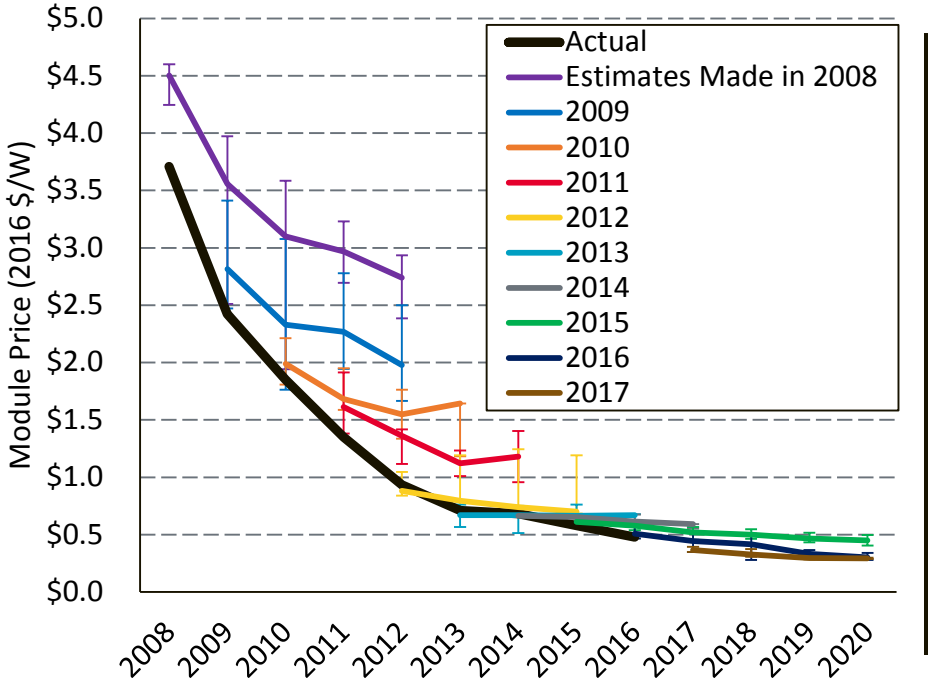
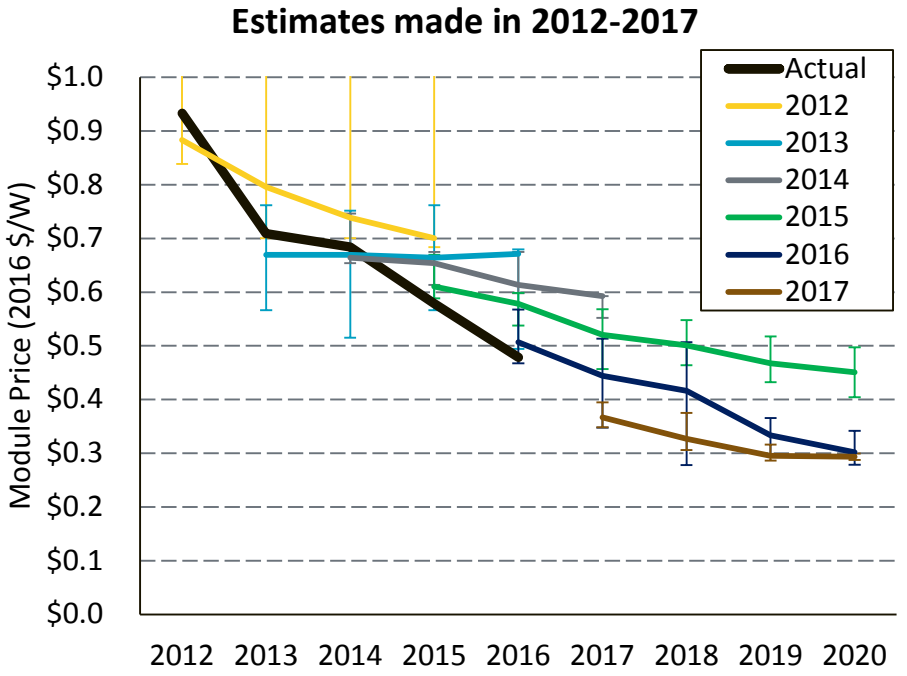
Historical Projections vs. Actual U.S. Module ASP





- Historical deployment likely exceeded expectations because PV pricing has dropped faster than historically expected.
- A rapid drop in module price from 2008 to 2012 caught many in the industry by surprise causing the module ASP for 2012 to be almost 3X lower than was expected in 2008.
- A similar trend is occurring in 2017—the median estimate of 2017 module ASP made in 2014 was approximately $0.57/W; in the first three months of 2017 the median estimate was $0.37/W.

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Notes: Median, maximum, and minimums may vary because of the differing set of analyst projections for each year.
Sources: 86 separate estimates from 17 institutions.

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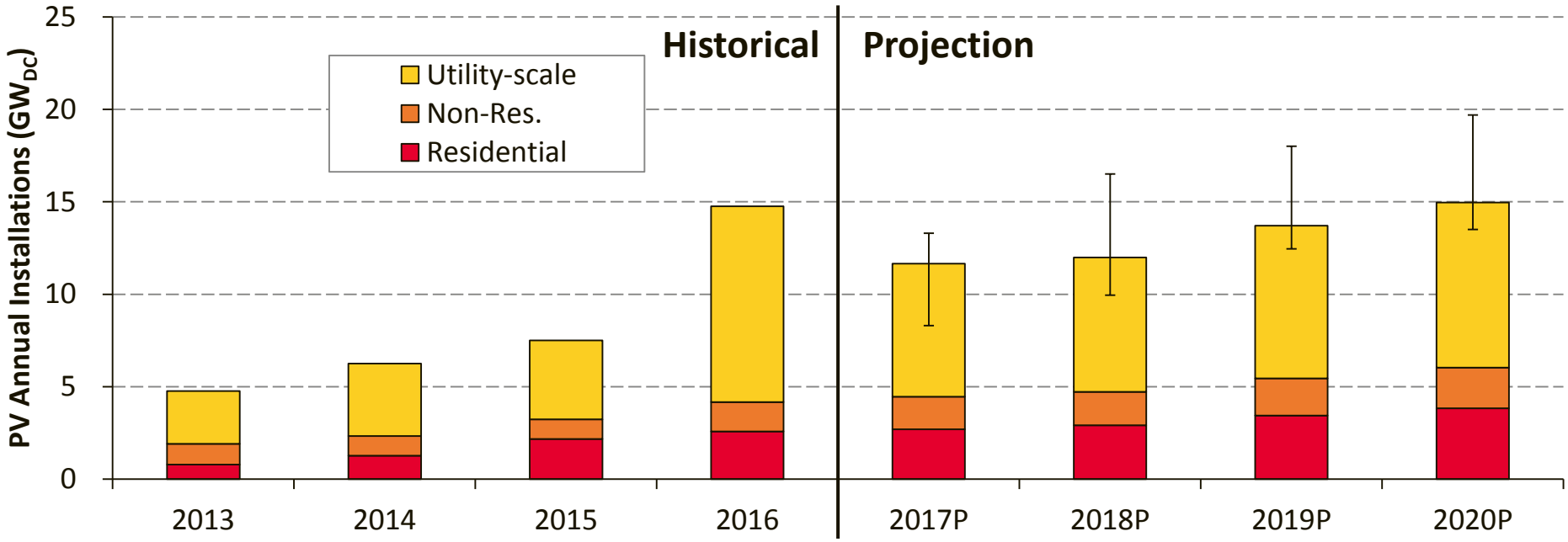
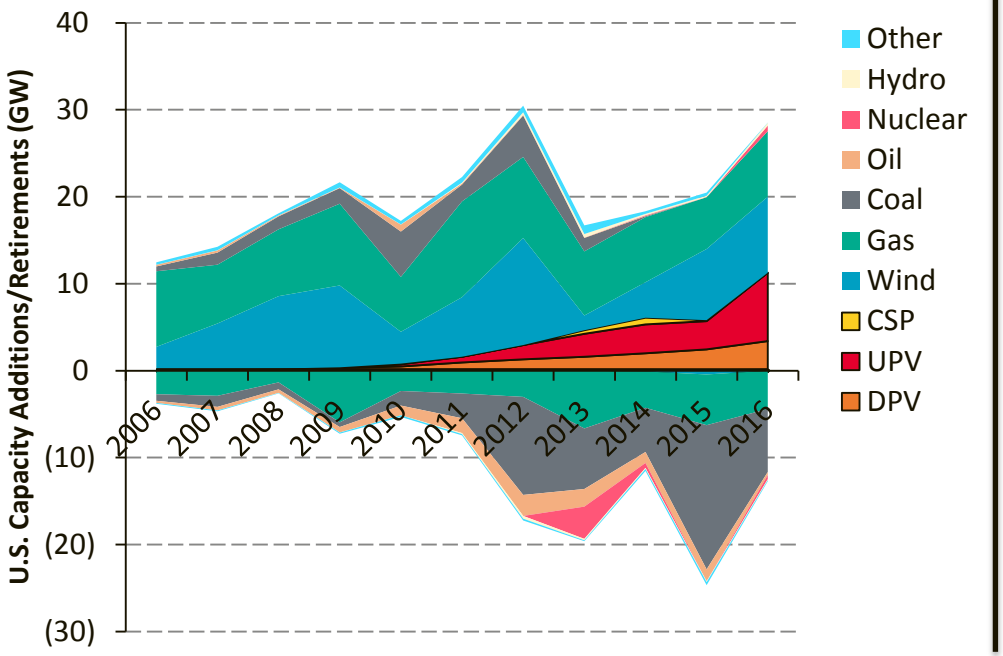
U.S. PV Demand

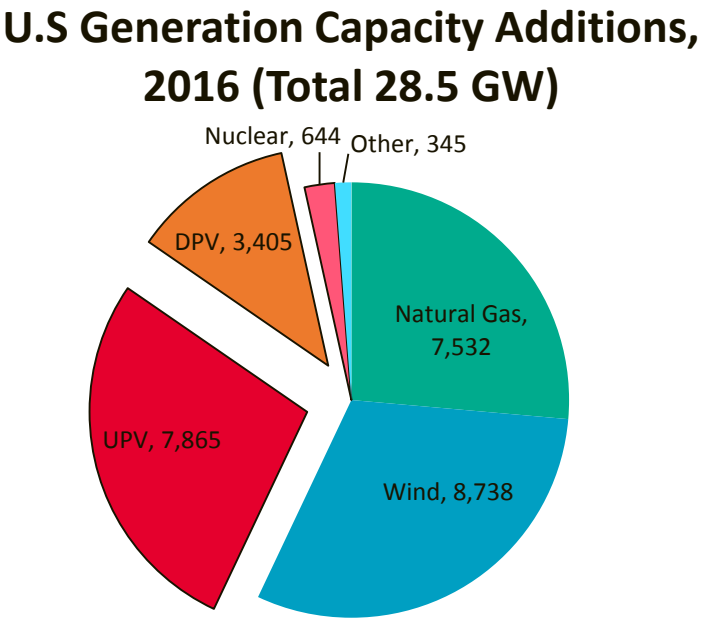


- Analysts estimate U.S. solar installations in 2017 will be between 8.5 GW and 13.5 GW - a drop from the 2016 peak, however, larger than every other previous year.
  - The drop in deployment is expected to come entirely from the utility-scale sector, as the other sectors are expected to grow between 2016 and 2017.
- The median analyst figures project that 50 GW of PV will be installed between 2017 and 2020, more than doubling the current installed capacity of 40 GW.
- Between 2017 and 2020, utility-scale PV installations are projected to remain the largest market sector; however, the distributed market is estimated to grow beyond 6 GW of annual deployment by 2020.

Note: P = projection. Bar represents median projection. Error bars represent high and low projections
Sources: 2013–2016 data from GTM Research & SEIA (U.S. SMI 2016 YIR); 2017-2020 data displayed represents the median figures from the following sources: BNEF (12/20/16); Cowen & Co. (08/23/16); Deutsche Bank (010/15/16); Goldman Sachs (01/02/17); GTM Research & SEIA (March 2017); IHS Technology (3/31/17).

U.S. Generation Capacity Additions by Source

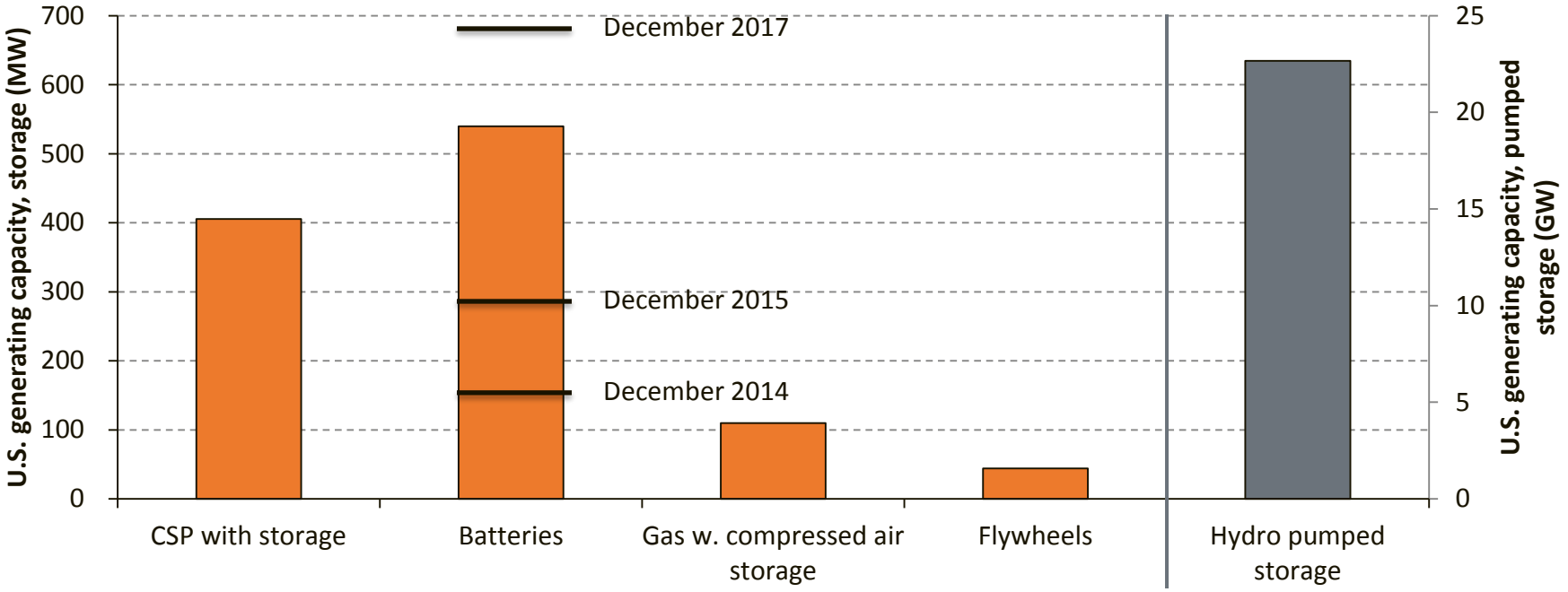




- In 2016, for the first time in U.S. history, solar was the largest source of new electricity generation capacity, with approximately 40% of all new generation capacity.
  - Wind and solar combined for 70% of new generation.
- U.S. has installed ~20 GW of new capacity per year in past decade, while retiring ~17 GW annually in the past five years—the retirements are mostly gas plants, which are being replaced, and coal plants.
  - It would take 50-60 years to change the entire U.S. generation fleet at the current pace of replacement.

Sources: 2004-2010 (except solar): EIA.U.S installed capacity, Form 860. 2011-2013: FERC: "Office of Energy Projects Energy Infrastructure Update for December 2012/2013/2014/2015." 2006-2013 Distribute Solar (DPV), GTM/SEIA, U.S. Solar Market Insight Q4 2014, using PV converted to AC using .8333 derate factor. 2014 DPV, SEPA "2014/2015 Solar Market Snapshot". 2009-2016 Utility PV, and 2015-16 DPV, EIA "Electric Power Monthly" (February 2017).

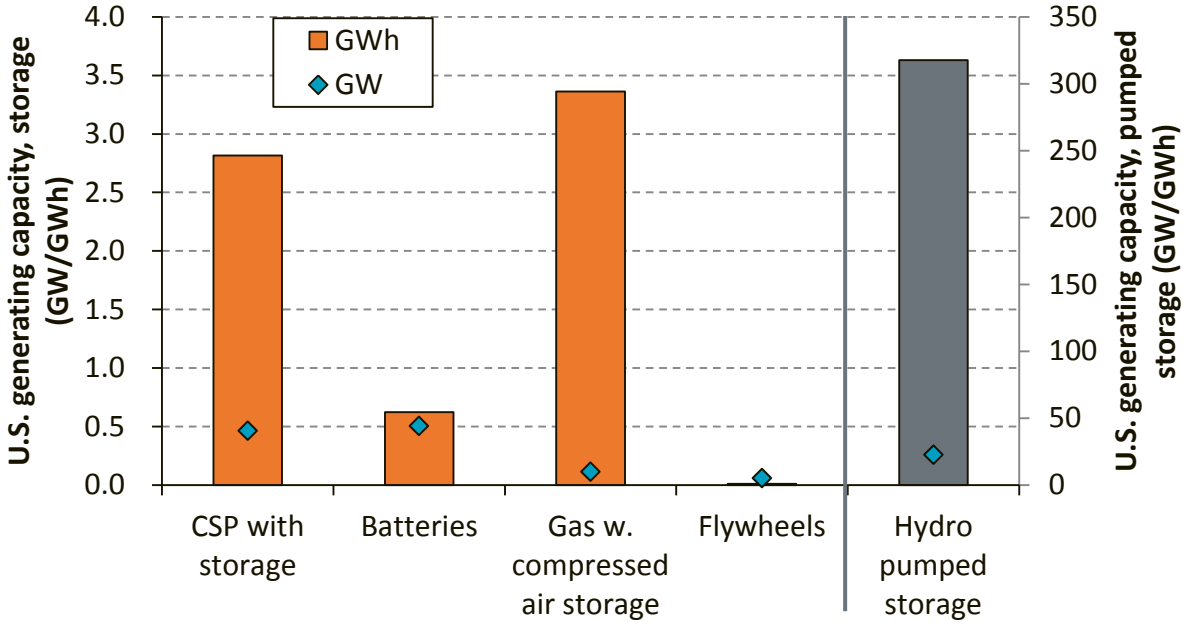
U.S. Electric Storage Capacity, December 2016

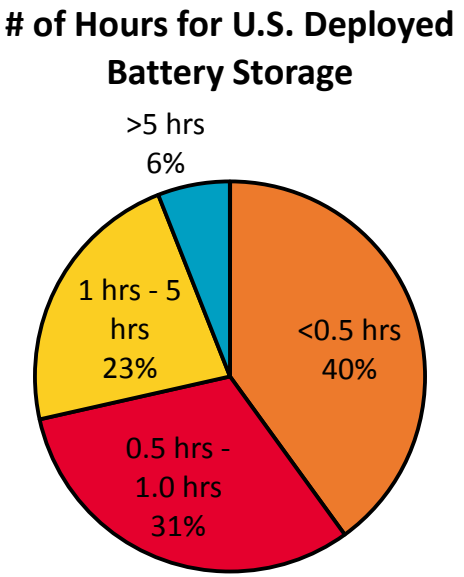


- As of December 2016, CSP had the third-largest storage capacity of any technology in the United States, behind pumped storage (23 GW) and batteries (540 MW).
- U.S. battery storage grew 85% in 2016, and the EIA plans for a further 26% increase in 2017 to 678 MW.
  - 2017 plans may underestimate battery growth as previous year's planned total was 24% of what was actually installed in 2016.

Source: EIA "Electric Power Monthly," Table 6.1. Electric Generating Summer Capacity Changes (MW), November 2016 to December 2016.

U.S. Electric Storage Capacity vs. Duration, April 2017

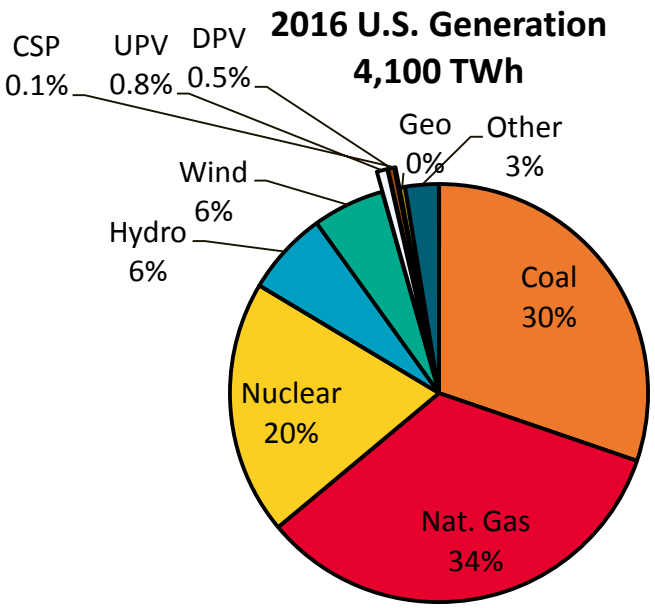


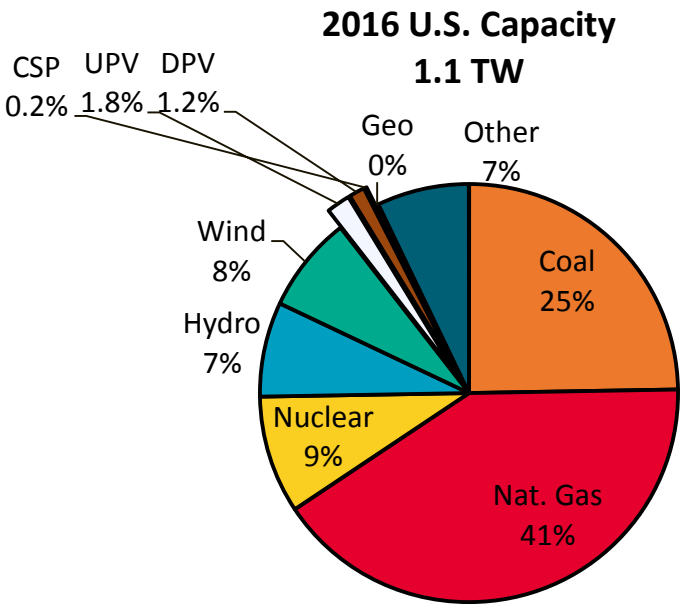


- Despite batteries growing to be the second largest source of storage in the United States they provide fewer hours of storage than other technologies, such as CSP.
  - For example, CSP plants with storage can provide, on average, six hours of energy, versus one hour for batteries.
  - 40% of U.S. deployed battery systems can provide fewer than 30 minutes of storage, while only 6% offer more than 5 hours of storage.
- Short- and long-term storage provide different services to the grid.
  - Short-term storage can smooth variability in generation while long-term storage can replace baseload power.

Source: Department of Energy "Global Energy Storage Database, accessed April 20, 2017. https://www.energystorageexchange.org/

2016 U.S. Capacity and Generation





- Despite solar representing a large amount of new generation, it still represents a relatively small amount of total U.S. capacity and generation.
  - At the end of 2016, solar represented 3.2% of net summer capacity and 1.4% of annual generation.
- 65% of U.S. generation came from fossil fuels in 2016 with another 20% coming from nuclear.
  - Capacity is not proportional to generation as certain technologies (e.g. nat. gas) have lower capacity factors than others (e.g. nuclear).

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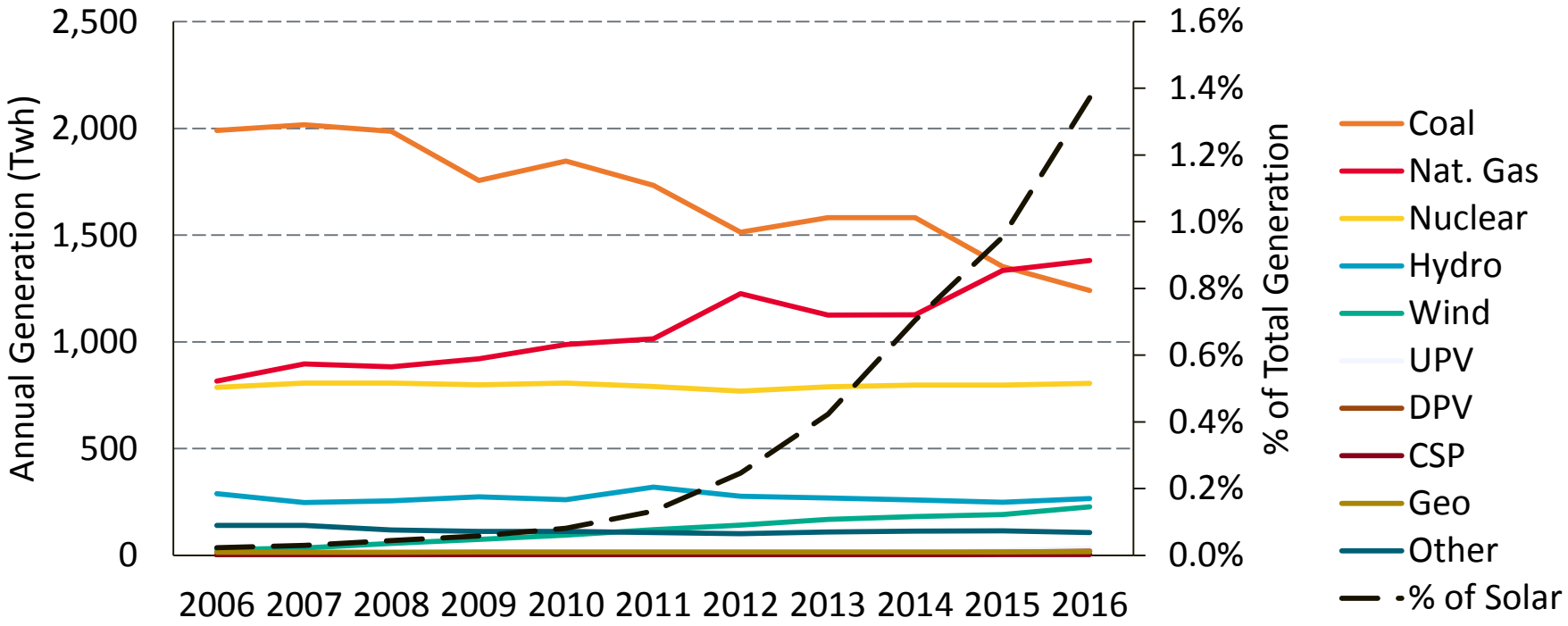
Sources: EIA Electric Power Monthly (February 2017).

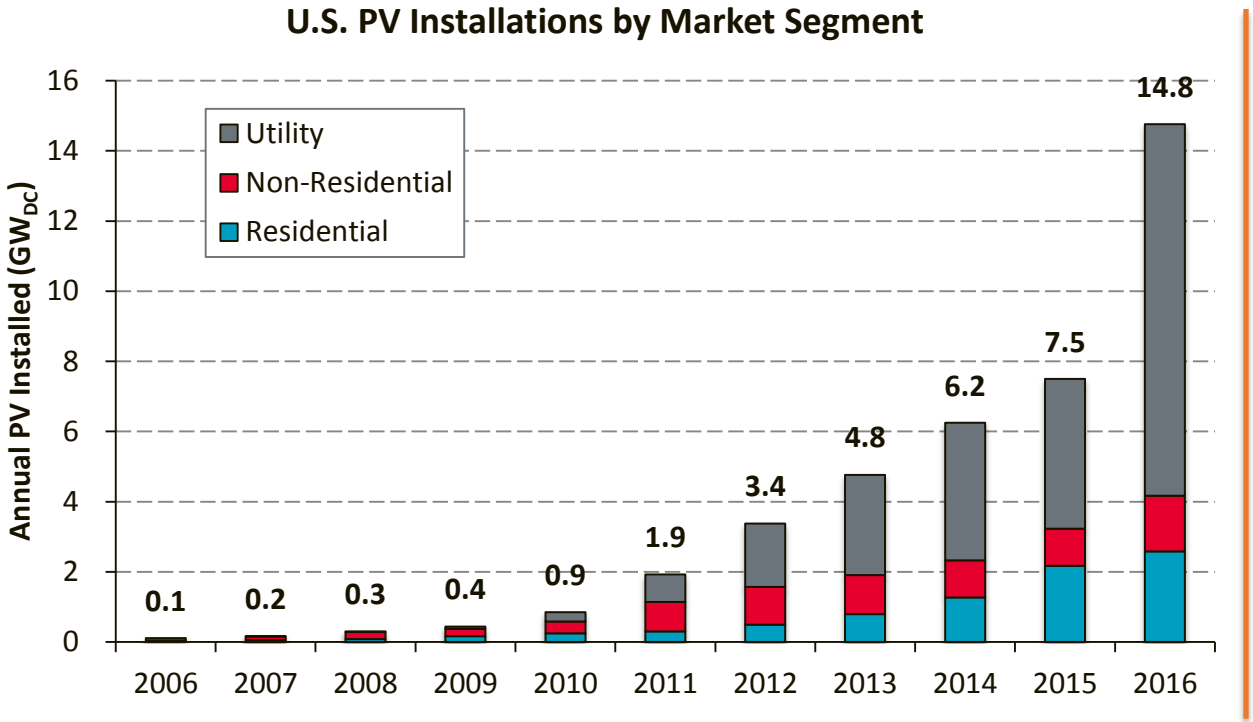
U.S. Generation, 2006–2016

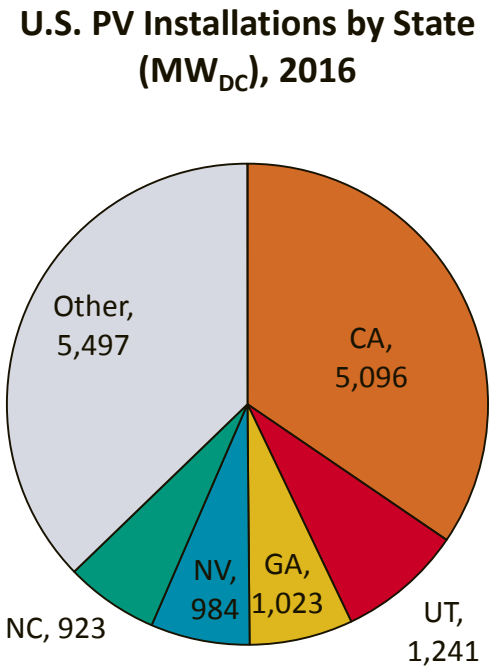


- Coal and natural gas generation have been heading in opposite directions.
  - In 2016, natural gas facilities produced more electricity than coal facilities for the first time, compared to 2006 when coal generated approximately 3X natural gas.
- Despite solar only contributing 1.4% of electric generation its percentage has increased 73X since 2006.

Sources: EIA Electric Power Monthly. Solar DPV values before 2013 are from SEIA & GTM Research, assuming an average production of 1,300 kWh/kW.

U.S. Installation Breakdown





- The United States installed 14.8 GW_{DC} of PV in 2016, 40.4 GW total
  - 2016 PV installations were larger than 2014 and 2015 combined, or all PV installations before 2014 combined
  - Utility-scale PV installations represented 72% of 2016 annual installations; however, the residential and non-residential markets also grew by 19% and 50% respectively, y/y.
- In 2016, the top 5 states represented 63% of the market—22 states installed more than 100 MW, 9 states had more than 1 GW of cumulative PV capacity.

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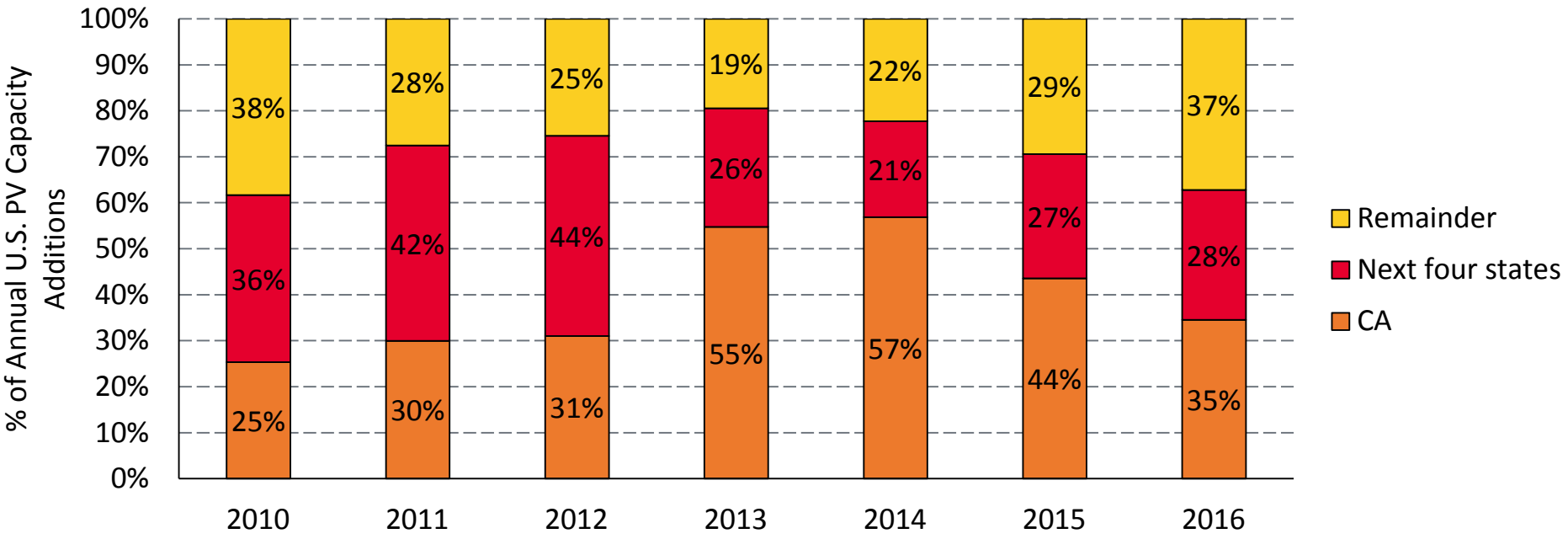
Source: GTM Research/SEIA : U.S. Solar Market Insight 2016 Year in Review.

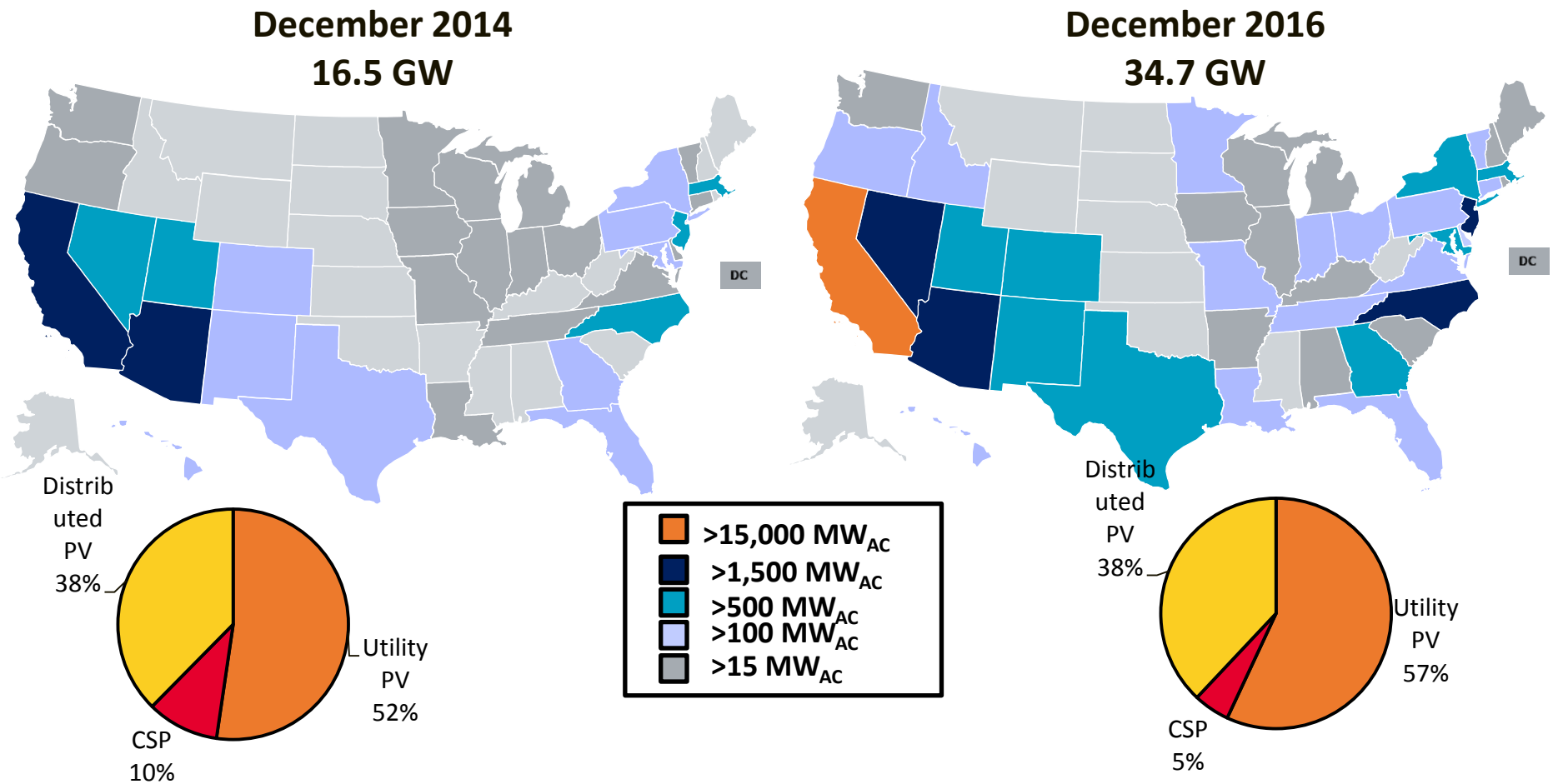
U.S. Installation Breakdown



- While California PV installations grew by 56% from 2015 to 2016, the state contributed much less to total U.S. PV deployment than in the previous three years.
- 63% of all new solar capacity in 2016 was built in five states; however, this is the smallest concentration since 2010 when the United States only installed 850 MW_{DC}.
  - In 2016, five states installed more than the total U.S. did in 2010, and 16 states installed more than the largest 2010 market (California).

Source: GTM Research/SEIA : U.S. Solar Market Insight 2016 Year in Review.

Cumulative Solar Change, 2014–2016

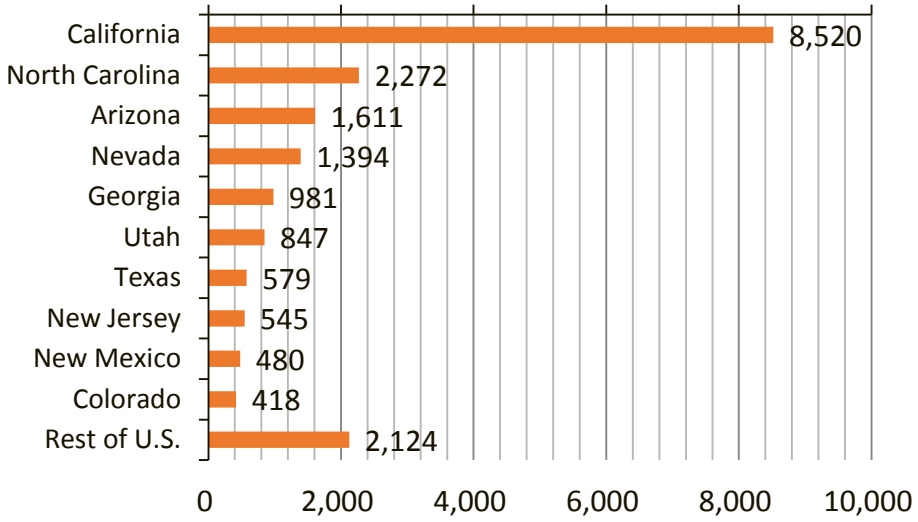


- At the end of 2016, there were more than 100 MW-AC of solar in 28 states (15 states in 2014) and more than 15 MW-AC in 39 states and DC (32 states and DC in 2014).
  - More than half of solar capacity is still in two states.

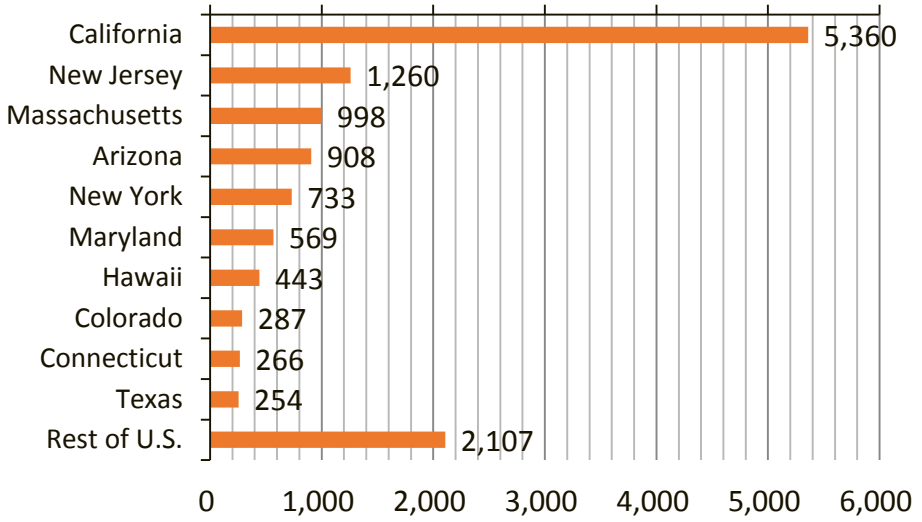
Source: EIA, Electric Power Monthly (February 2017, February 2015).

U.S. Installation Breakdown

Utility-Scale PV Installed Capacity, Top 10 States, as of Dec. 2016
Megawatts (MW_{AC})



Distributed PV Installed Capacity, Top 10 States, as of Dec. 2016
Megawatts (MW_{AC})



- At the end of December 2016, there were 33.0 GW-AC of solar systems in the United States.
  - Of the 33.0 GW, 19.8 GW were utility-scale PV and 13.2 GW were distributed PV.
- As of December 2016, California system capacity represented 42% of all U.S. PV capacity, leading in both the utility-scale and distributed sectors.
- Half of the top 10 states led in both the utility-scale and distributed sectors, while the other states on the list had less diverse deployment.

Source: EIA, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861 (February 2017).
Note: EIA monthly data for 2016 is 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.

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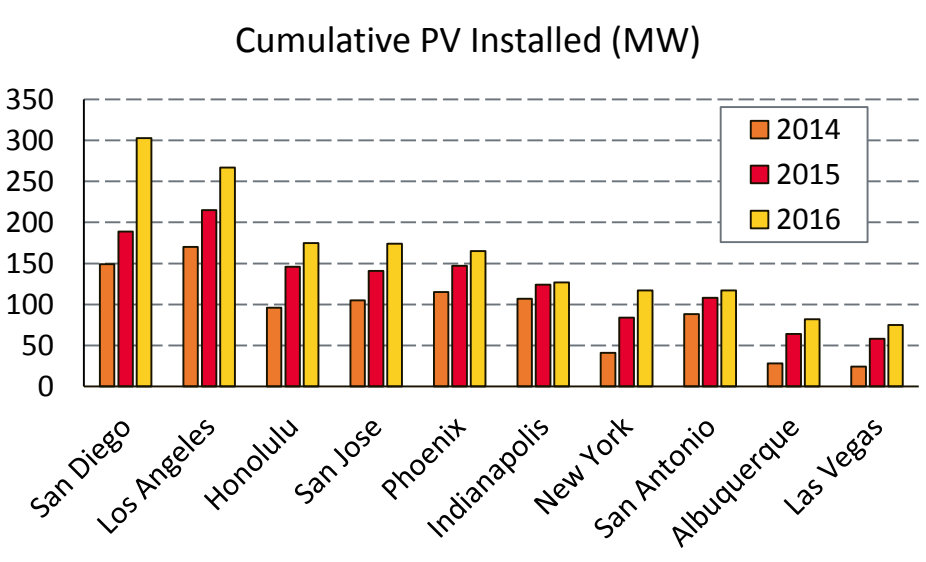
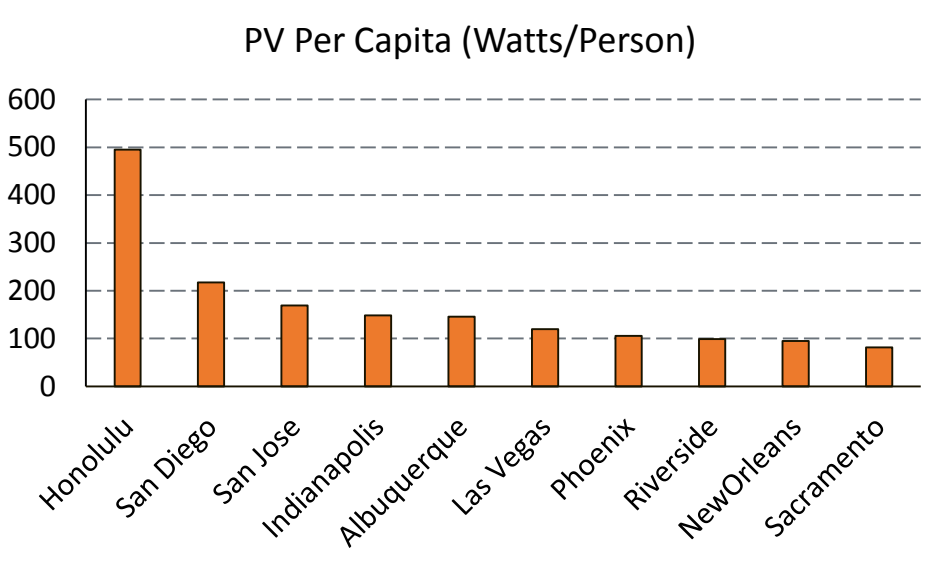
Leading U.S. Cities

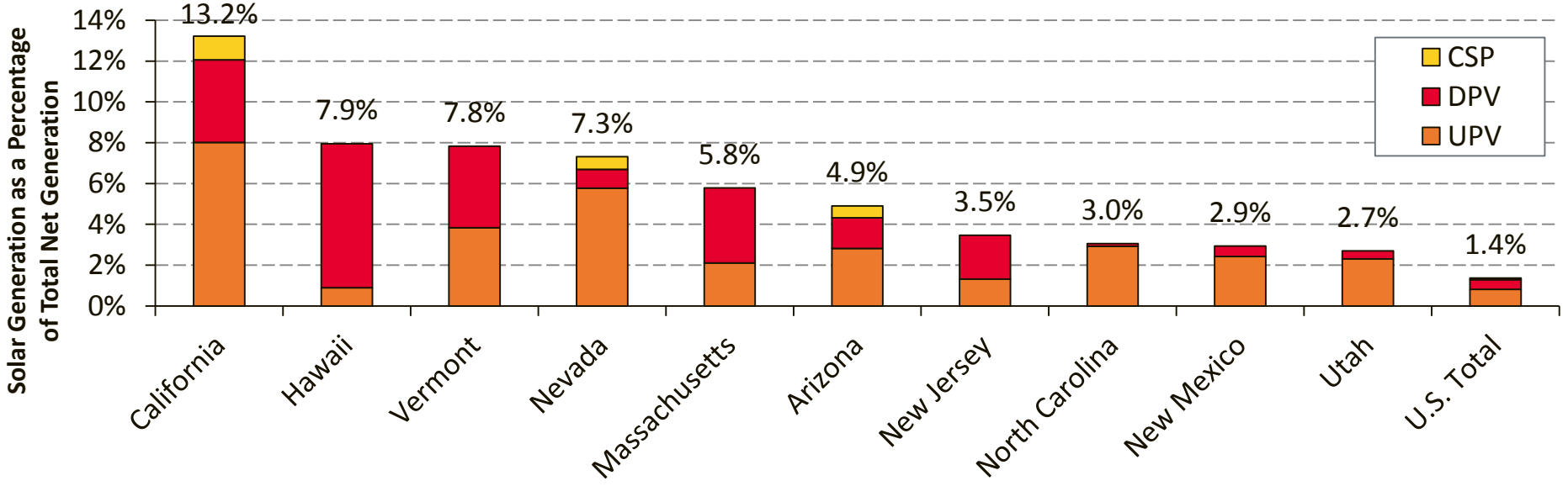




- At the end of 2016, the top 10 cities represented 1.6 GW of cumulative PV capacity, or 4% of total installed U.S. PV capacity.
  - It is estimated that these cities are only using 3%–14% of their technical potential for rooftop installations.
- Seventeen cities had installed more than 50 watts/person at the end of 2016.
  - Honolulu had installed approximately 0.5 kW per person.

Source: "Shining Cities Harnessing the Benefits of Solar Energy in America." Spring 2017.

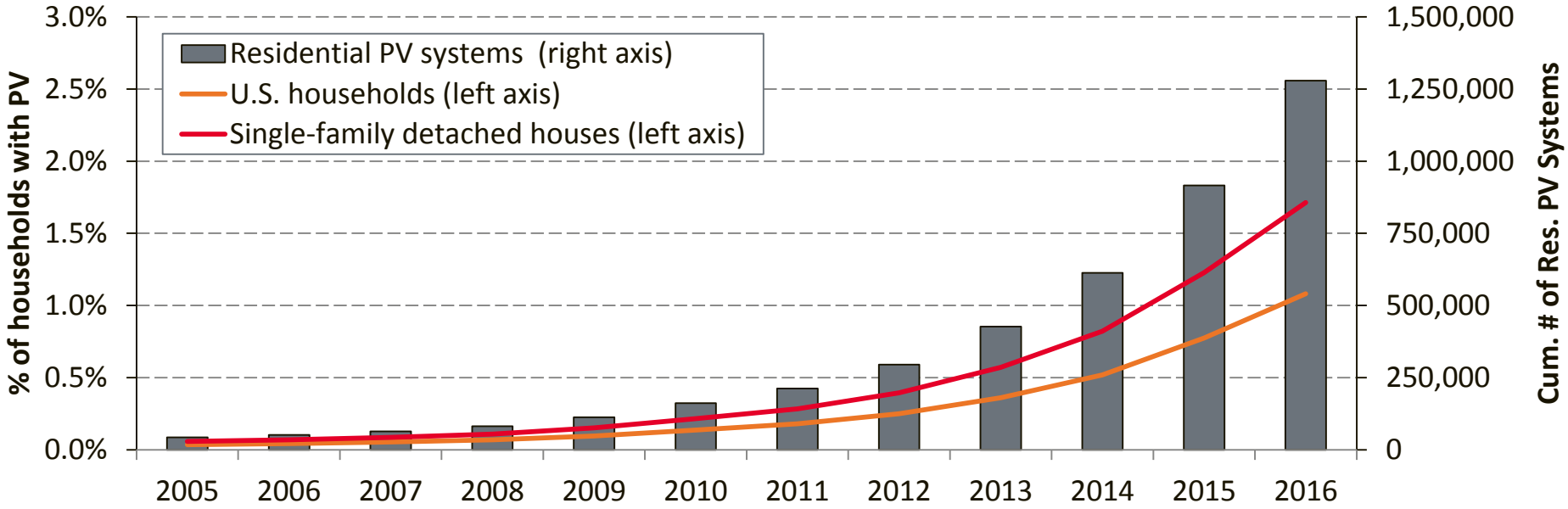
Solar Generation as a Percentage of Total Generation, 2016



- Five states produced more than 5% of total net generation from solar in 2016, and an additional five states produced more than 2.5% of total net generation from solar.
- Solar technology contribution varied by state, with Hawaii generating most of its energy from distributed PV, while North Carolina generated the vast majority of its energy from utility-scale PV.
  - During the same time period, CSP generated more than 1% of California's electricity and more than 0.5% in Nevada and Arizona.

Source: EIA, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861 (February 2017).
Note: EIA monthly data for 2016 is 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.

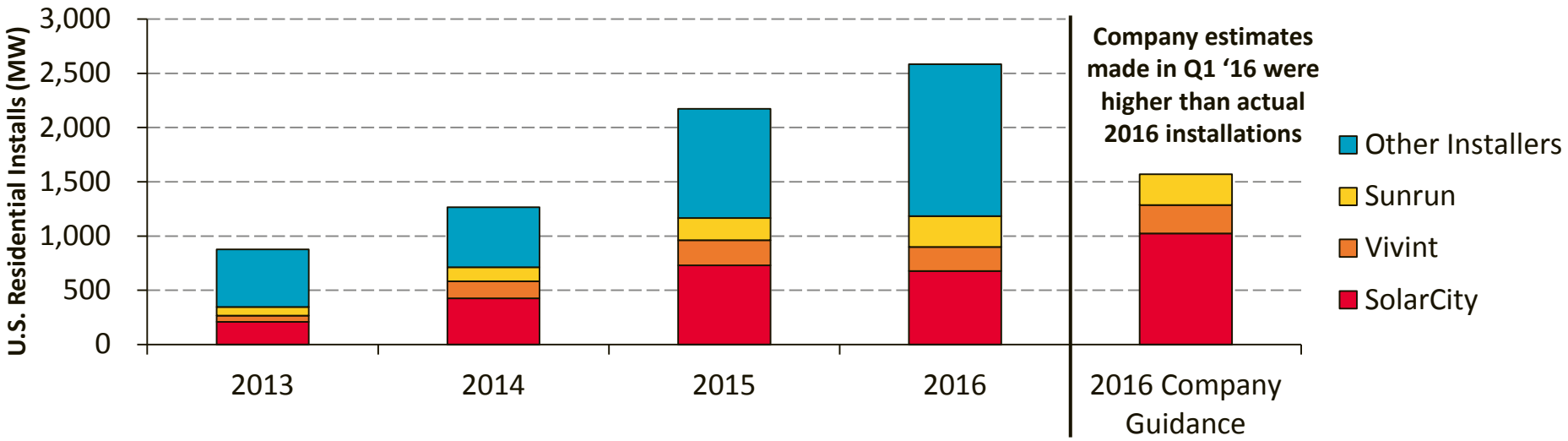
U.S. Residential PV Penetration



- Since 2005, when the investment tax credit was passed by congress, the residential PV market has grown by approximately 51% per year, or about 95X.
- At the end of 2016, there were over 1.25 million residential PV systems in the United States.
  - The millionth U.S. residential PV system was likely installed in Q2 2016.
- Still, only 1.1% of households own or lease a PV system (or about 1.7% of households living in single-family detached structures).
  - However, solar penetration varies by location. Hawaii, California, and Arizona have residential systems on an estimated 29%, 9%, and 7% of households living in single-family detached structures.

Sources. Res. PV Installations: 2000-2009, IREC 2010 Solar Market Trends Report; 2010-2015, SEIA/GTM Solar Market Insight 2010-16 Year-in-Review. U.S. Households U.S. Census Bureau, 2015 American Housing Survey; state percentages based on 2000 survey.

SolarCity, Vivint Solar, and Sunrun Residential Market Share

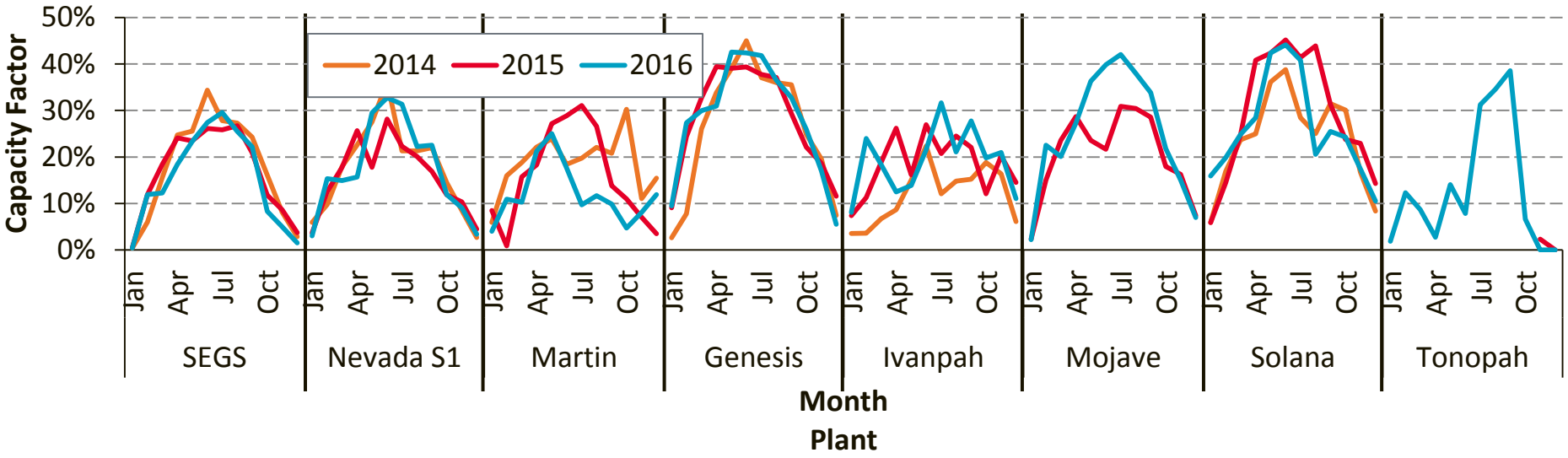


- Residential Solar installations have historically been dominated by a few installers.
- Flat sales by Vivint Solar and SolarCity/Tesla in 2016 stood in contrast to overall market expansion.
  - SolarCity (-34%) and Vivint (-15%) significantly underperformed their own guidance for 2016 deployment, which were made in Q1 2016.
  - With the acquisition of SolarCity by Tesla, the company has emphasized "cash preservation over growth" and has shifted from leasing to selling systems.
- SolarCity/Tesla and Sunrun are also expanding product offerings through PV+storage.
  - Tesla announced 98 MWh of energy storage deployed in Q4 2016.
  - Sunrun 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: Corporate Filing, GTM/SEIA SMI 2016 Year-in-review.

Note: SolarCity Q4 2016 residential deployment and 2016 guidance are assumed to have the same percentage of total deployment that occurred in Q3 2016.

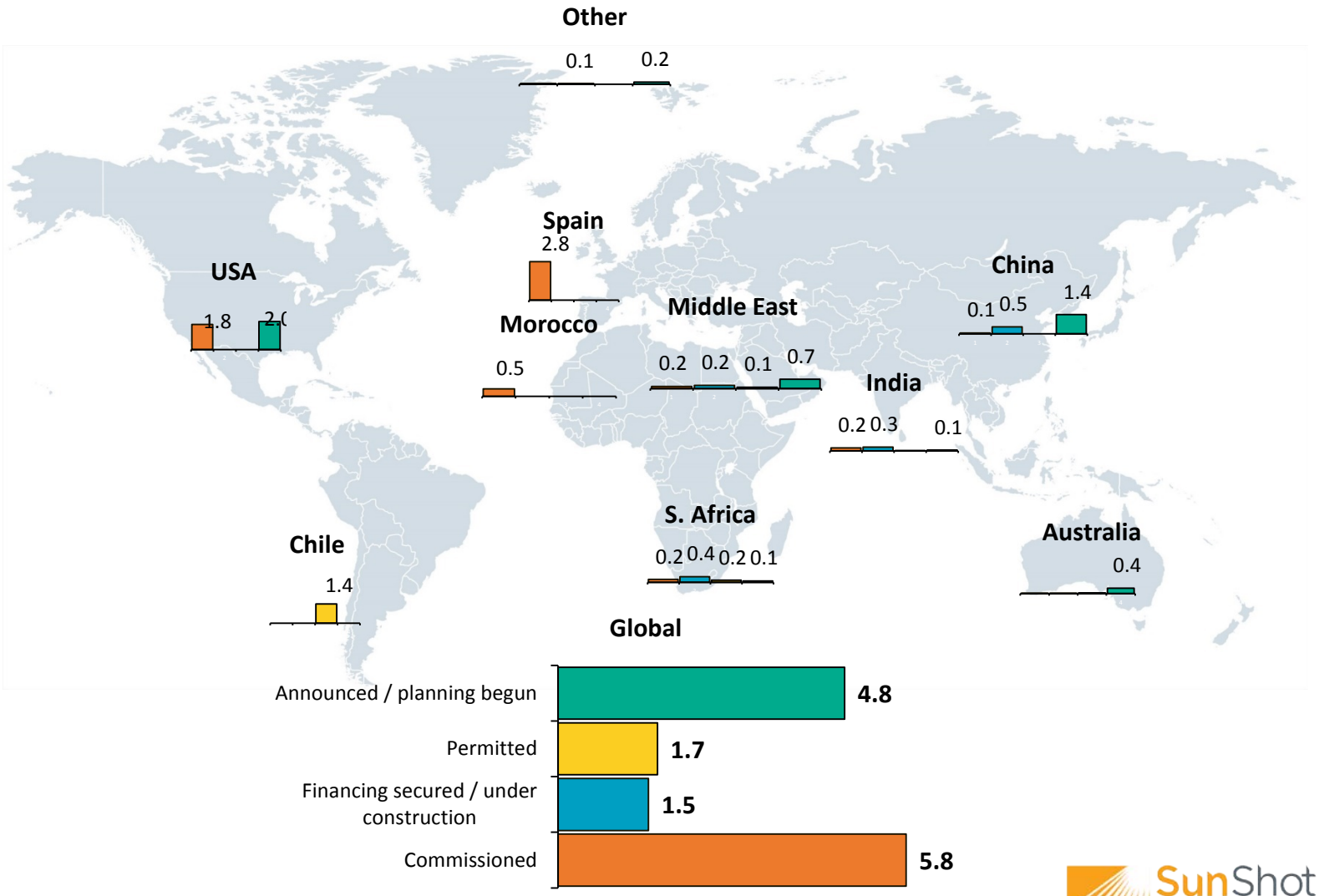
Capacity Factor of CSP Projects



- In 2016, U.S. CSP plants produced roughly the same energy as in previous years, given the DNI variability each month and year, with three exceptions:
  - Mojave produced 41% more energy from May to September 2016 than it did during the same period in 2015.
  - Tonopah began producing energy in November 2015 though stopped producing in October 2016 through the end of the year due to a molten-salt leak.
  - Martin produced 25% and 36% less in 2016 than in 2015 and 2014 respectively.

Source: System AC nameplate capacity is sourced from EIA Form 860. Monthly system electricity production is sourced from EIA Form 923.

CSP Market Worldwide



Source: Bloomberg NEF "Power Plant" database, accessed 03/22/17. U.S. figures adjusted to include the announced 2 GW Nevada project by SolarReserve.

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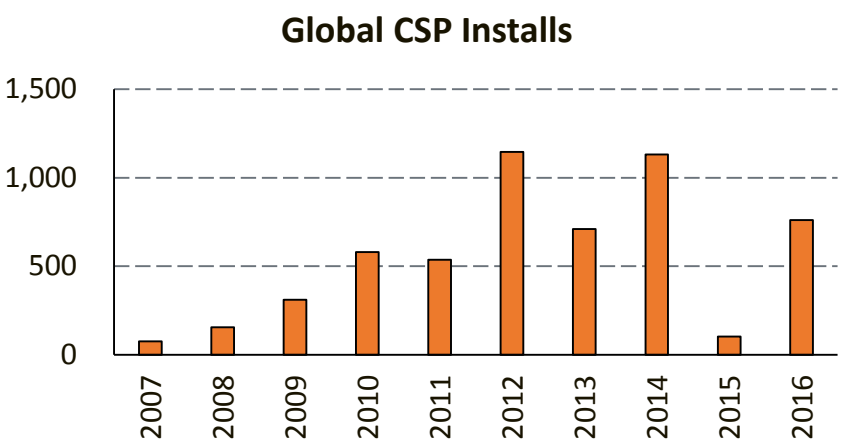
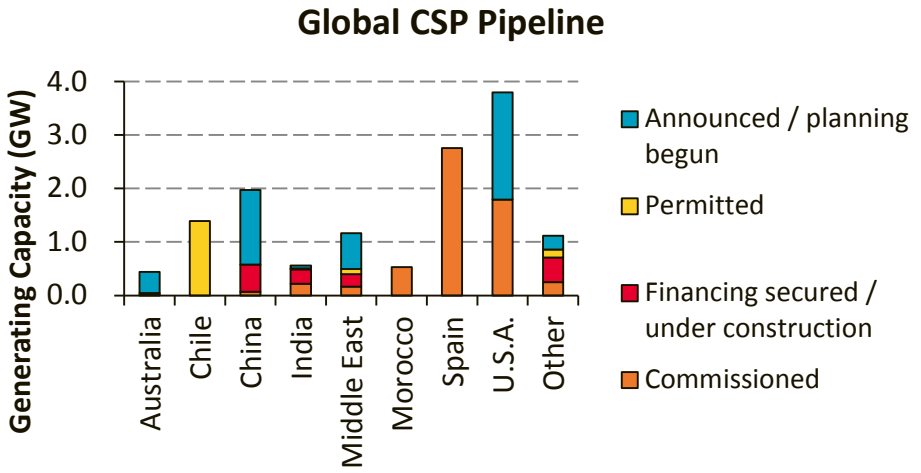
CSP Market Development





- A little more than 750 MW of CSP was installed globally in 2016.
- Between 0.5 GW—1.5 GW of annual CSP installations has occurred globally six of the past seven years.
  - The sustained demand is due to large quantities of CSP deployment in different countries over the years.
- China and Chile are the next two countries to push strong levels of CSP deployment. If the projects in their pipeline are completed they could have comparable markets to Spain and the United States.
  - China could grow even larger as it has set a solar thermal target of 5 GW by 2020 (but has thus far missed its CSP targets).
- The United States also has a very large pipeline; however, it is made up of one 2 GW project by SolarReserve in Nevada—the project differs from many other global projects in development in that it has no electricity offtaker.
- Continued development around the globe has allowed the technology to continue to drop in price
  - In Chile, SolarReserve bid its Copiapó project with a capacity of 240 MW and 14 hours of thermal energy storage, at a record-low CSP price of $63/MWh (in part, due to capacity payments it could receive, highlighting the *value* of CSP).
  - SolarReserve announced that its 2 GW Nevada project, "will be lower cost than natural gas power plants, but just as reliable during peak periods."

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Sources: Bloomberg NEF "Power Plant" database, accessed 03/22/17; CSP Today (09/07/16); Reuters (09/14/16); Utilitydive (10/17/16)

Global Presence of U.S.-based CSP Companies

- U.S.-based company Glasspoint uses CSP technology for enhanced oil recovery. It currently has a 1-GW thermal capacity project in Oman scheduled for completion in 2017.
- BrightSource, a U.S.- and Israeli-based company, has two major projects using tower and heliostat CSP technologies—the 392-MW Ivanpah plant in California, and the 121-MW Ashalim project under construction in Israel. BrightSource, along with the U.S.-based CSP manufacturer SkyFuel, are also providing technology for 199 MW of projects being developed in China.
- The U.S.-based developer SolarReserve, which focuses on tower and heliostat plants using molten-salt technology, currently has one commissioned plant—the 125 MW Tonopah plant in Nevada. They also are pursuing prospects in South Africa, Chile, and a 2 GW project in the United States, which have thus far not received financing or a PPA.

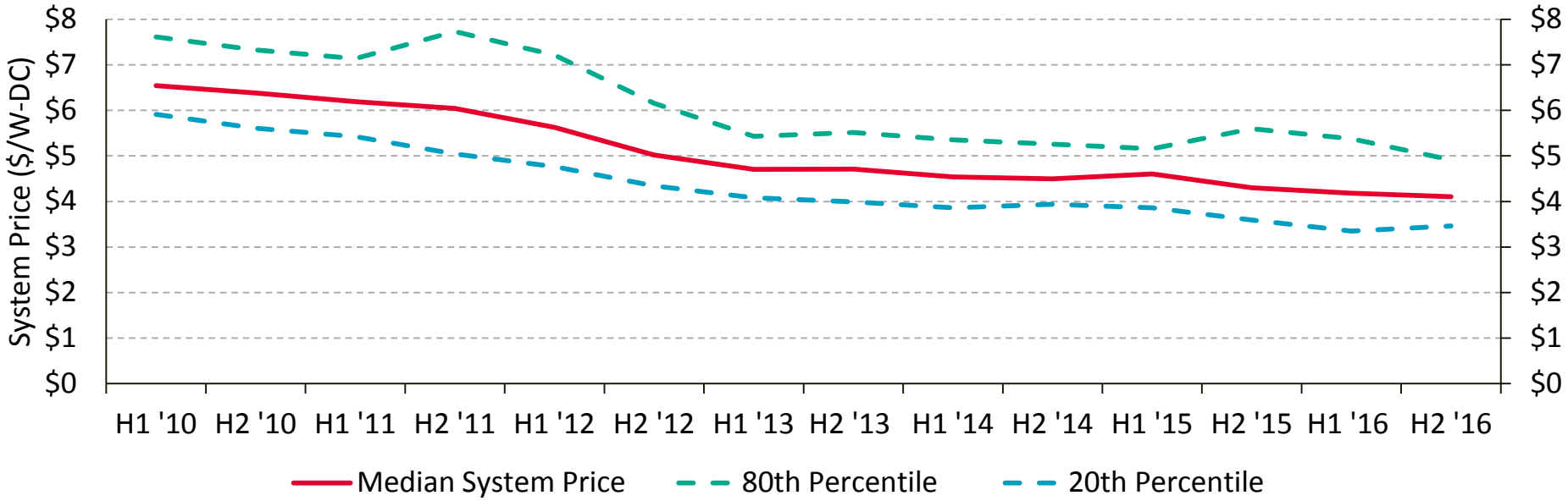
Sources: Bloomberg NEF "Solar Thermal Market Outlook." January 20, 2017.

Agenda

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

System Pricing from Select States

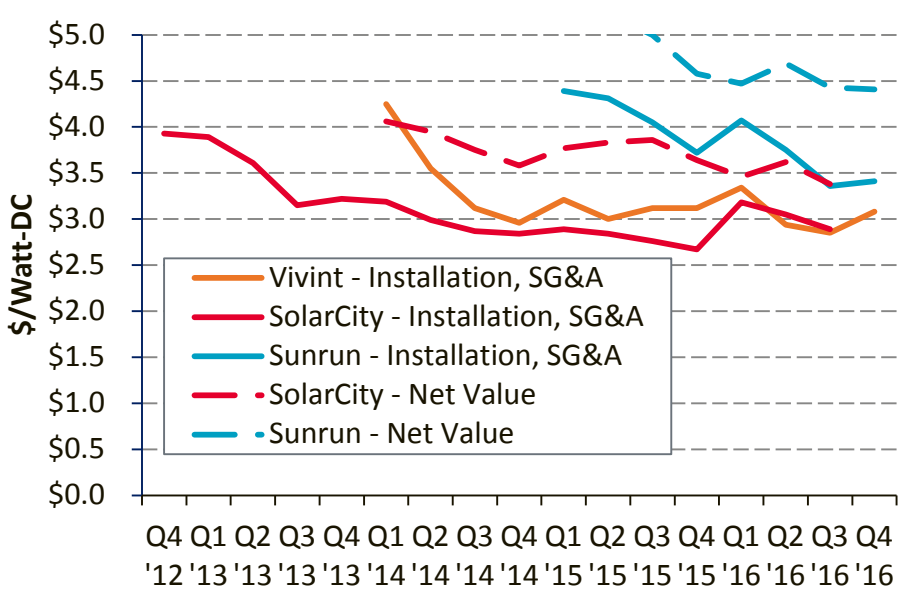
2.5 kW–10 kW

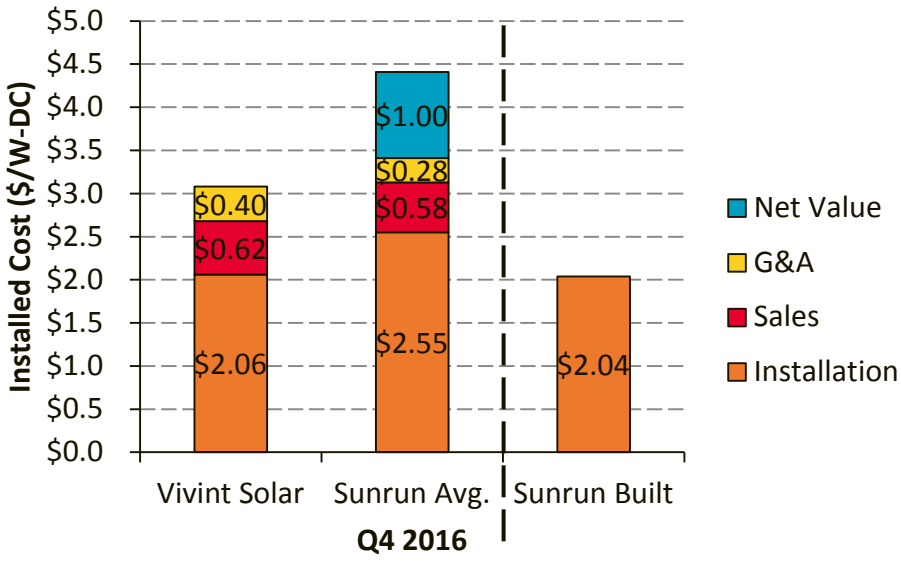


- In 2016, the median reported system prices fell 4%, and the price range contracted.
- System prices fell, on average, 1.7% between H1 2016 and H2 2016.
- Lowest prices (20th percentile) were seen in Arizona ($2.96/W), while higher prices (80th percentile) were seen in Maryland ($5.04/W) in H2 2016.

2016 MW: AZ (82); CA (387); MA HO (79); MA 3-P (35); MD (2); NY H.O (37); NY 3rd-P (59).
Note: MA does not report whether a system is third-party owned. Therefore, it was estimated using the "applicant entity" or "installer" for the following organizations: SolarCity, CPF Capital, Sunrun, Vivint, and Sungevity.
Sources: CA NEM database; MA SREC program; Arizona Public Services and Salt River Project; MD Energy Administration; NY PV Incentive Program. All programs accessed 4/4/17

SolarCity, Vivint Solar, and Sunrun Cost & Value



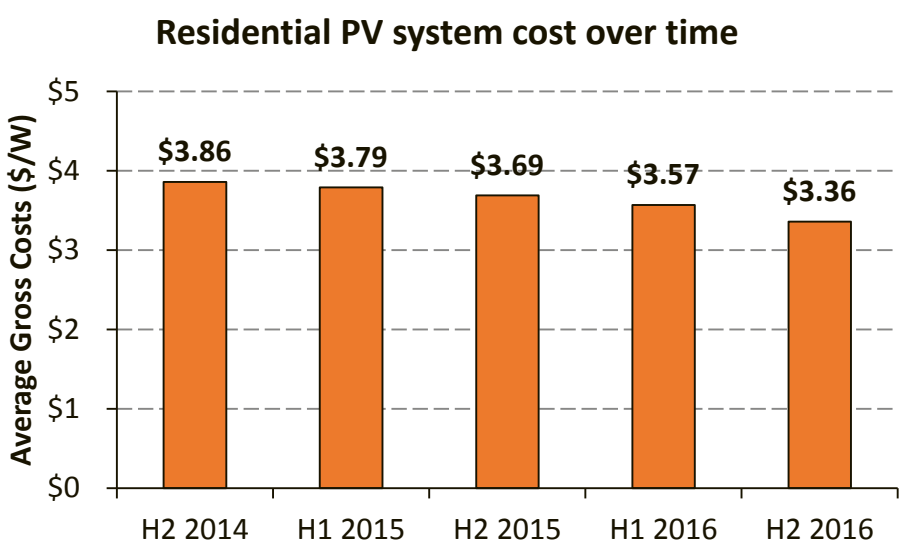


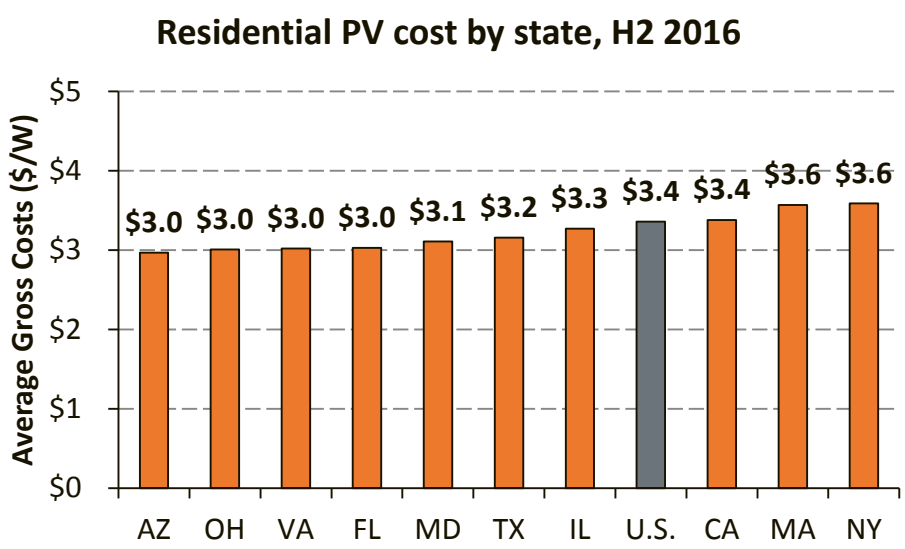
- From Q4 '15 to Q4 '16, Vivint Solar and Sunrun systems total costs decreased 1% and 8% respectively.
  - Installation costs for both companies decreased 12% y/y; however, overhead costs have been burdened by lower than expected total installs.
- Sunrun reported a profit (or net value) of $1/W in Q4 2016; however, $0.60/W of that comes from assumed contract renewals.
- With Tesla's acquisition of SolarCity there is less transparency of their costs.

Sources: Corporate Filings.

System Costs Reported by EnergySage

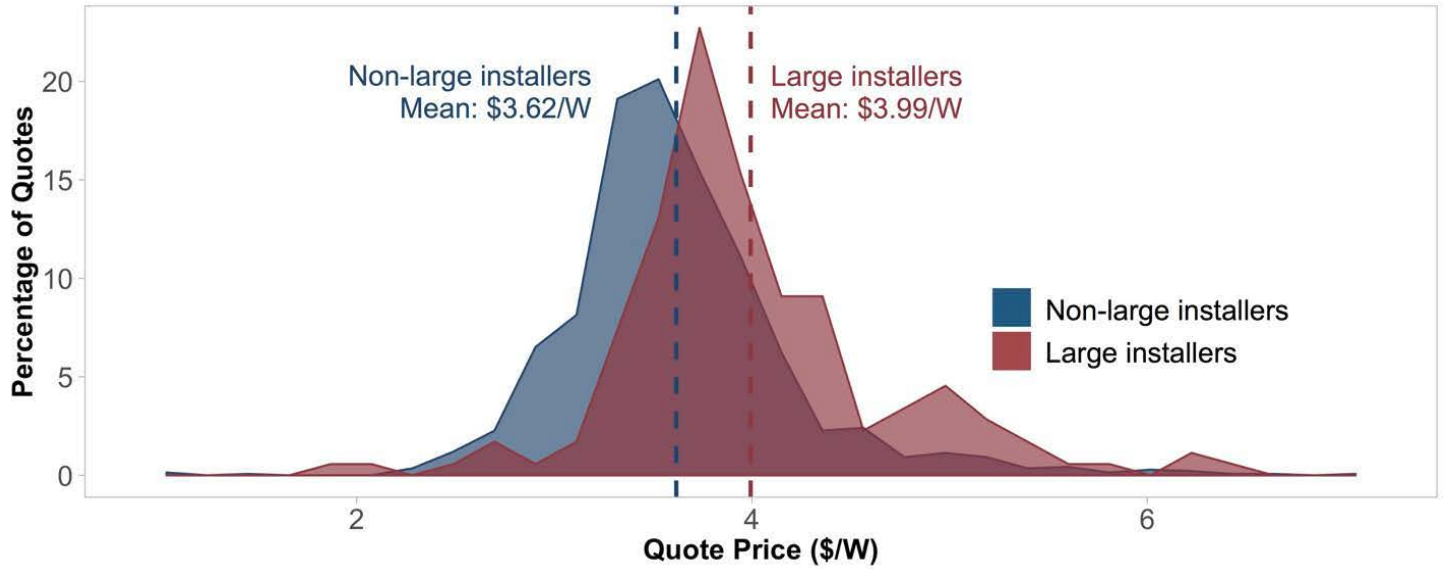
- From H2 2015 to H2 2016, EnergySage reported a 9% reduction in the average gross costs of a residential system.
  - The standard deviation of PV system quotes in H2 2016 was $0.48/W.
  - EnergySage quotes also reported an average system payback period of 7-8 years.
- Residential system quotes varied by state. In H2 2016, the average gross cost of a residential system in New York was 21% higher than the average gross cost of a residential system in Arizona.





Sources: EnergySage "Solar Market place Intel Report H1 2016 – H2 2016"

NREL Study Find Pricing Differences Between Large and Small Installers

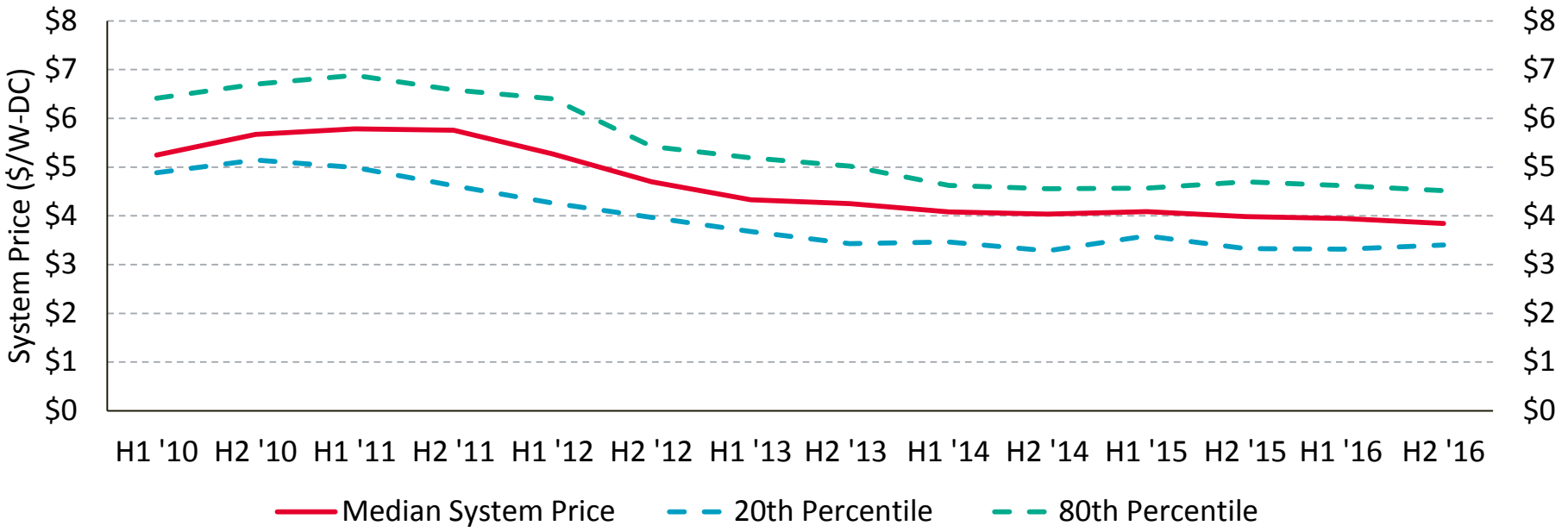


- A recent NREL study matched over 1,500 price quotes for residential PV systems from 2014 to 2016 and found that quotes from large installers were $0.33 higher than non-large installers (10%).
  - Large installers tended to quote smaller systems with a greater use of micro-inverters; adjusting for these factors NREL still found a $0.21/W difference in price.
  - The study also found that the range of price quotes from small installers tended to be narrower than that of larger installers ($1.61/W span between the 10th and 90th percentile quotes for larger installers; $1.25/W for small installers).
- The results of the report suggests, "that some residential PV customers may forego lower prices for the opportunity to work with a large installer [e.g., known-brand, better warranty, and inverter replacement terms] but also that customers could benefit from obtaining more quotes before deciding to install a system."

Source: Eric O'Shaughnessy and Robert Margolis. "Using Residential Solar PV Quote Data to Analyze the Relationship between Installer Pricing and Firm Size." NREL. April 2017.

System Pricing from Select States

10 kW–100 kW



- Reported host-owned system prices for systems 10 kW–100 kW fell 3% between H1 and H2 2016.
  - Third-party systems also fell by 7% during that timeframe.
  - Third-party systems are being *reported*, on average, $1/W–$2/W more expensive than host-owned systems. Third-party owners may use different methodologies to determine a price.
- Lowest prices (20th percentile) were seen in Arizona ($2.82/W), while highest (80th percentile) were seen in Massachusetts ($5.04/W) for third-party-owned systems.

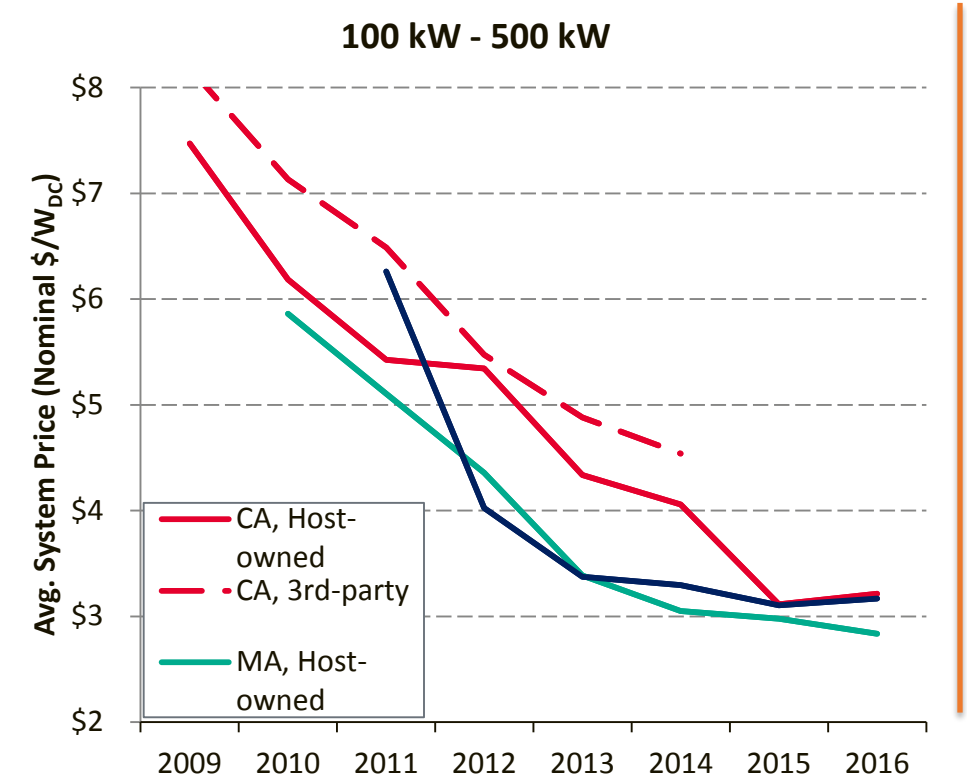
2016 MW: AZ (54); CA (126); MA HO (47); MA 3-P (17); MD (3); NY H.O (36); NY 3rd-P (32).

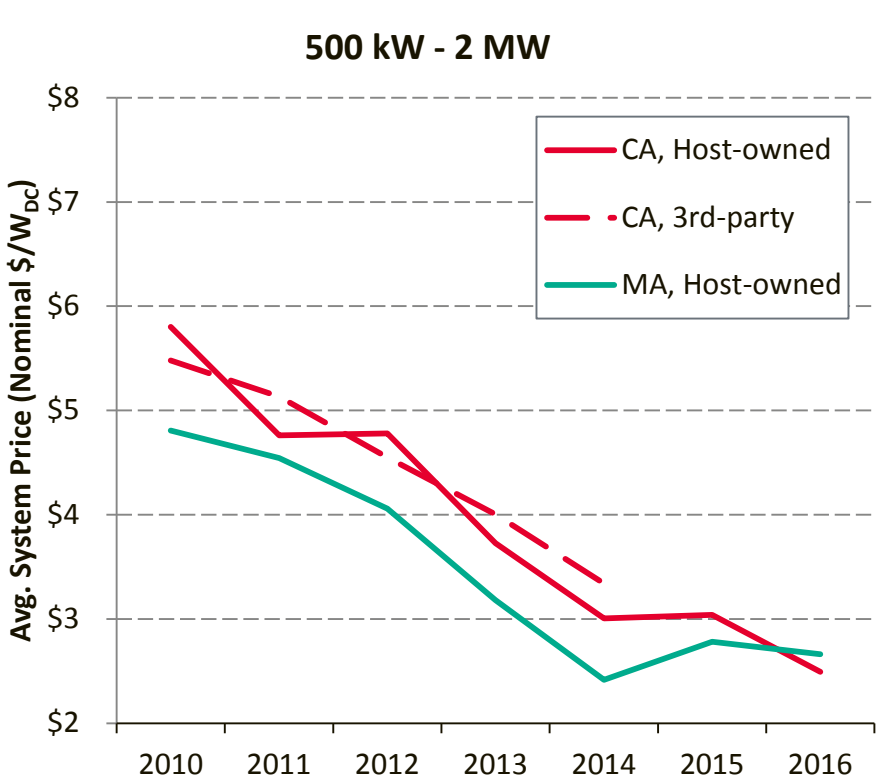
Note: MA does not report whether a system is third-party owned. Therefore, it was estimated using the "applicant entity" or "installer" for the following organizations: SolarCity, CPF Capital, Sunrun, Vivint, and Sungevity.

Sources: CA NEM database; MA SREC Program; Arizona Public Services and Salt River Project; MD Energy Administration; NY PV Incentive Program. All programs accessed 4/4/17.

Average System Pricing by Size and State

100 kW–500 kW and 500 kW–2 MW



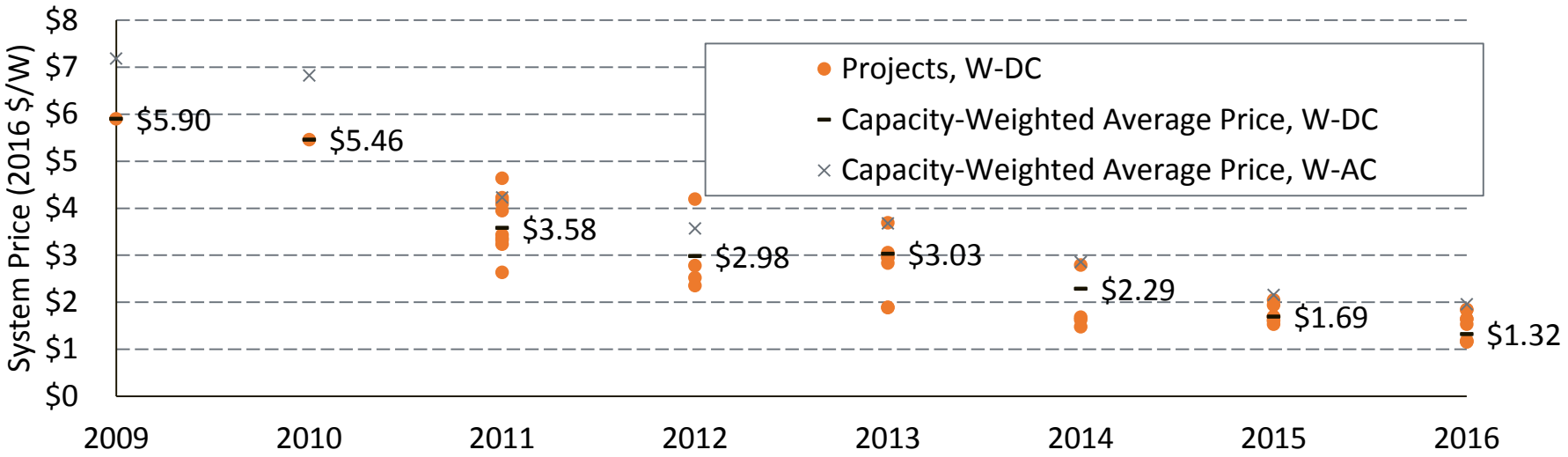


- Systems sized 100 KW – 500 KW see flat pricing on average with slight increases in New York and California.
- Prices for systems 500 KW – 2 MW fell 11% between 2015 and 2016, largely driven by dramatic drop in price in California.

2016 MW: (100–500 kW): CA H.O. (98); MA H.O.(29); NY (26). (500 kW–2 MW): CA H.O. (70); MA H.O.(87).

Sources: CA NEM database; MA SREC program; NY PV incentive program. All programs accessed 4/4/17.

Utility-owned PV Pricing (>5 MW)



- In the above system price data set for nine regulated utilities the capacity weighted average price of a utility-owned PV system fell 78% to \$1.32/W_{DC} (\$1.95/W_{AC}) between 2009 and 2016.
  - The capacity weighted average system price fell 22% from 2015 to 2016
- From 2015 to 2016 PV system prices in Watts-AC fell slower than they did in Watts-DC because of an increase in inverter loading ratio, from roughly 1.3 to 1.5.
  - With cheaper modules, it is may be more economical to add more modules per inverter.
- The majority of utility-scale systems are owned by IPPs, which have PPAs with utilities. PPA pricing, while not in lock-step with system pricing, generally followed the same trends.
  - From 2010 to 2016 the generation-weighted average PPA price for utility-scale systems placed in service in that year fell 64%; from 2015 to 2016 PPA prices dropped 33% for systems placed in service in that year.
  - Systems should have much lower PPA pricing in the near future. as the average price for a PPA signed in 2015 was around \$40/MWh, or 30% lower than PPAs for systems installed in 2016.

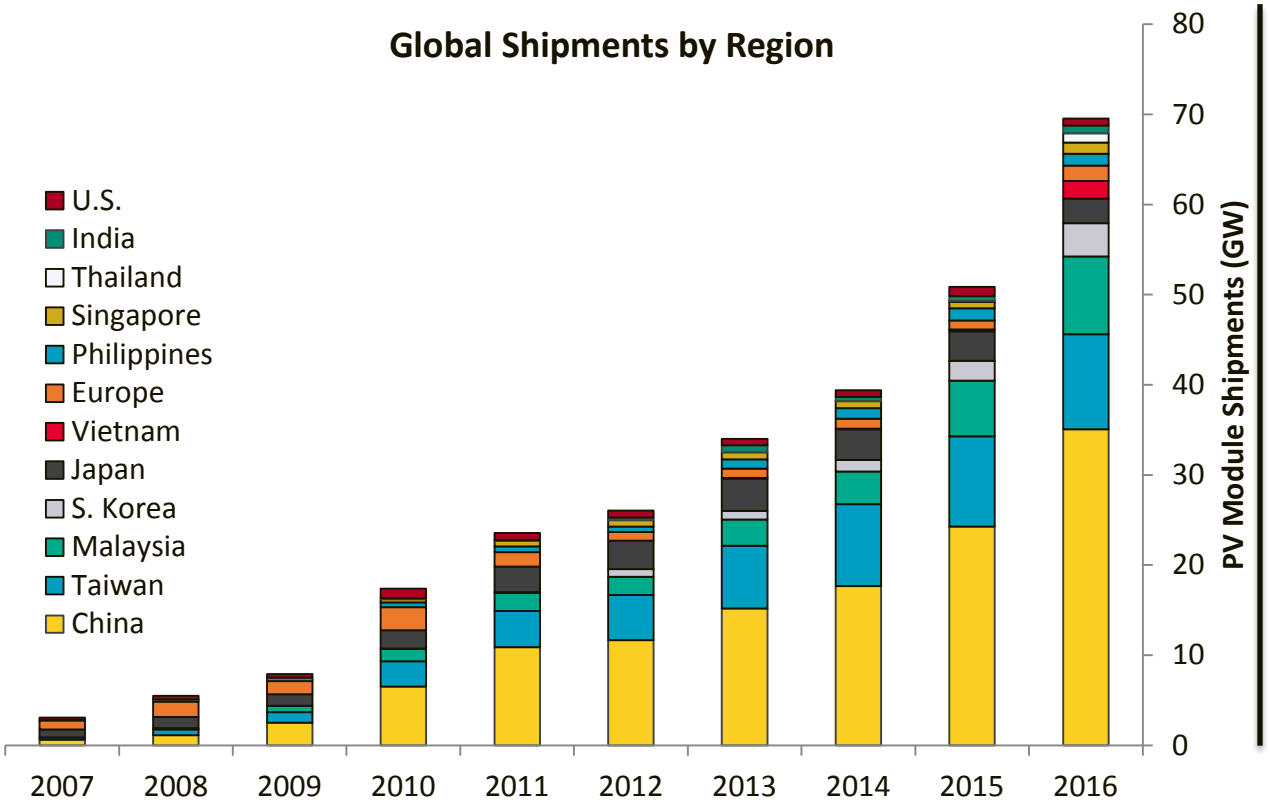
Note: data sample consists of 42 projects with 1.2 GW–DC of capacity

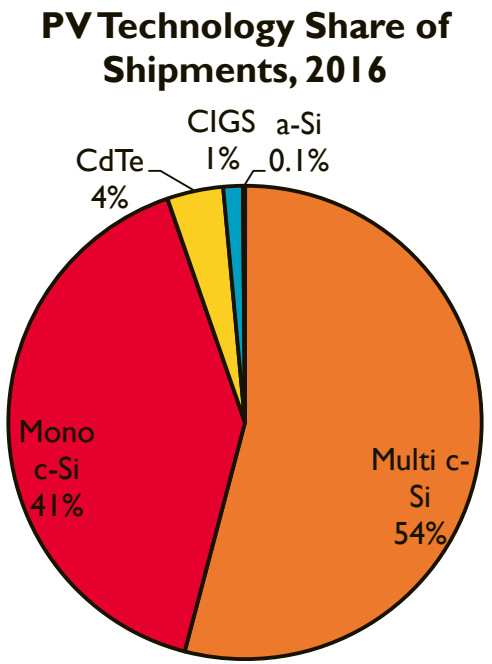
Sources: FERC Form 1 Filings from the following utilities: Arizona Public Service; Florida Power & Light; Duke Energy Progressive; Georgia Power; Indiana Michigan Power Company; Kentucky Utilities; Pacific Gas & Electric; Public Service of New Mexico; Southern California Edison. PPA pricing from "Utility-Scale Solar 2015" (Bolinger and Seel 2016).

Agenda

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

Global Annual PV Shipments by Region*





- In 2016, global shipments increased 37% y/y and 22X in the past 10 years.
  - China & Taiwan manufactured 66% of shipments in 2016; Asia countries manufactured ~96%.
  - Ten countries shipped over 1 GW of PV in 2016.
- 95% of shipments in 2016 came from crystalline technology, 4% CdTe (First Solar, etc.), 1% CIGS (Solar Frontier, etc.).

***Note:** Excludes inventory sales and outsourcing.
Source: 2007-2016: Paula Mints. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2016/2017." SPV Market Research. Report SPV-Supply7. April 2017.

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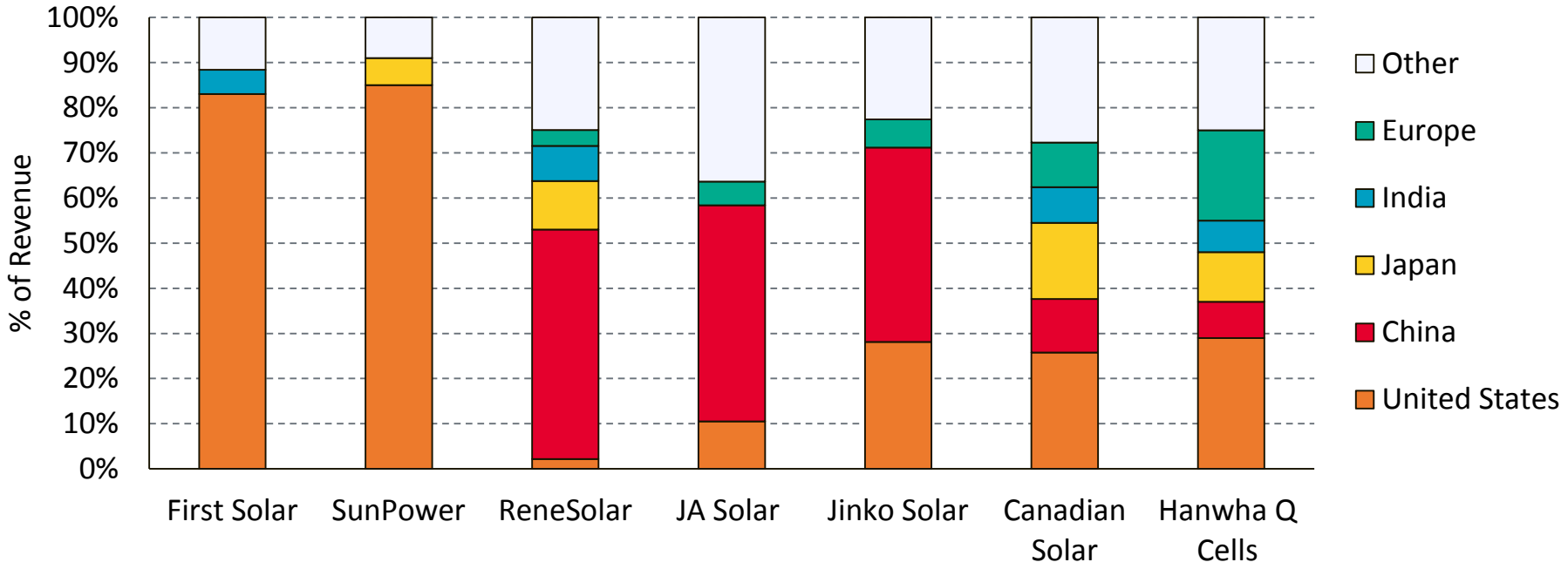
PV Mfgs. % of Sales Revenue by Region, 2016



- PV manufacturers have varying degrees of regional exposure.
  - The majority of revenue from First Solar and SunPower came from the United States with virtually no penetration in the Chinese market.
  - Many of the publicly traded Chinese companies have large revenues from their domestic market, but are less dependent on their home market than U.S. firms.

Note: not all companies separate revenue into each geographic location represented in graphic. In those instances, all non-separated numbers are classified in "other" unless otherwise stated. Canadian Solar and Hanwha Q Cells have not filed their annual reports yet so 2015 numbers are reflected. U.S. numbers for Jinko Solar represent revenues the company received from all of "America" as U.S. was not broken out separately. Renesola's figures are as a weighted averaged of reported quarterly figures.

Sources: Company figures based on Q4 '16 (and previous) SEC filings by the respective companies.

Global Leading PV Manufacturers, by Shipments

2016 2015 2010 2005

Rank	Manufacturer (2016)	Shipments (GW)	Manufacturer (2015)	Shipments (GW)	Manufacturer (2010)	Shipments (GW)	Manufacturer (2005)	Shipments (GW)
1	**Trina**	**5.0**	Trina	3.6	Suntech	1.6	Sharp	0.375
2	**JA Solar**	**4.9**	JA Solar	3.6	JA Solar	1.5	Kyocera	0.142
3	**Hanwha**	**4.0**	Hanwha	3.4	First Solar	1.4	Q-Cells	0.131
4	**Jinko Solar**	**3.9**	Canadian Solar	2.7	Yingli	1.1	Schott Solar	0.095
5	**Motech**	**2.9**	First Solar	2.5	Q-Cells	1.0	BP Solar	0.086
6	**First Solar**	**2.7**	JinkoSolar	2.4	Sharp	0.9	Mitsubishi	0.085
7	**Longi Lerri**	**2.7**	Yingli	2.4	Trina	0.9	Sanyo	0.084
8	**Canadian Solar**	**2.4**	**Motech**	2.1	**Motech**	0.9	Shell Solar	0.055
9	**Yingli**	**2.4**	Neosolar	2.1	Gintech	0.8	**Motech**	0.045
10	**Shunfeng-Suntech**	**2.2**	Shunfeng-Suntech	2.0	Kyocera	0.6	Isofoton	0.039
Other		**36.4**		26.8		6.8		0.270
Total		**69.5**		50.9		17.4		1.410

Sources: Paula Mints. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2016/2017." SPV Market Research. Report SPV-Supply7. April 2017. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2015/2016." SPV Market Research. Report SPV-Supply3. April 2016. Navigant "Photovoltaic manufacturer Shipments, Capacity & Competitive Analysis" (April 2009).

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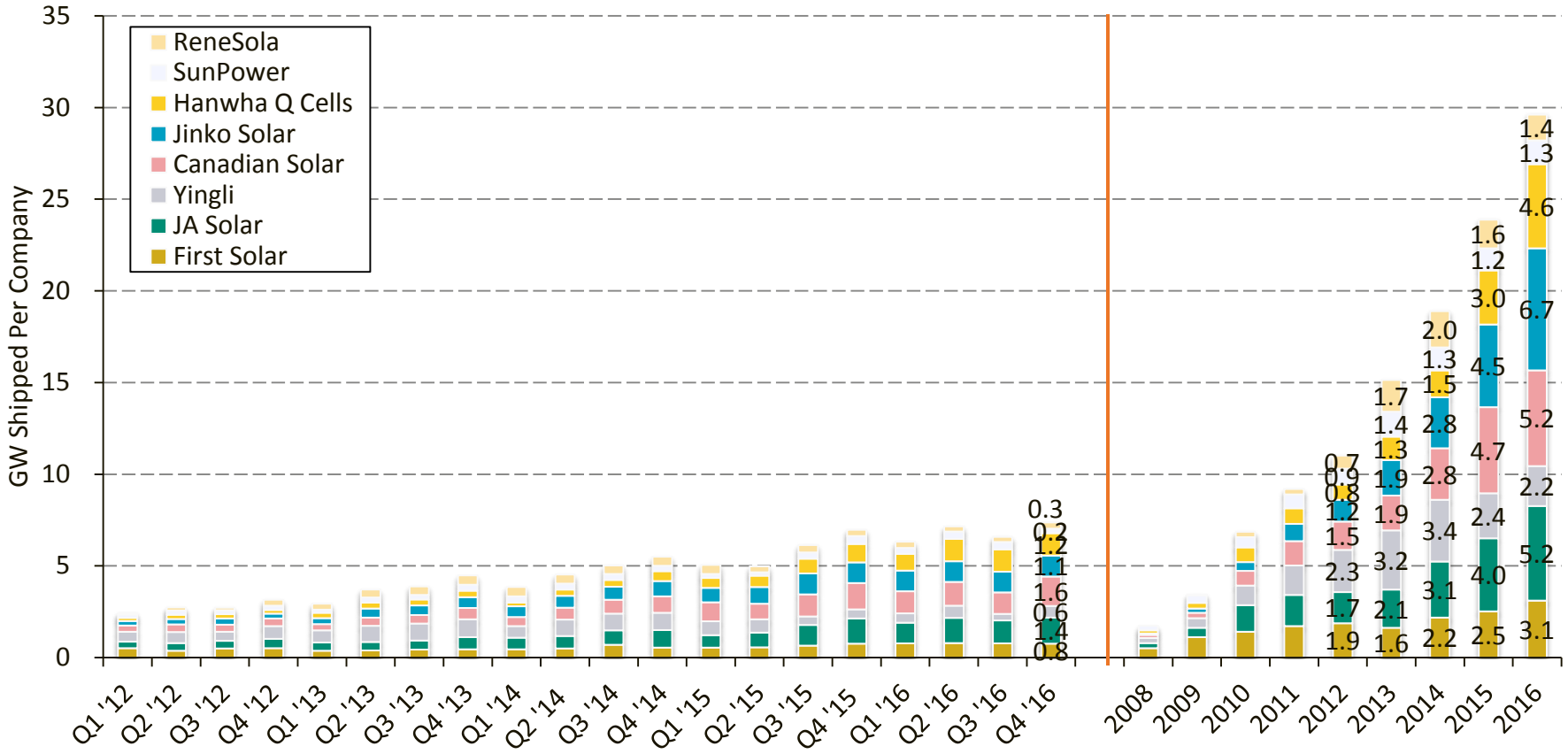
Manufacturers' Shipments

Publically Traded Cell/Module Manufacturers



- In 2016, the above leading companies shipped 29 GW, 20% more than in 2015.
  - In Q4 '16, the above companies recorded 7.3 GW of shipments, a 9.5% increase over Q3 '16.
  - Jinko reported the largest shipments to lead with 6.7 GW shipped in 2016.

Note: First Solar reports production, not shipments. Only ReneSola modules represented. For 2016, Hanwha Q Cell's quarterly shipments based on total year reporting.

Sources: Company figures based on Q4 '16 (and previous) SEC filings by the respective companies.

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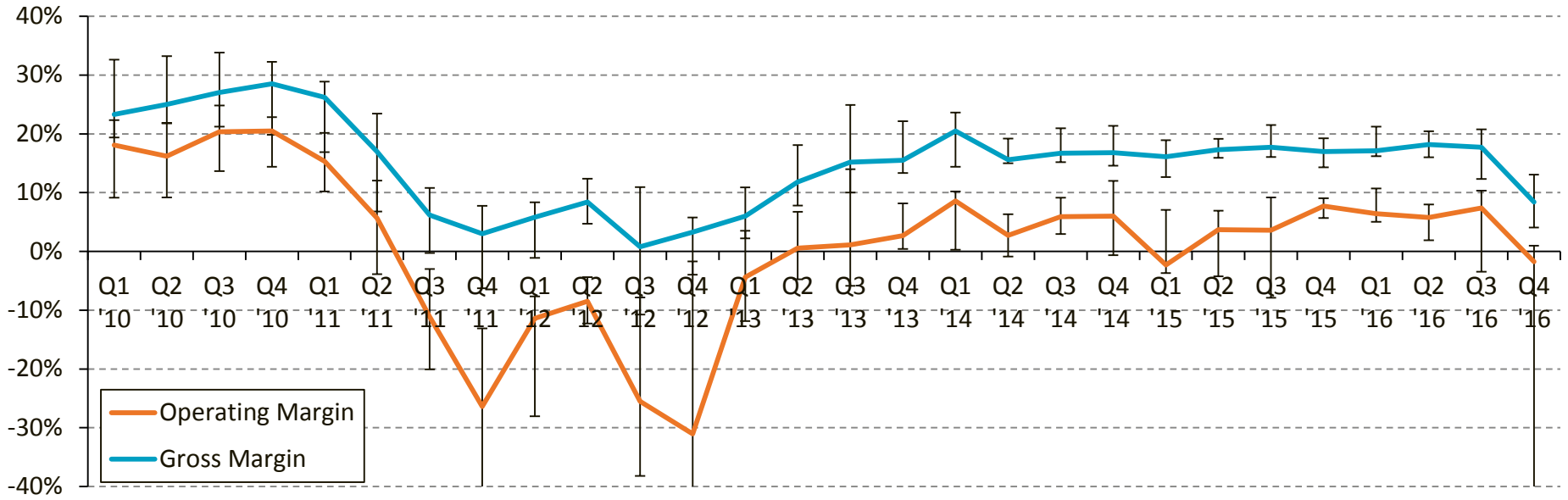
PV Manufacturers' Margins

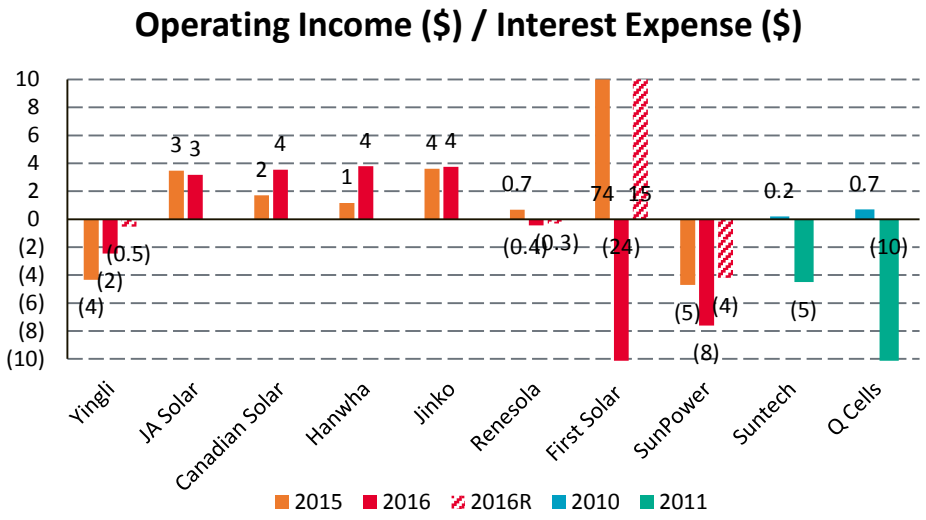


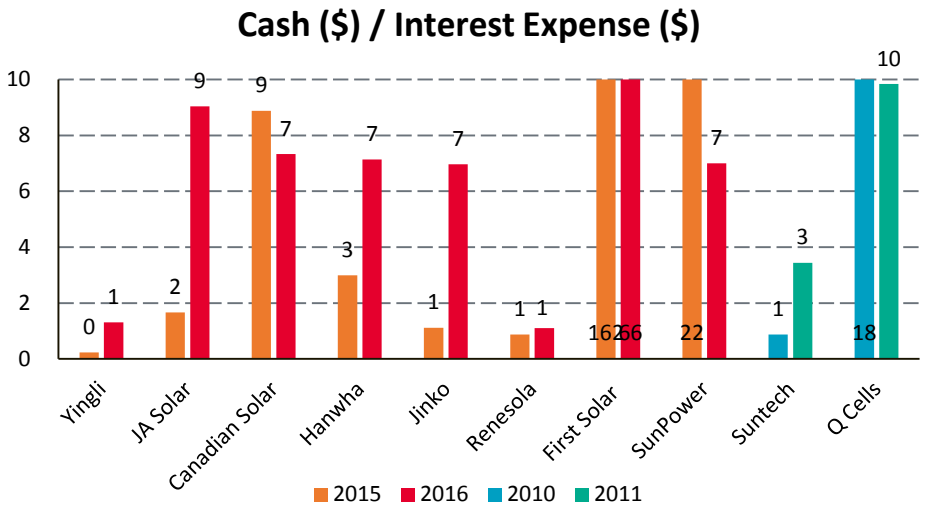
**Line represents the median, with error bars representing 80th and 20th percentiles for the following companies: Canadian Solar, First Solar, Hanwha Q Cells, JA Solar, Jinko Solar, ReneSola, SunPower, Trina Solar, and Yingli Solar.*

- Industry margins declined from Q3–Q4 2016, with some variation among individual companies.
  - The median gross margins was 8% and the median operating margin was -2% for the above companies in Q4 2016.
- Jinko saw the strongest gross margins in the industry (14%) and the most shipments; SunPower had the lowest gross margin of the surveyed companies at -3% in Q4 2016 and the fewest shipments.
  - Most Asian manufacturers saw gross margins of 7%–13% in Q4 2016.
  - First Solar saw a dramatic drop in margin due to the one time restructuring of assets related to Series 5/Series 6 module development.
- All manufacturers saw drops in margins from Q3 2016 –Q4 2016, consistent with reports of declining module costs.

Sources: Company figures based on Q4 2016 (and previous) SEC filings by the respective companies .

Debt Load of Manufacturers

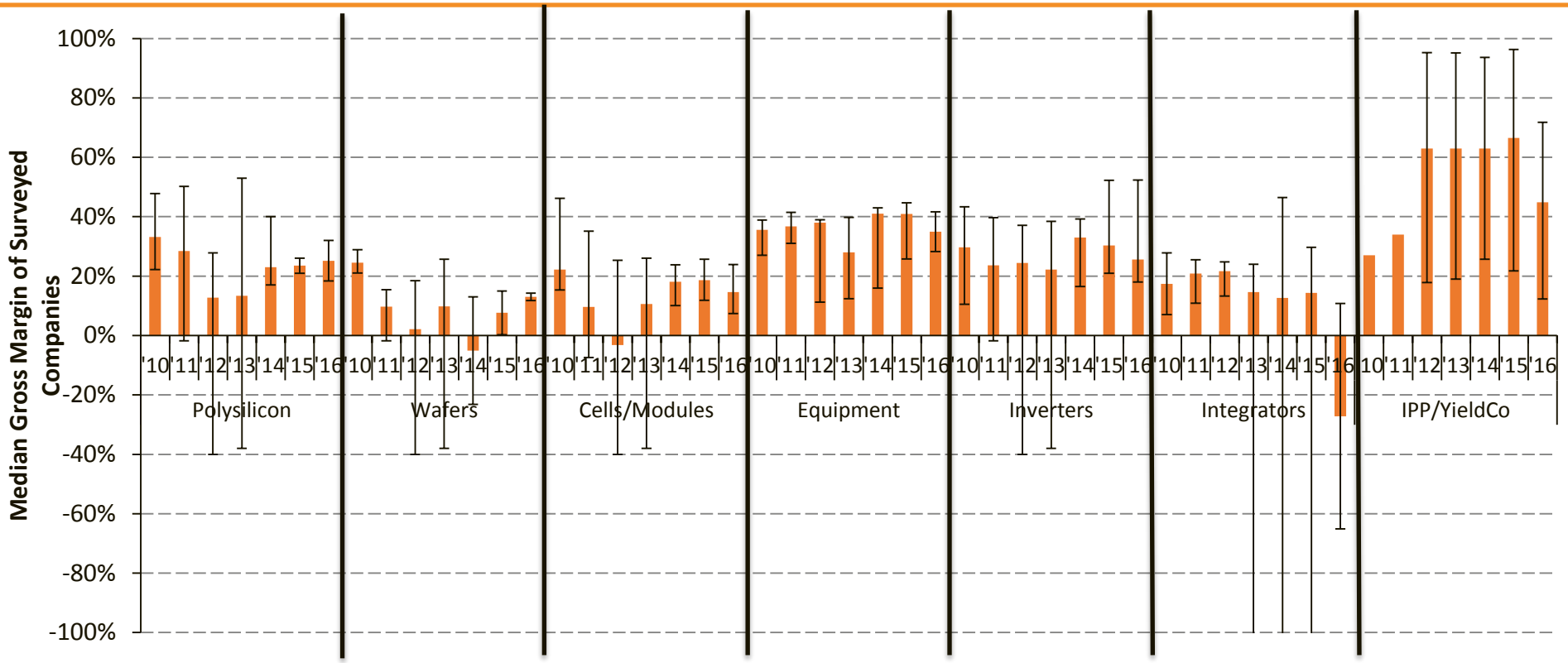




- Manufacturers show differing abilities to service their debts.
- In 2016, the above manufacturers had a median interest coverage ratio (relationship between operating profits, and interest expenses) of 1.37.
  - An interest coverage ratio below 1 means that a company's earnings were not sufficient to make payments on debt, and a company may have to draw from cash reserves to service loans.
- Many western companies have historically had higher cash-to-debt levels, and so could afford to draw upon cash.
  - First Solar and SunPower were able to incur restructuring charges in 2016 of $819 million and $207 million respectively, and were still able to service their debt.
  - Excluding the restructuring charges these companies would have healthier coverage ratios.
- Yingli's debt and cash levels are improving and doing better than historical levels achieved by bankrupt companies, such as Suntech and Q-Cells. That said, they will be challenged by a downturn in margins as well as finding the cash to make restructuring improvements to better compete.

"2016R" represents the ratio ***excluding*** restructuring charges
Sources: Corporate Filings (Q4 '16)

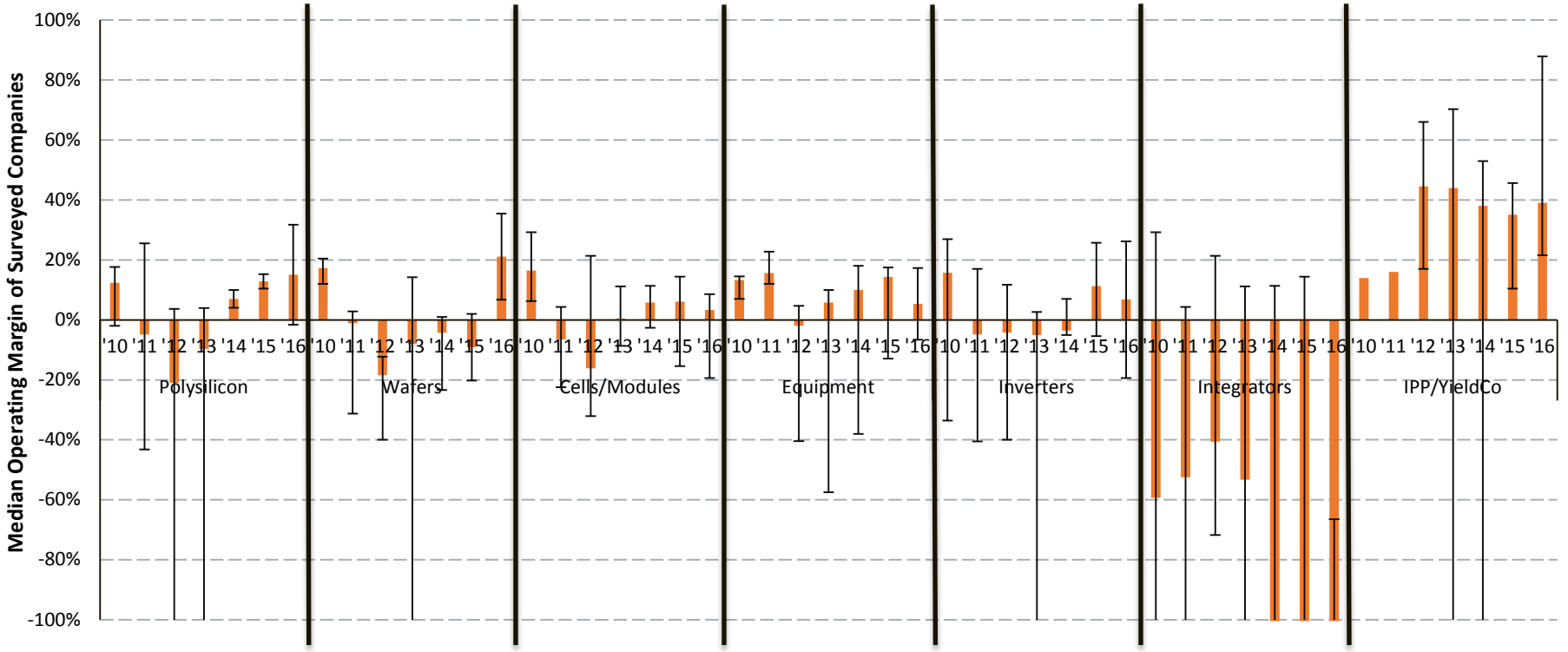
Gross Margin Across Supply Chain



- Gross margins generally dropped in 2016 though there was still substantial variation among individual companies.
- Yieldcos continue to get higher margins than other sectors of the supply chain, however their margins, on average, also dipped significantly in 2016, and had substantial variation.
  - There was a wide variation in profitability for integrators.

Sources: Company figures based on Q4 '16 (and previous) SEC filings by the respective companies. Error bars represent high and low values of surveyed companies. Companies surveyed are: Wafers - LDK Solar, ReneSola, SAS Wafers, Wafer Works Corp., Solargiga; Poly - GCL-Poly, REC Silicon, Wacker, LDK Solar; Cells/Modules, Gintech ,Motech, First Solar, JA Solar, Yingli, Trina Solar, Canadian, PV Crystalox Solar ,Hanwha SolarOne, Jinko Solar, SunPower, LDK Solar; Integrators - Real Goods Solar, SolarCity, Vivint, SunEdison; Inverters - Power-One, SMA, Satcon, Enphase Energy, Advanced Energy Industries; IPP/Yieldco - Abengoa Yield, NRG Yield, NextEra Energy Partners, Northland Power Inc., Pattern Energy, Terraform Power, Sky Solar Holdings.

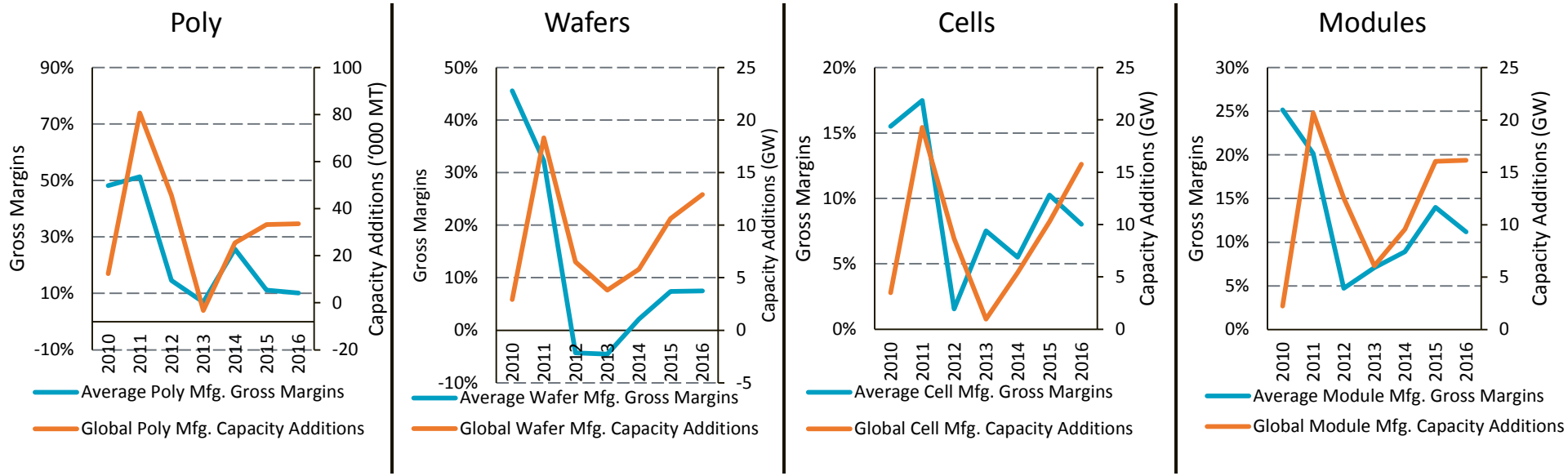
Operating Margin Across Supply Chain



- There was a wide variation in operating margins as companies try to gain market share and pursue new strategies.
  - There was substantial variation across the supply chain as integrators sacrifice short term profits to scale rapidly.
- Operating margin is not necessarily an indicator of corporate profitability, though with strong margins companies should eventually figure a way to profitability.

Sources: Company figures based on Q4 '16 (and previous) SEC filings and Annual Reports by the respective companies. Error bars represent high and low values of surveyed companies. Companies surveyed are: Wafers - LDK Solar, ReneSola, SAS Wafers, Wafer Works Corp., PV Crystalox, Solargiga; Poly - GCL-Poly, REC Silicon, Wacker, LDK Solar; Cells/Modules, Gintech ,Motech, First Solar, JA Solar, Yingli, Trina Solar, Canadian Solar ,Hanwha SolarOne, Jinko Solar, SunPower, LDK Solar; Integrators - Real Goods Solar, SolarCity, Vivint, SunEdison; Inverters - Power-One, SMA, Satcon, Enphase Energy, Advanced Energy Industries; IPP/Yieldco - Abengoa Yield, NRG Yield, NextEra Energy Partners, Northland Power Inc., Pattern Energy, Terraform Power, Sky Solar Holdings.

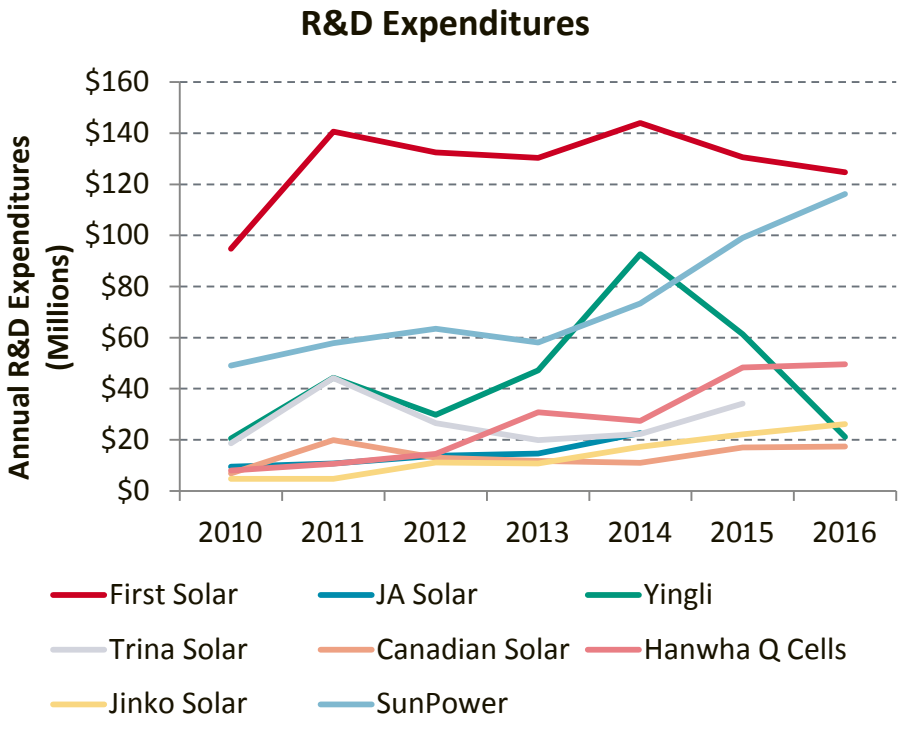
Profit vs. Manufacturing Capacity Additions

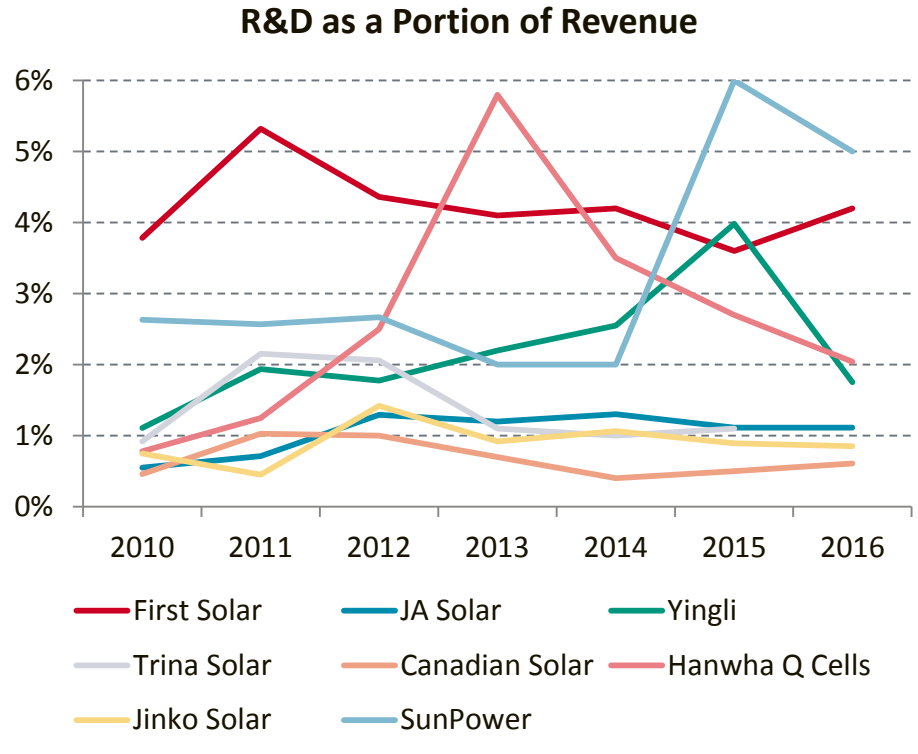


- Manufacturing capacity additions slumped in 2012–2013 following the slump in gross margins across the supply chain but rose again following the increase in margins.
- Margins started to fall again in 2016; while capacity additions generally rose in 2016, they significantly dropped Q/Q toward the end of the year.

Sources: IHS PV Integrated Market Tracker Q4 2016. December 23 2016.

Research & Development





- In 2016, these companies spent over $380 million on R&D, down 5% YoY.
- First Solar continues to lead in R&D spending, though SunPower has been increasing its R&D expenditures annually.
- The majority of Chinese manufacturers are providing lower but relatively consistent levels of funding to research.
  - Yingli significantly cut its R&D budget as it endeavors to avoid bankruptcy.

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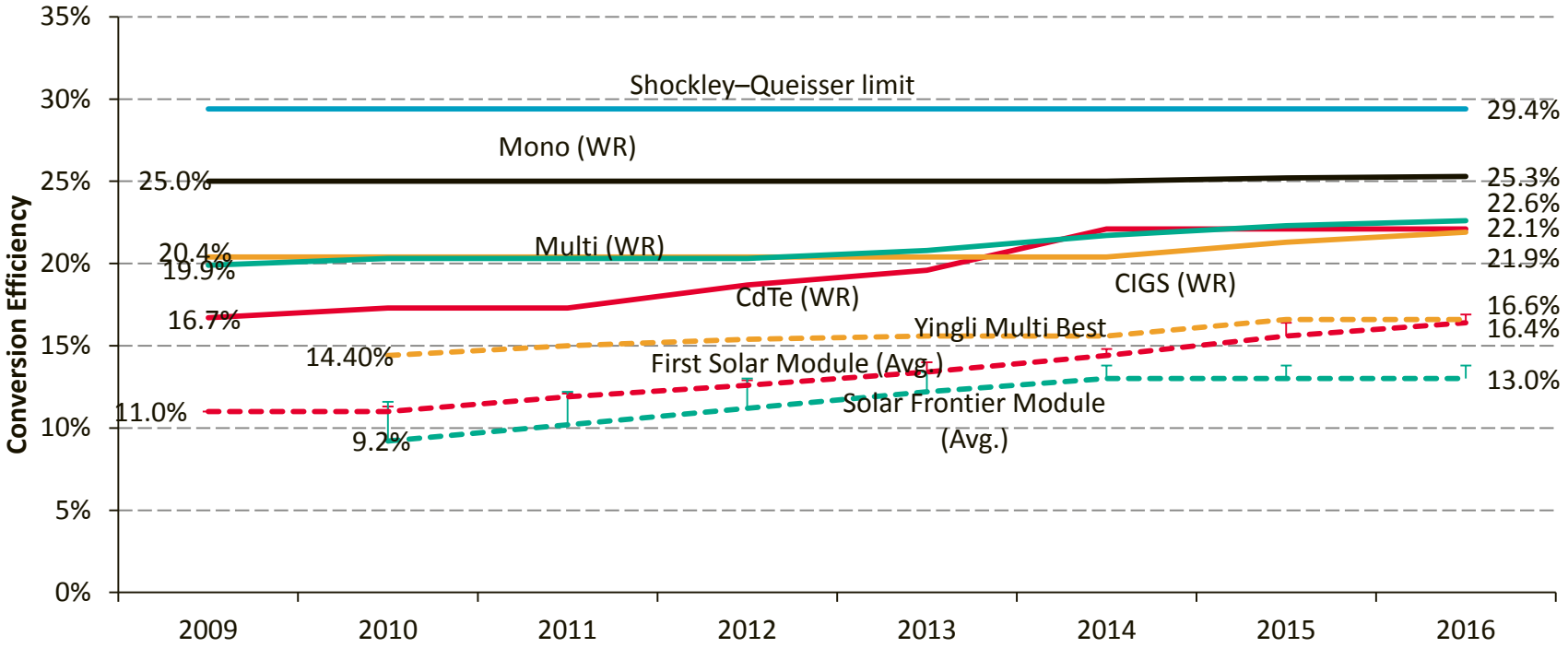
Sources: Company figures based on Q4 2016 (and previous) SEC filings by the respective companies.

PV Efficiency Improvements



- Most technologies saw slight increases in efficiency in 2016.
- CIGS/CdTe now have similar WR efficiencies to multi c-Si and average-efficiency CdTe modules are closing the gap.
- A key question is whether CIGS/CdTe will be able to close the gap with mono c-Si world records or if there are structural barriers preventing this from occurring.

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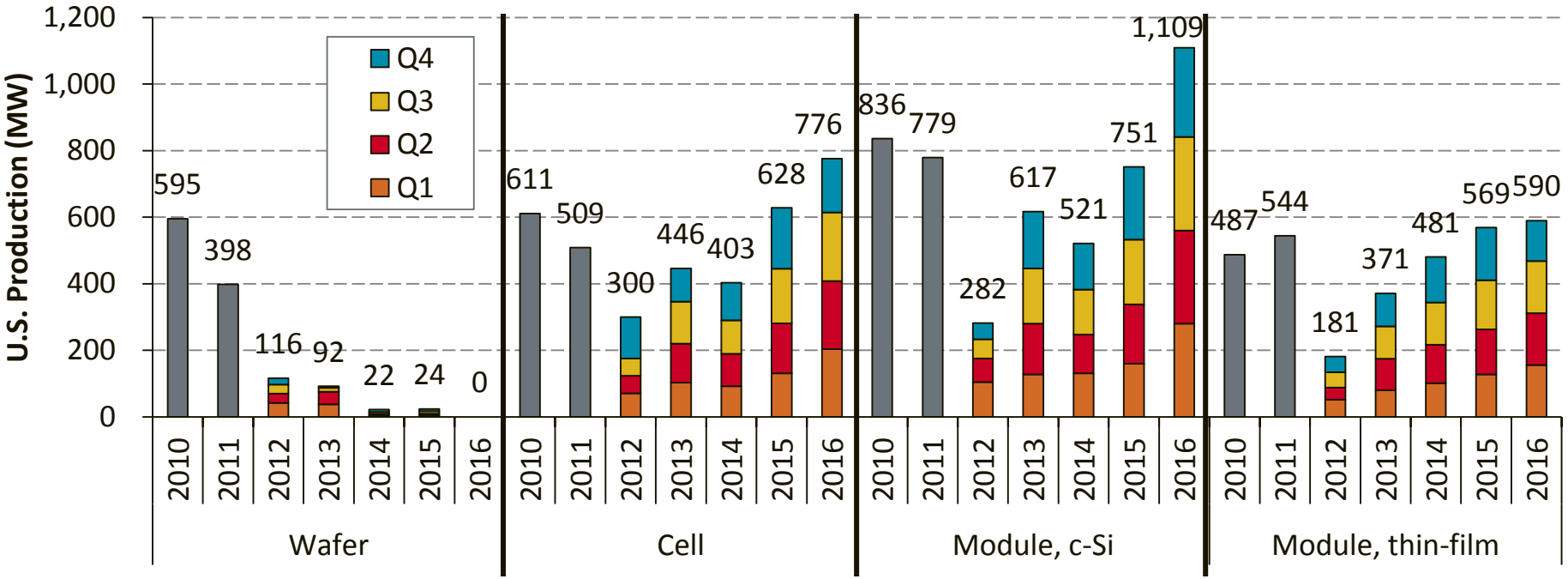
Sources: Corporate press releases and public filings, NREL World Records.

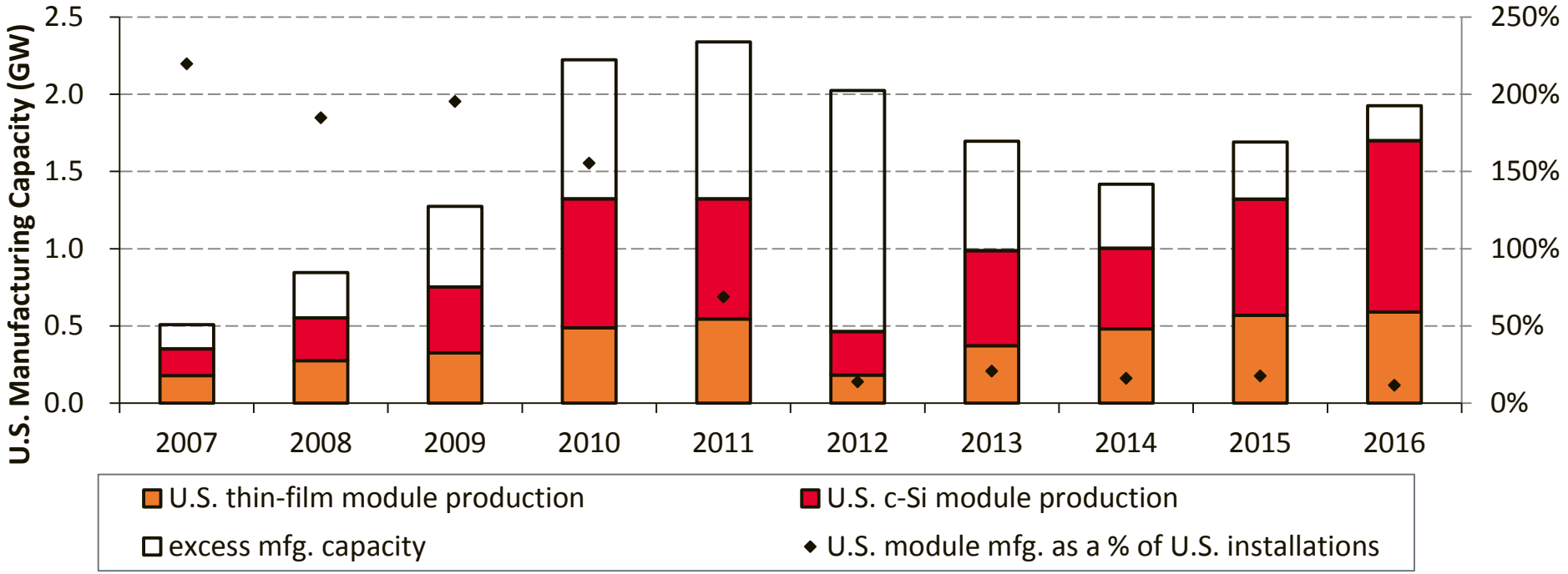
U.S. Manufacturing



- U.S. module and cell production increased again in 2016, growing y/y 29% and 24% respectively.
  - U.S. tariffs on Chinese modules and cells, and a growing U.S. market, contributed to increased production levels.
  - In 2016, module production was split 65% c-Si, 24%, CdTe, and 11% CIGS.
- Wafer production halted in the United States in 2016 as SunEdison consolidated its R&D facilities; however, wafer production in the U.S. effectively ended a few years ago.

Source: GTM Research & SEIA. "U.S. Solar Market Insight: Q4 2016."

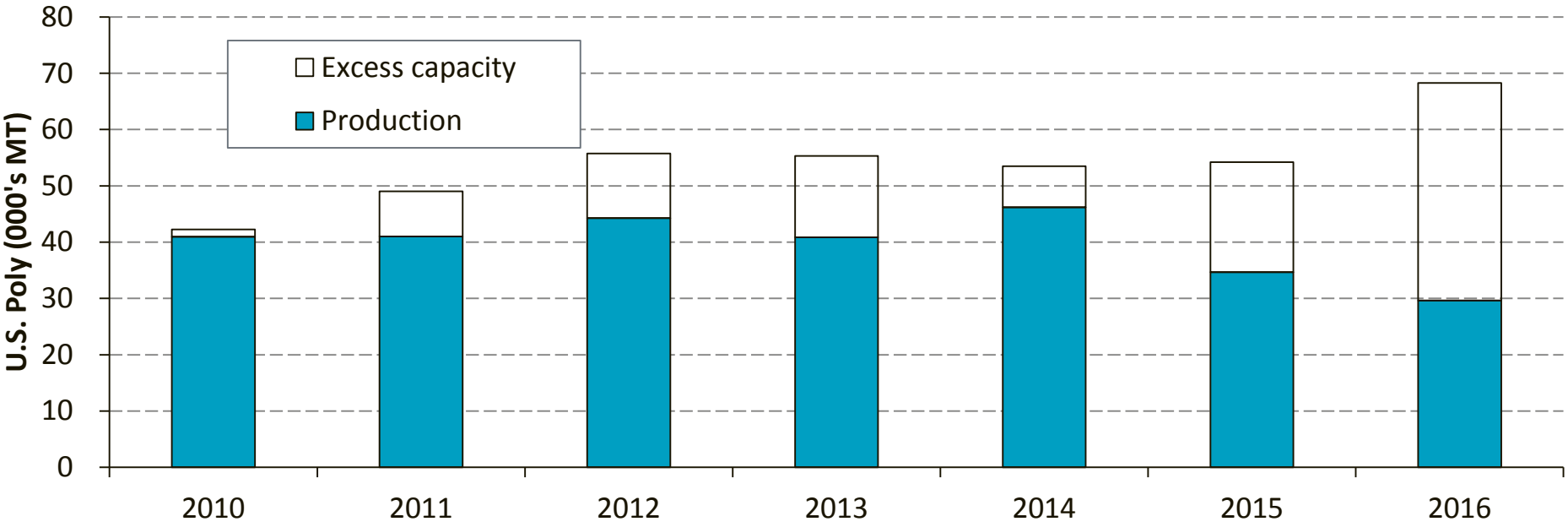
U.S. Module Manufacturing vs. U.S. Deployment



- Pre- 2011, the United States was a net-exporter of PV modules; in 2016 U.S. module production surpassed its previous peak from 2011; however, the U.S. domestic deployment market has increased by a factor of 16.3 since 2010.
  - U.S. manufacturing represented 12% of U.S. deployment in 2016.

Source: GTM Research & SEIA. "U.S. Solar Market Insight: Q4 2016."

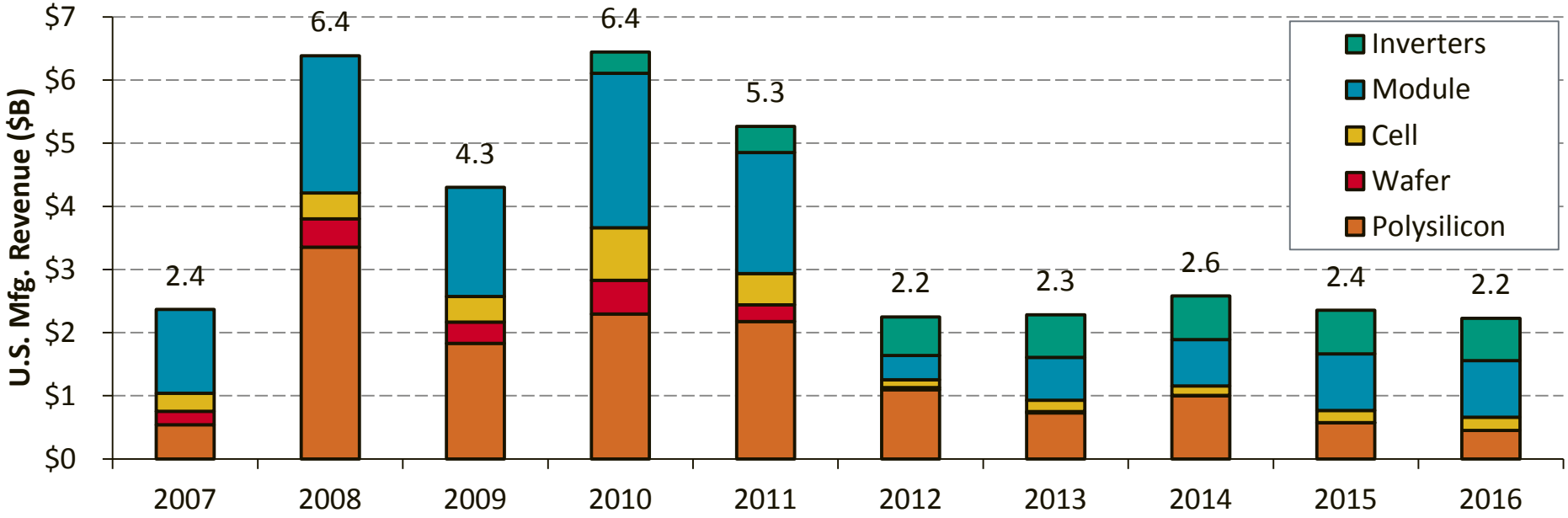
U.S. Polysilicon Manufacturing



- From 2010 to 2014, U.S. polysilicon production was relatively flat; however, China's antidumping tariffs, which were effectively implemented in August 2014, appear to be having an effect on U.S. polysilicon manufacturing.
  - Poly utilization rate was down from 86% in 2014 to 43% in 2016.

Source: GTM Research & SEIA. "U.S. Solar Market Insight: Q4 2016."

Estimated U.S. Manufacturing Revenue



- In 2016, estimated U.S. PV & inverter revenue was $2.2B, fairly flat since 2012 but down 65% from ’10.
  - Poly revenue decreased 55% from 2014 to 2016 due to a 36% decrease in production and 29% decrease in price.
  - Module and inverter revenues were flat y/y as the increase in production was counteracted by the decreased in price.
  - Modules, inverters and polysilicon were 40%, 30%, and 20% of U.S. revenue, respectively.

Note: measured by U.S. production x average component price

Sources: production of wafer/cell/module 2007-11: GTM "Wafer Cell Module Database 2012". June 2012. Polysilicon 2007-11: IEA, U.S. NSR, 2007-2011. Wafer/cell/module/poly 2012-5 (production and price) : GTM/SEIA “U.S. Solar Market Insight Q4 ’15” (March ‘16). Price, 2007-11: Photon Consulting, "Solar Annual 2012" & "Solar Annual 2009“; 2014 production and price: GTM/SEIA “U.S. Solar Market Insight 2015 Year-in-Review” (March ‘16).

Agenda

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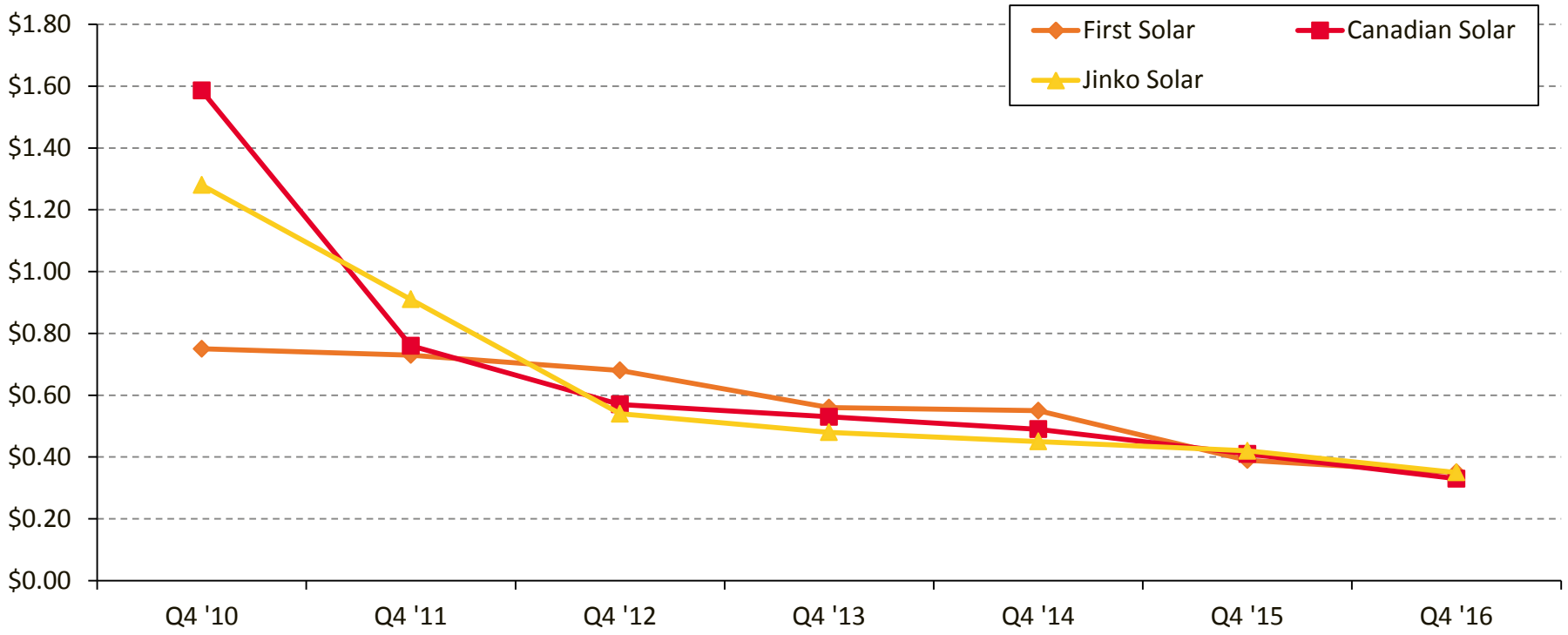
- Market Activity

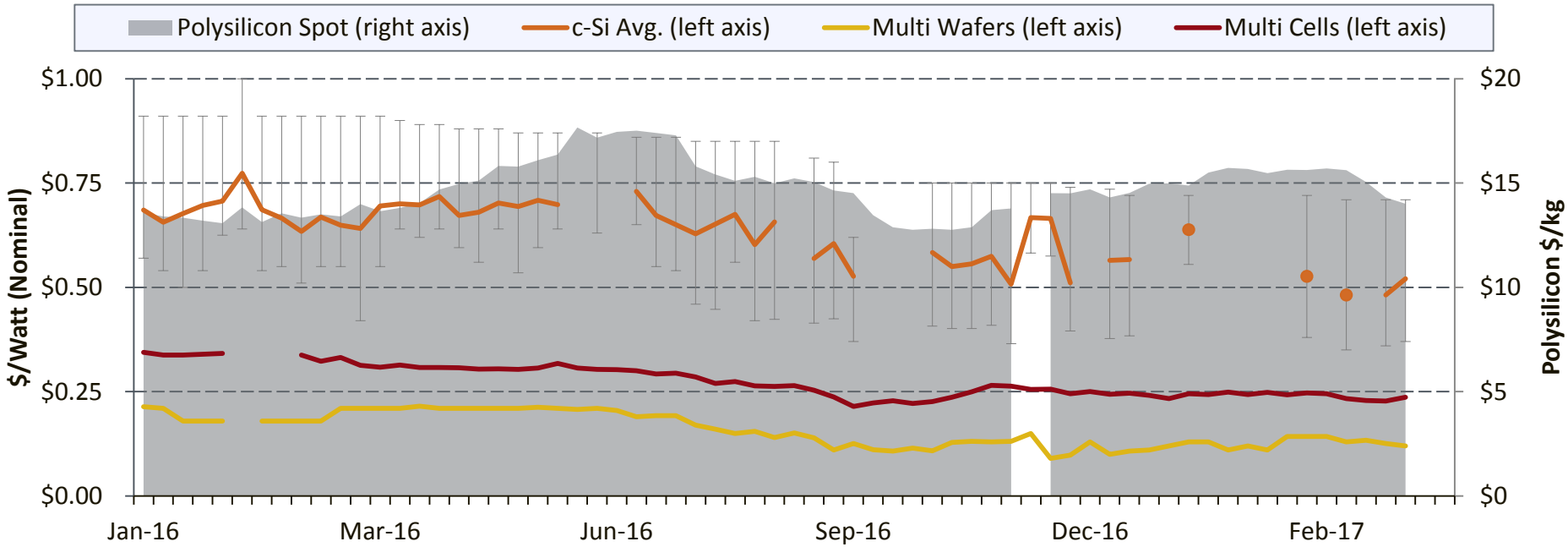
PV Manufacturers' Cost



- In Q4 '16 module costs were between $0.33/W and $0.35/W.
  - Q4 '16 costs from the above companies were, on average, 15% less than Q4 '15, though these three companies may not be representative of the industry as a whole.

Sources: Company figures based on Q4 '16(and previous) SEC filings by the respective companies. Deutsche Bank (12/17/15 (4/26/16) (3/31/17).

Module, Cell, Wafer, and Polysilicon Price



- Module and component prices continued to decline in the first quarter of 2017 after rapid declines in 2016.
  - BNEF reports Q1 2017 price reductions. Q/Q, for modules (18%), cell (4%), wafer (8%), and poly (4%).
  - From Q1 2016 to Q1 2017 BNEF reports price reductions for modules (25%), cell (23%), and wafers (43%), but an increase of poly prices by 3%.
- Despite the general consensus of a lower-priced environment, there are a range of reported market prices, due in part to geographic differences, variations in order size and the difference between delivered prices versus booked prices.

Note: Error bars represent high and low quotes Module pricing reflects orders of approximately 1 MW; bigger orders are more likely to receive favorable pricing .
Source: BNEF Solar Spot Price Index (04/07/17).

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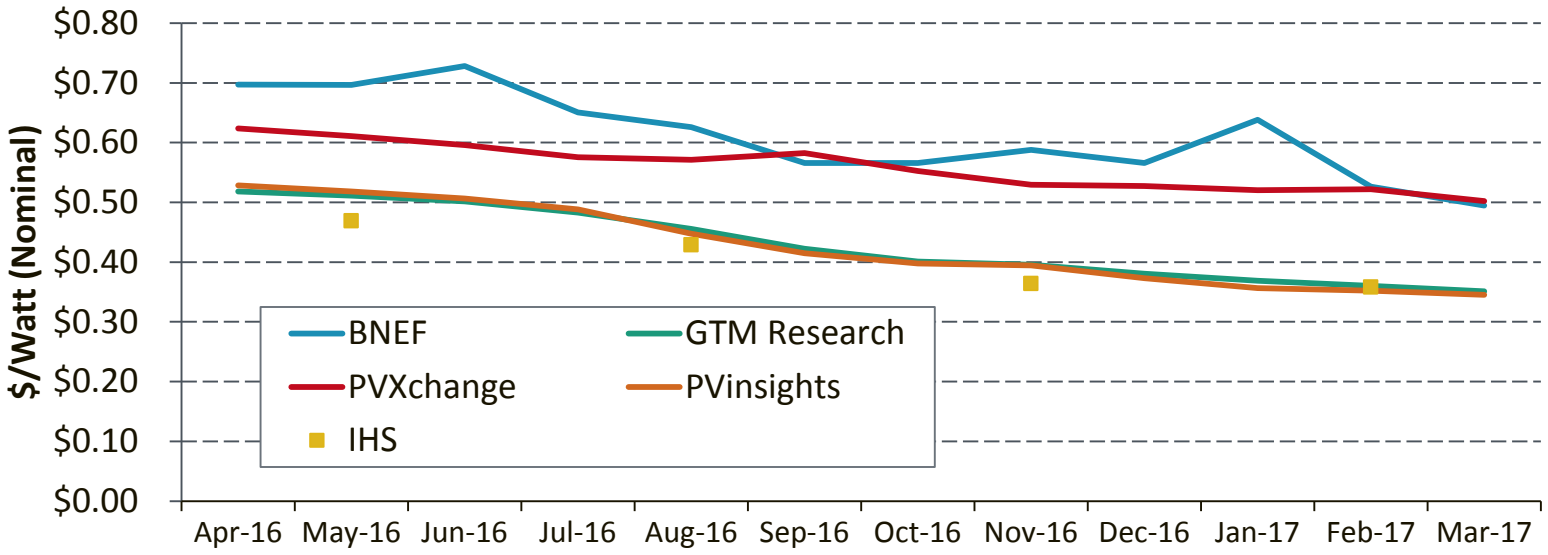
Different Estimates of Module ASP



- Estimates of module ASP vary be source; as of March 2017, most estimates quote module ASP as $0.35/W or $0.50/W.
  - PVXchange only reports European markets data, which currently has a module price-floor agreement in place with many Chinese companies (price floor currently ~$0.49/W)
  - BNEF explicitly tracks smaller orders, approximately 1 MW in size, in their spot pricing index; their estimate of larger orders, above 10 MW, is consistent with the lower estimated prices.
  - Upper end pricing may reflect higher-priced markets or products, or smaller buyers.

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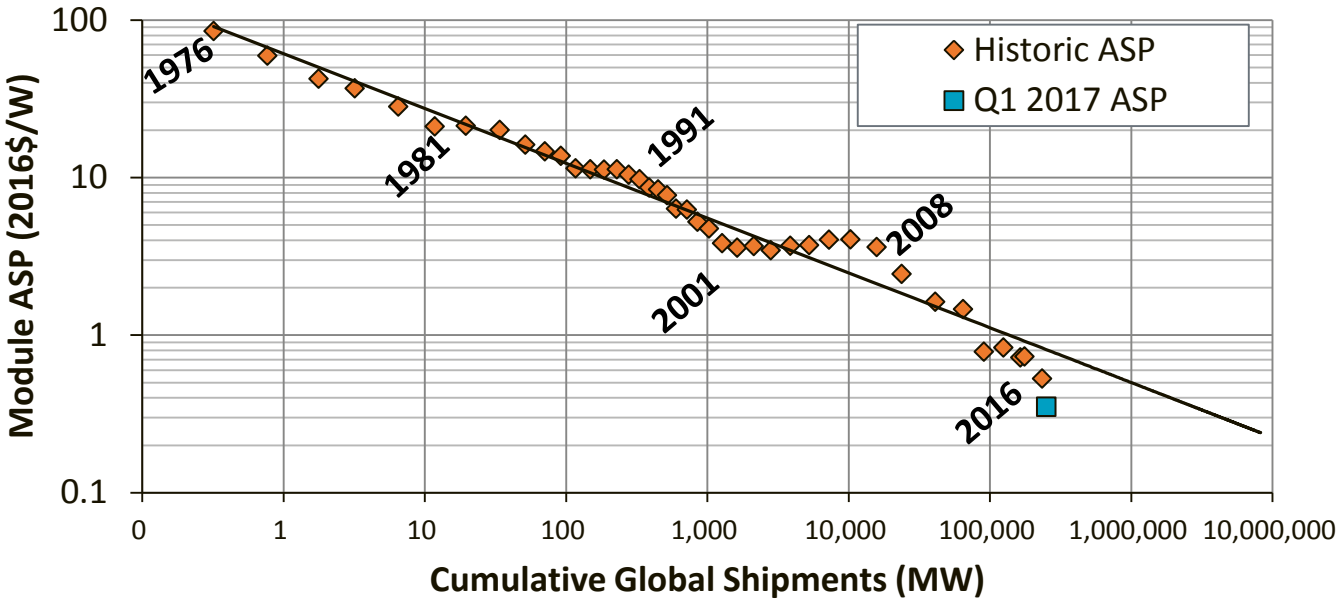
Sources: BNEF Solar Spot Price Index (04/07/17); GTM Research (February 2017, April 2017); IHS Technology (December 2016); PVInsights (04/07/17); PVXchange (04/07/17); Mercom (01/26/17) .

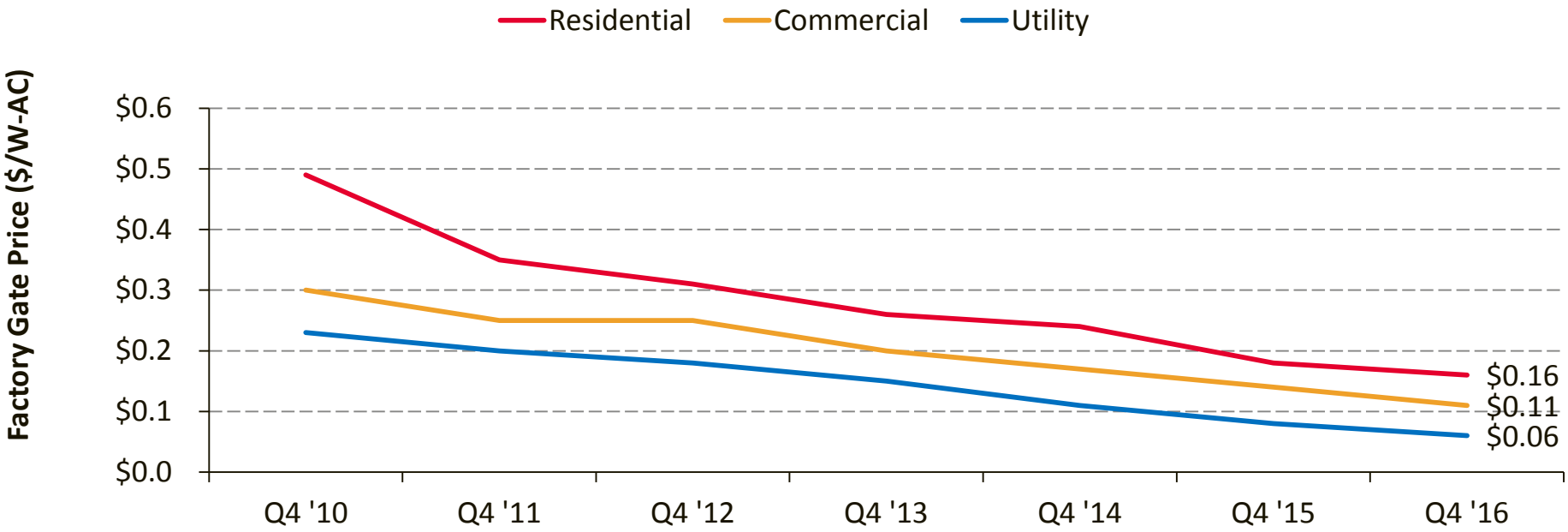
Experience Curve



- This experience curve displays the relationship, in logarithmic form, between the average selling price of a PV module and the cumulative global shipments of PV modules. As shown, for every doubling of cumulative PV shipments there is on average a corresponding ~21% reduction in PV module price.
- Since 2012, module ASP has been below the historical experience curve, which would have extrapolated that the industry would have needed to produce 2.8 TW of panels to get to Q1 2017 module ASP—the industry has produced 250 GW – 300 GW.

Sources: For 2001-2016: Paula Mints. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2016/2017." SPV Market Research. Report SPV-Supply5. April 2017. For 1999-2000: Paula Mints. "Photovoltaic Manufacturer Capacity, Shipments, Price & Revenues 2014/2015." SPV Market Research. Report SPV-Supply3. April 2015. For 1984-1998: Navigant Consulting (2010), Photovoltaic Manufacturer Shipments, Capacity & Competitive Analysis 2009/2010, Report NPS-Supply5 (April 2010). For 1980-1984: Navigant Consulting (2006), Photovoltaic Manufacturer Shipments 2005/2006, Report NPS-Supply1 (August 2006). For 1976-1980: Strategies Unlimited (2003), Photovoltaic Manufacture Shipments and Profiles, 2001-2003, Report SUMPM 53 (September 2003).

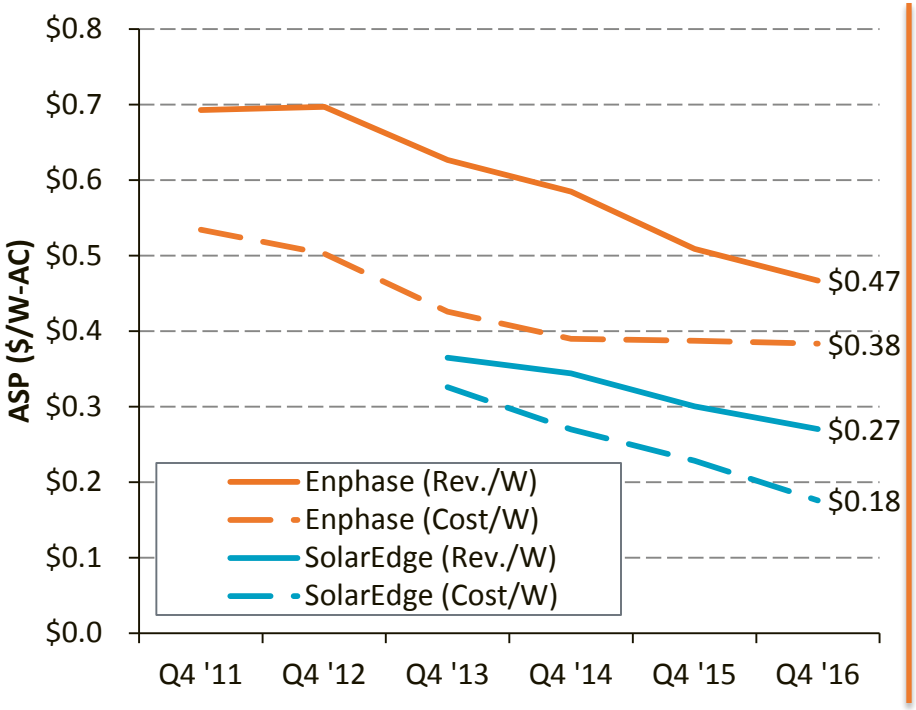
Inverter Pricing

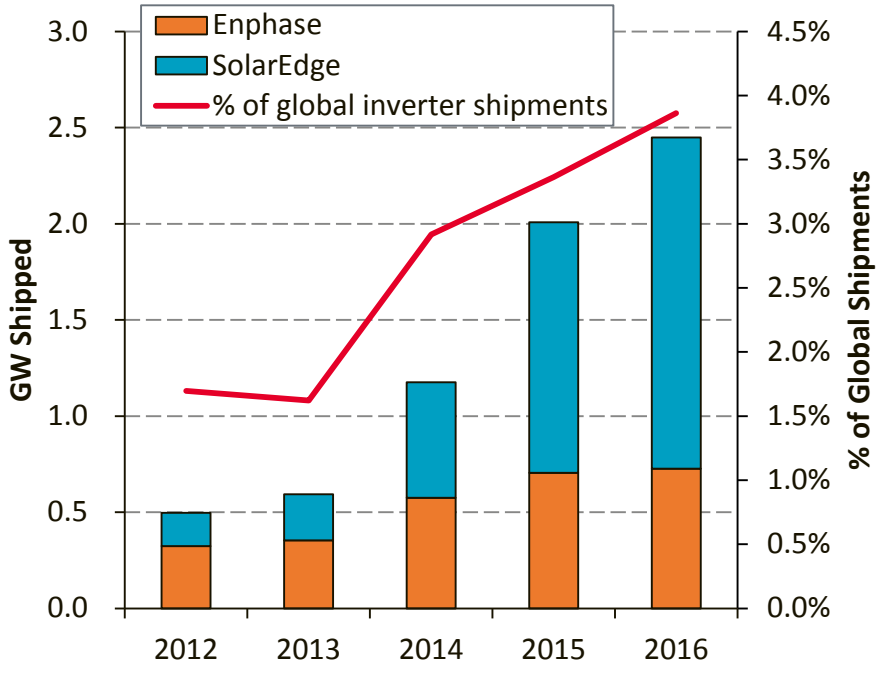


- Since Q4 ‘10, inverter prices have fallen by 63%–74%.
- From Q4 ’15 to Q4 ‘16 inverter prices dropped 11%–25%.

Source: GTM/SEIA “Solar Market Insight 2016 Year-in-review.”

Enphase Microinverters and SolarEdge DC-Optimized Inverter Systems





- From Q4 '15 to Q4 '16 Enphase inverter and SolarEdge optimizer prices fell 8% and 10% respectively.
  - SolarEdge costs also decreased by 23% while Enphase costs have been flat for two years.
- SolarEdge shipped 1.7 GW in 2016—23% growth y/y; Enphase shipped 0.7 GW in 2016—up 3% y/y.
  - SolarEdge and Enphase shipments have increased from approximately 1.7% of total global shipments in 2012 to 3.9% in 2016.

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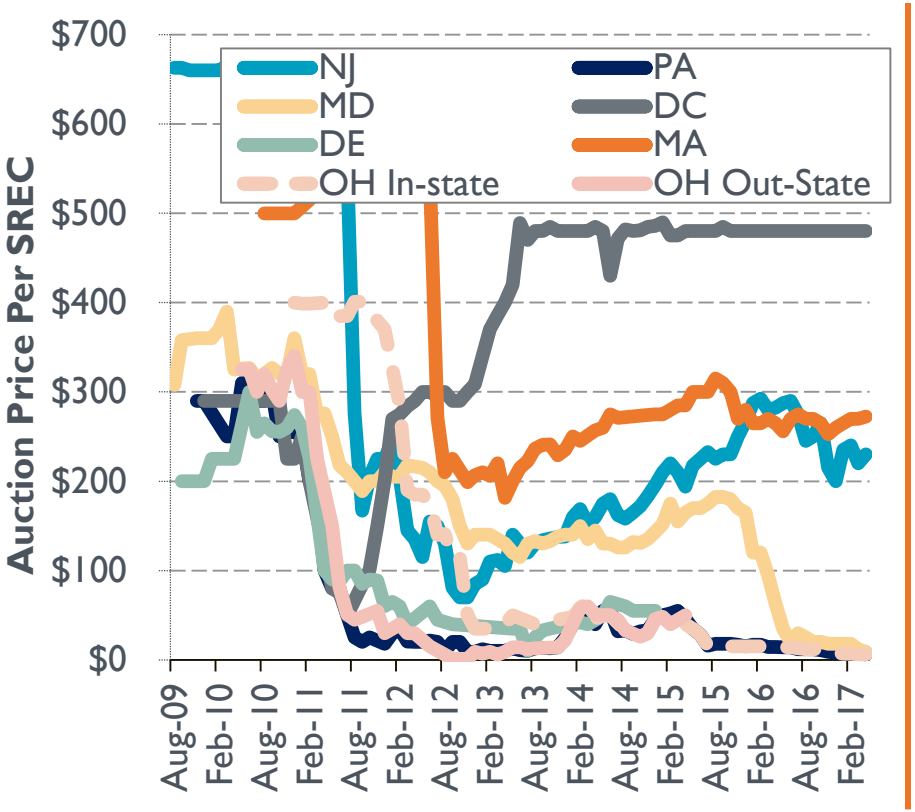
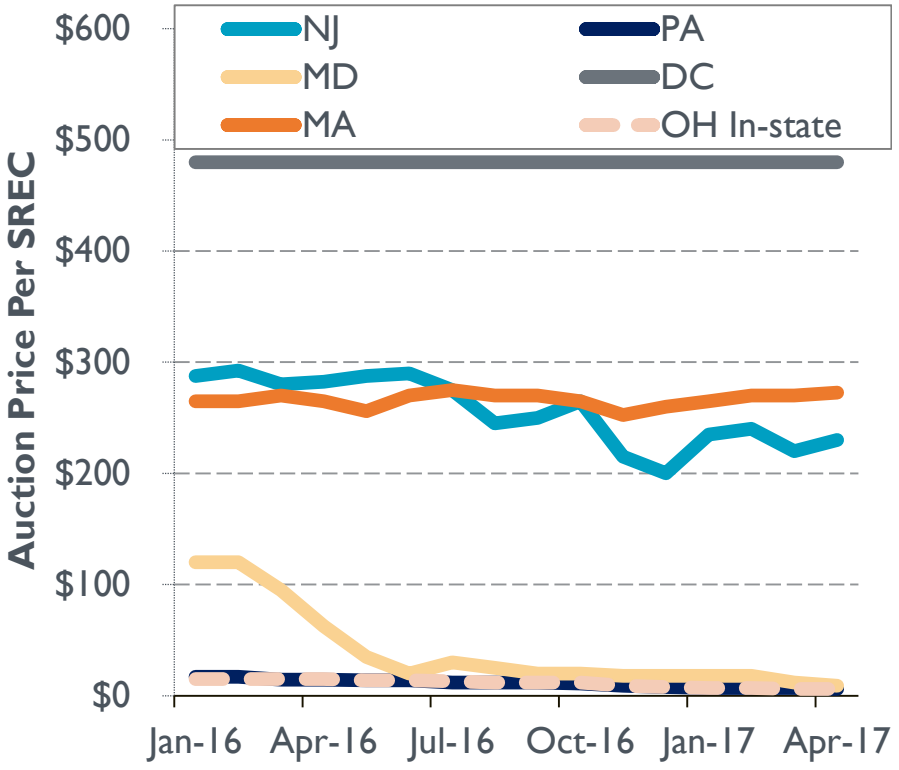
Sources: Enphase/SolarEdge public filings. Global inverter shipments from GTM Research.

Agenda

- State and Federal Updates
- Long-term Solar Projections
- U.S. Deployment
- U.S. Pricing
- Global Manufacturing
- Component Pricing
- Market Activity

SREC Markets



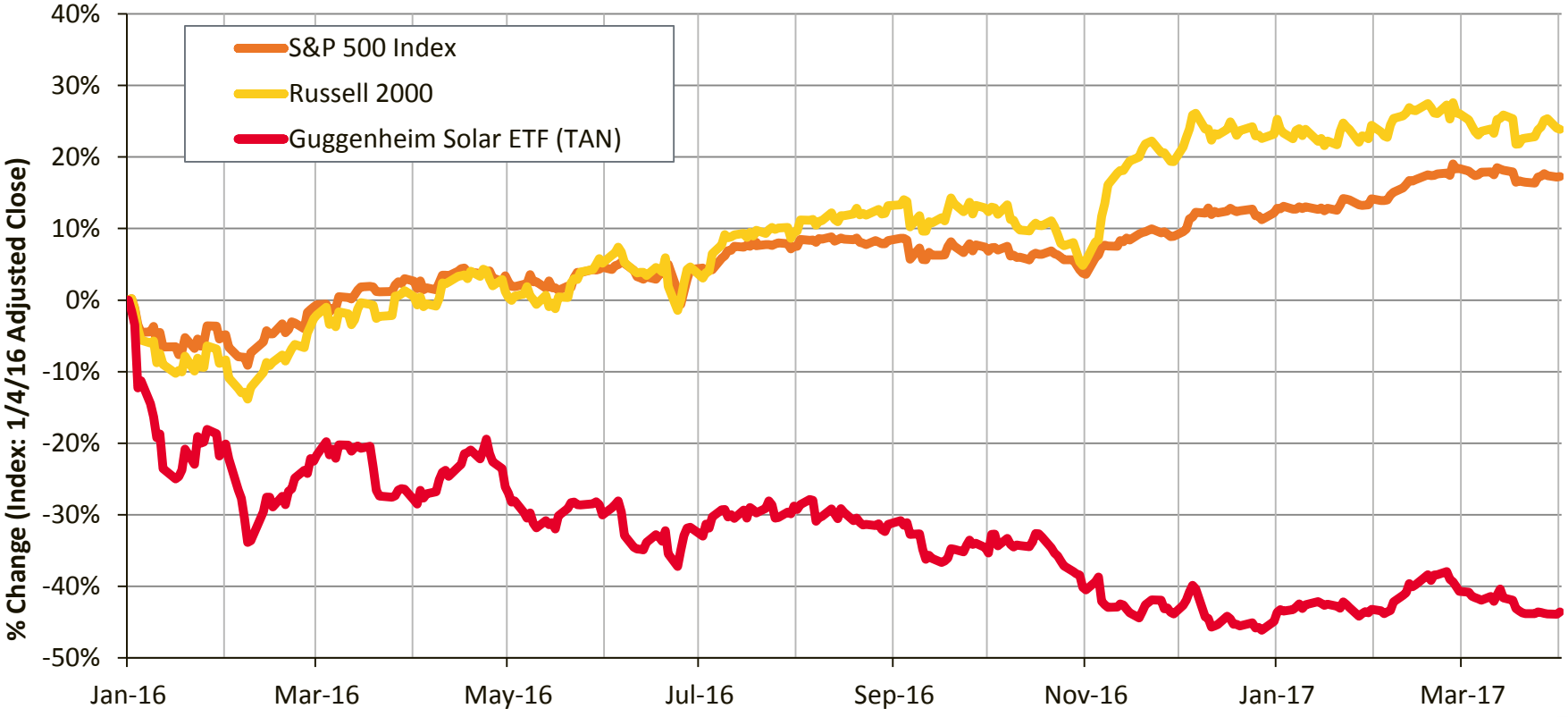


- SREC prices saw dramatic changes in some markets and stability in others.
- Ohio, Pennsylvania and Maryland saw drops in SREC value in 2016.
  - The value of MD SRECS decreased 93% from January 2016 to April 2017, as the state approached its RPS cap; the state raised its RPS cap in February 2017, which should place upward pressure on SRECs, as the cap increased.

Source: Blog, SRECTrade, www.srectrade.com (accessed April 14, 2017); Utility Dive (February 3, 2017)

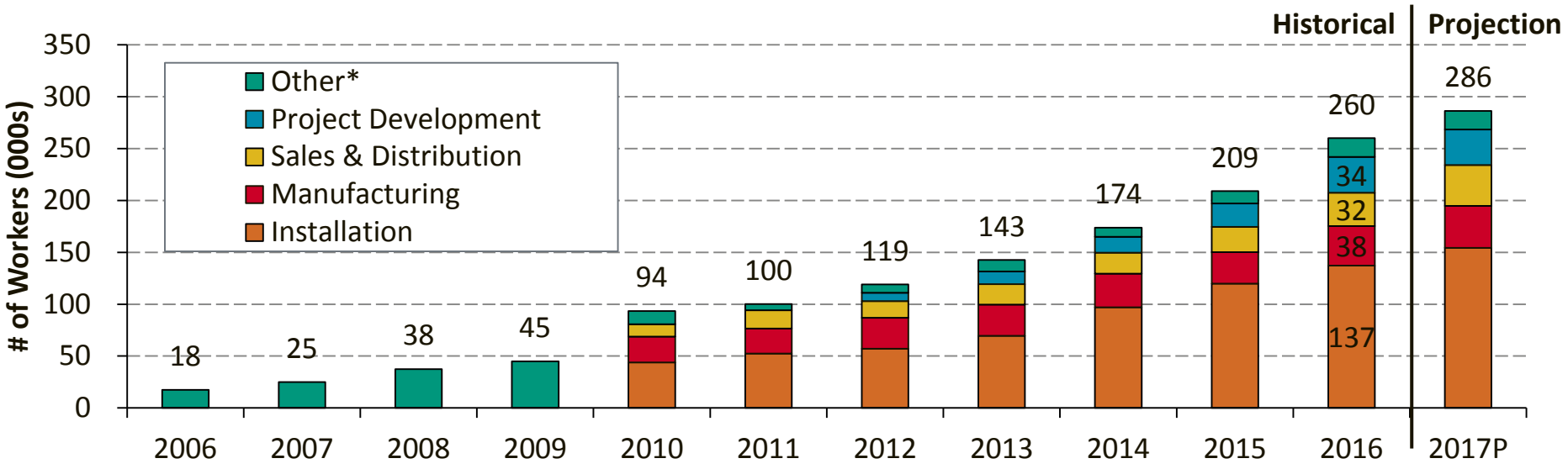
Market Activity

- Solar stocks saw significant losses in 2016, but began to track more closely to the broader market in Q1 2017.
  - TAN was ↑2% in Q1 2017, after seeing large losses in 2016.
  - S&P 500 was ↑4.5%, Russell 2000 was flat, over the same time period.



Notes: Average market cap. of securities in TAN was $9.8 Billion (12/31/16), Russell 2000, $1.6b (6/27/16).
Sources: Stock Market: YahooFinance (04/4/17).

U.S. Solar Workforce



- As of January 2017, the U.S. solar industry employed 260,000 workers, adding 51,000 jobs in 2016.
  - This represents the fourth straight year of 20%+ workforce growth.
  - Installations jobs represented 53% of total U.S. solar jobs in 2016; however, other areas had higher growth rates. For example, manufacturing jobs grew 26% y/y to over 38,000 and are expected to grow again in 2017.

*Changes in the number of jobs in the "Other" category between years are not necessarily a reflection of actual increases or decreases in employment, but may instead be due to changes in the types of jobs included in this category.

Source: The Solar Foundation, "The National Solar Jobs Census 2015." January 2017.

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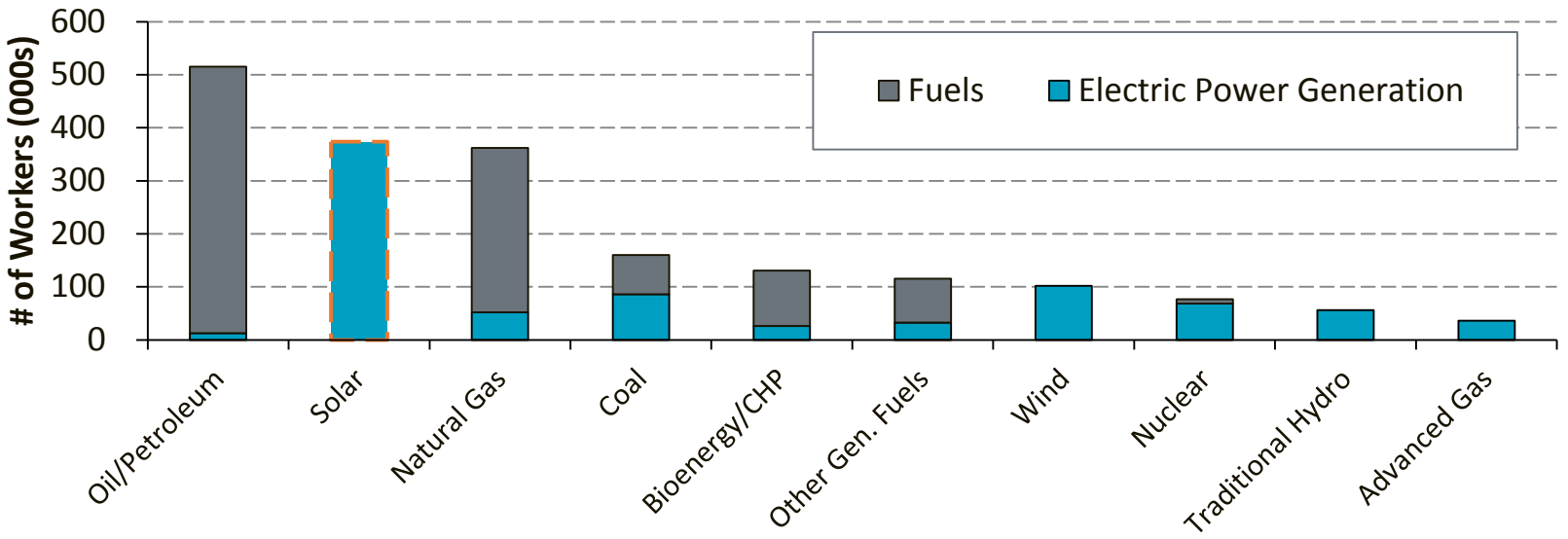
U.S. Solar Workforce (cont.)

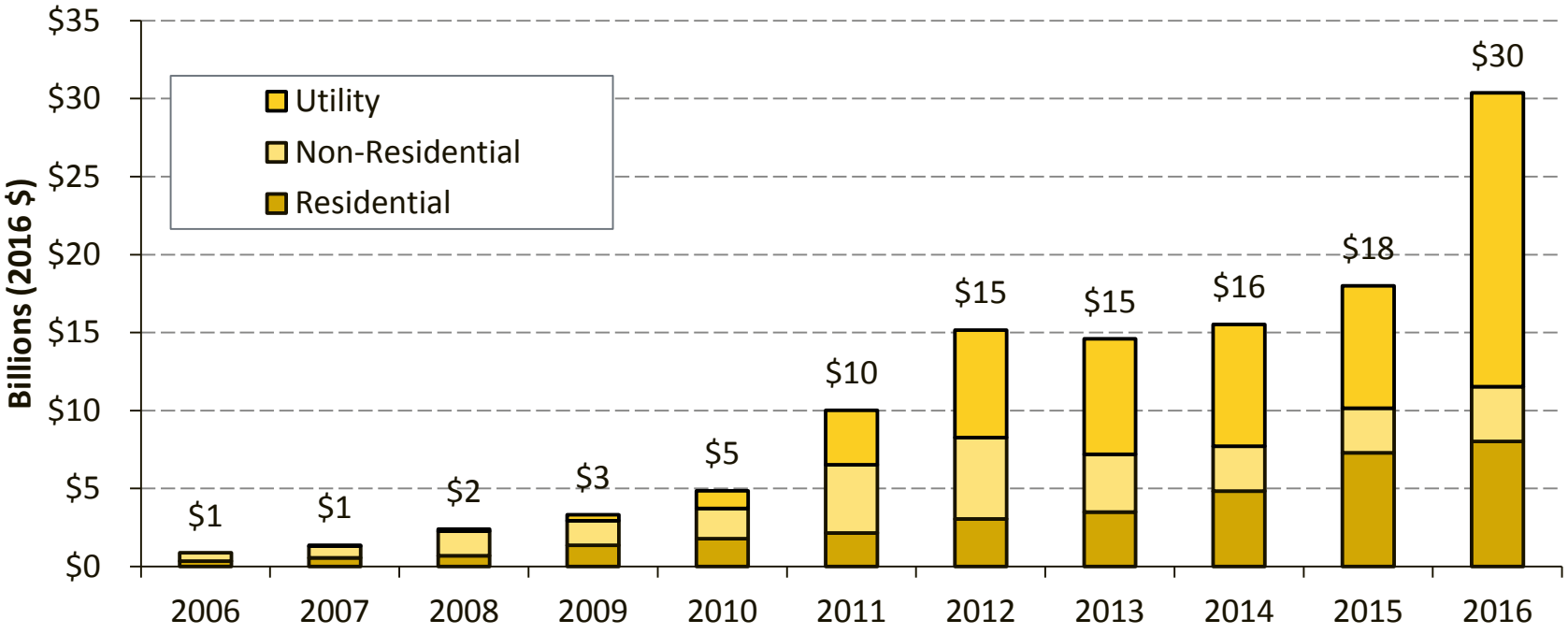


- While 260,000 people in the United States spend at least ½ of their time on solar-related work, 374,000 employees spend some time working for the solar industry—larger than every other energy sector but petroleum.
- The solar industry is creating jobs at a rate 17 times greater than the overall U.S. economy.
  - In 2016, *one in fifty* new jobs added in the United States was created by the solar industry.
- In 2016, women represented 28% of the solar workforce; veterans accounted for 9.3%—both percentages represent a growth y/y.
- Nearly 80% of solar employers report that they have some difficulty finding qualified employees they need, despite installers offering a medium wage of $26/hr.

Source: The Solar Foundation, "The National Solar Jobs Census 2015." January 2017.

Estimated Value of U.S. Solar Installations

- The estimated value of U.S. PV Installations in 2016 was approximately $30 billion.
  - This represents an increase of 69% over 2015.
  - 62% of 2016 annual value was in the utility sector, 26% in the residential sector, and 12% in the non-residential sector.
- Worldwide installations in 2016 was approximately $100–$150 billion.



Sources: PV installations: DOE "2010 Solar Market Trends Report" (U.S. '06-'09); GTM Research / SEIA "Solar Market Insight 2016 Year in Review" (U.S. '10-'16). PV Price: LBNL "Tracking the Sun VIII" and "Utility-scale Solar" (2006-09); NREL "U.S. Solar Photovoltaic System Cost Benchmark Q1 2016"; U.S. Jobs: Solar Foundation "National Solar Jobs Census 2015" ('10-'15); SEIA Estimate ('06-'09).

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Thank You

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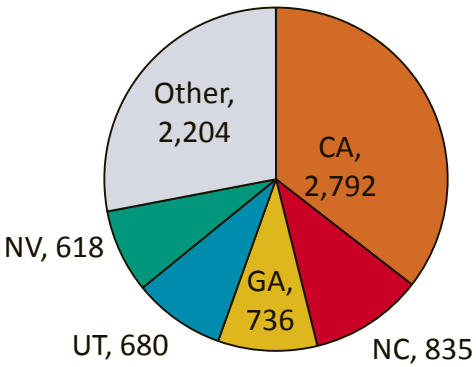
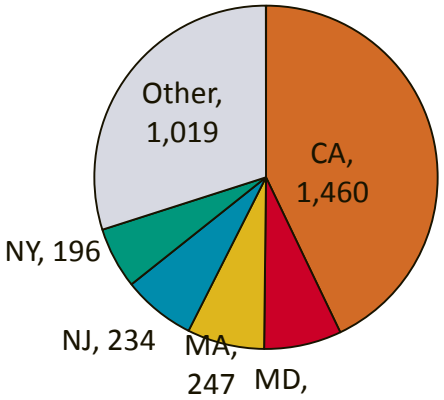
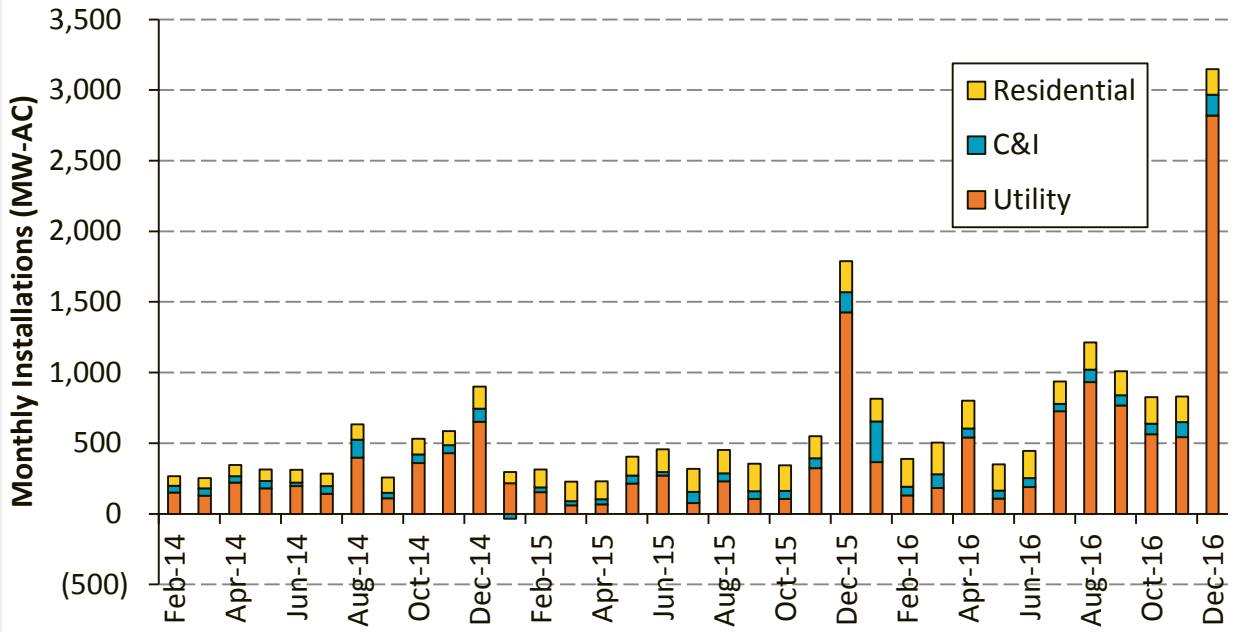
U.S. Installation Breakdown

U.S. PV Utility-Scale Installations by State (MW_{AC}), 2016



U.S. PV Distributed Installations by State (MW_{AC}), 2016

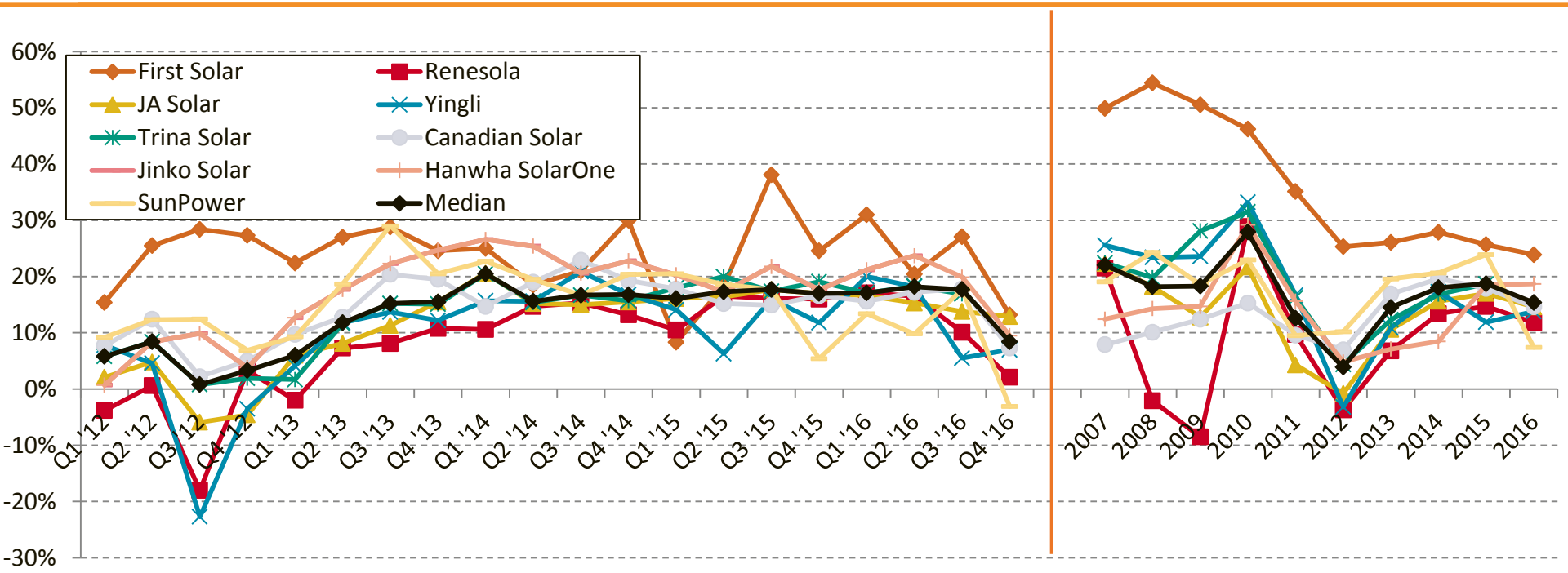




- The United States installed almost 4 GW_{DC} of PV in December 2016 and almost 1 GW_{DC} for 8 months in 2016.
- Utility-scale PV deployment has much greater seasonal variation than distributed PV deployment.

Sources: EIA, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861 (February 2017).
Notes: EIA monthly data for 2016 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.

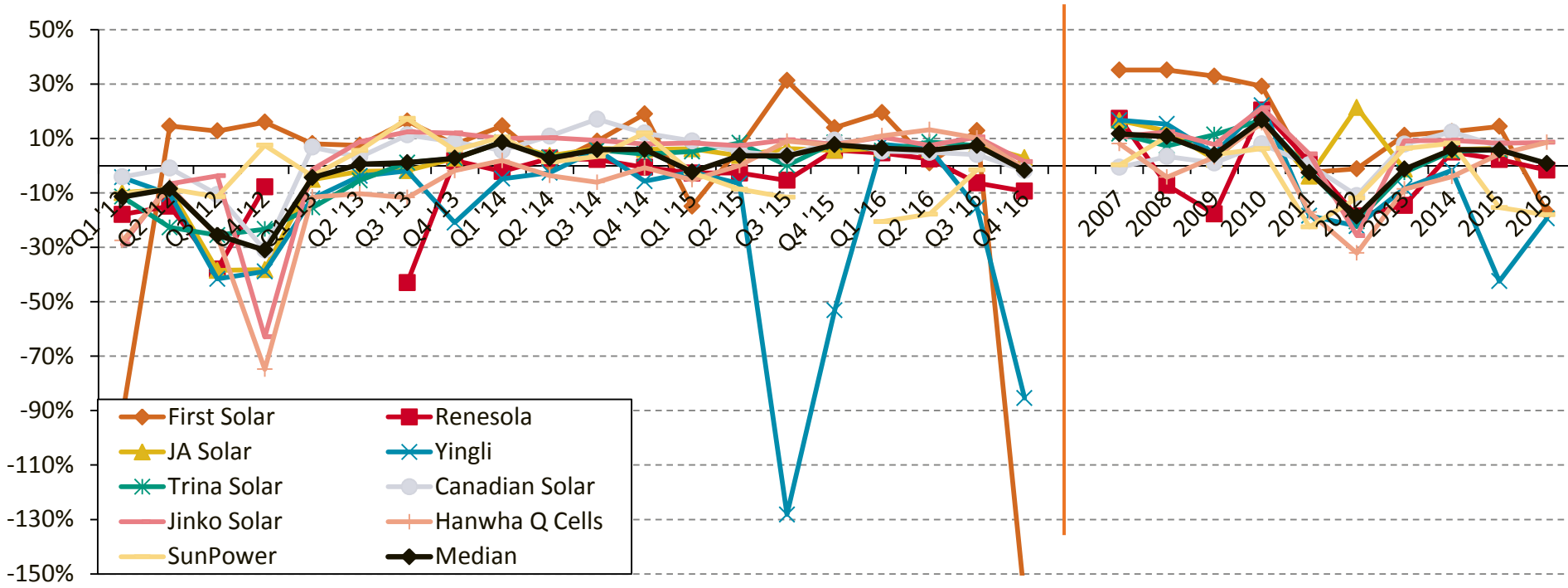
PV Manufacturers' Gross Margins



- Industry gross margins decreased by 55% Q3-Q4 '16, with some variation among individual companies:
  - 8% median gross margin of above companies in Q4 '16
  - 18% in Q3 '16
  - 17% in Q1 '16
  - 17% in Q4 '15.
- Drop in margin is consistent with reports of declining module prices.

Sources: Company figures based on Q4 '16 (and previous) SEC filings by the respective companies.

PV Manufacturers' Operating Margins



- Operating margins saw a downturn in 2016, with some companies posting operating losses:
  - -2% median operating margin of the above companies in Q4 16
  - Previous 8 quarters averaged 1%.

Sources: Company figures based on Q4 '16 (and previous) SEC filings by the respective companies.

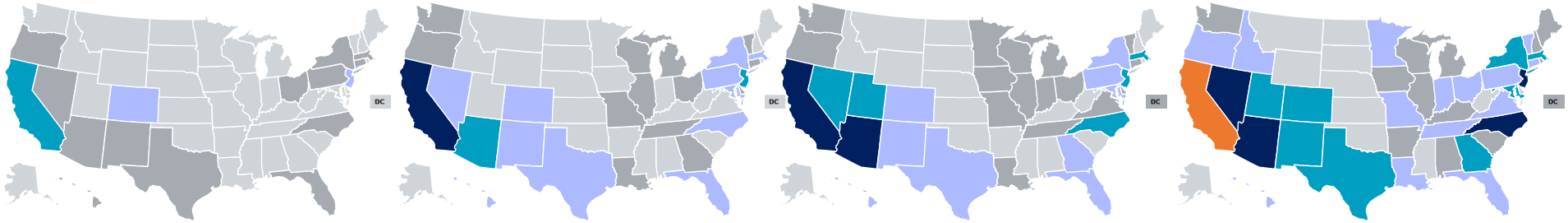
Cumulative Solar

December 2010
1.9 GW

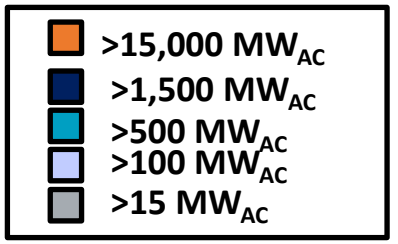
December 2012
6.4 GW

December 2014
16.5 GW

December 2016
34.7 GW



- The number of states with more than 100 MW-AC has grown from 3 in 2010 to 28 by the end of 2016.
- The number of states with more than 15 MW-AC has grown from 16 states in 2010 to 39 states and DC by the end of 2016.
- Despite the growth in the number of markets, more than half of the solar capacity in the United States is still installed in two states.



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Source: EIA, Electric Power Monthly (February 2017, February 2015).

List of Acronyms and Abbreviations

APAC	countries in Asia and Oceana, except China, India, and Japan
ARRA	American Recovery and Reinvestment Act of 2009
ASP	average selling price
BOS	balance-of-system
DG	distributed generation
FiT	feed-in-tariff
G&A	general and administrative expenses
kW	kilowatt
kWh	kilowatt-hour
LMI	low-to-moderate income
MW	megawatt
NEM	net energy metering
PCS	power controlling systems
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
SI	systems integration
STH	solar thermal heating
SREC	solar renewable energy certificates
TTM	tech-to-market
TWh	terawatt-hours
USD	U.S. dollars
W	watt
WACC	weighted average cost of capital
y/y	year over year
YTD	year to date