



U.S. SOLAR MARKET INSIGHT

Executive Summary

Q3 2017

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ABOUT THE REPORT

U.S. Solar Market Insight® is a quarterly publication of Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA)®. Each quarter, we collect granular data on the U.S. solar market from nearly 200 utilities, state agencies, installers and manufacturers. This data provides the backbone of this U.S. Solar Market Insight® report, in which we identify and analyze trends in U.S. solar demand, manufacturing and pricing by state and market segment. We also use this analysis to look forward and forecast demand over the next five years. All forecasts are from Wood Mackenzie, Limited; SEIA does not predict future pricing, bid terms, costs, deployment or supply.

-) References, data, charts and analysis from this executive summary should be attributed to “Wood Mackenzie, Limited/SEIA U.S. Solar Market Insight®.”
-) Media inquiries should be directed to Mike Munsell (munsell@gtmresearch.com) at GTM Research and Alex Hobson (ahobson@seia.org) at SEIA.
-) All figures are sourced from Wood Mackenzie, Limited. For more detail on methodology and sources, visit www.gtmresearch.com/solarinsight.
-) GTM Research partners with Clean Power Research to acquire project-level datasets from participating utilities that utilize the PowerClerk product platform. For more information on Clean Power Research’s product offerings, visit <https://www.cleanpower.com/>

Our coverage in the U.S. Solar Market Insight reports includes 40 individual states and Washington, D.C. However, the national totals reported include all 50 states, Washington, D.C., and Puerto Rico.

Detailed data and forecasts for 40 states and Washington, D.C. are contained within the full version of this report, available at www.greentechmedia.com/research/ussmi.

Author’s Note: Revision to U.S. Solar Market Insight report title

GTM Research and SEIA have changed the naming convention for the U.S. Solar Market Insight report series. Starting with the report released in June 2016 onward, the report title will reference the quarter in which the report is released, as opposed to the most recent quarter in which installation figures are tracked. The exception will be our “Year in Review” publication, which covers the preceding year’s installation volumes despite being released during the first quarter of the current year.

ABOUT THE AUTHORS

GTM Research | U.S. Research Team

Austin Perea, Solar Analyst (lead author)

Cory Honeyman, Associate Director of U.S. Solar

Shayle Kann, Senior Vice President

Allison Mond, Solar Analyst

MJ Shiao, Director of Solar Research

Jade Jones, Senior Solar Analyst

Scott Moskowitz, Senior Solar Analyst

Colin Smith, Solar Analyst

Benjamin Gallagher, Solar Analyst

Solar Energy Industries Association | SEIA

Shawn Rumery, Director of Research

Aaron Holm, Data Engineer

Katie O'Brien, Research Associate

Justin Baca, Vice President of Markets & Research

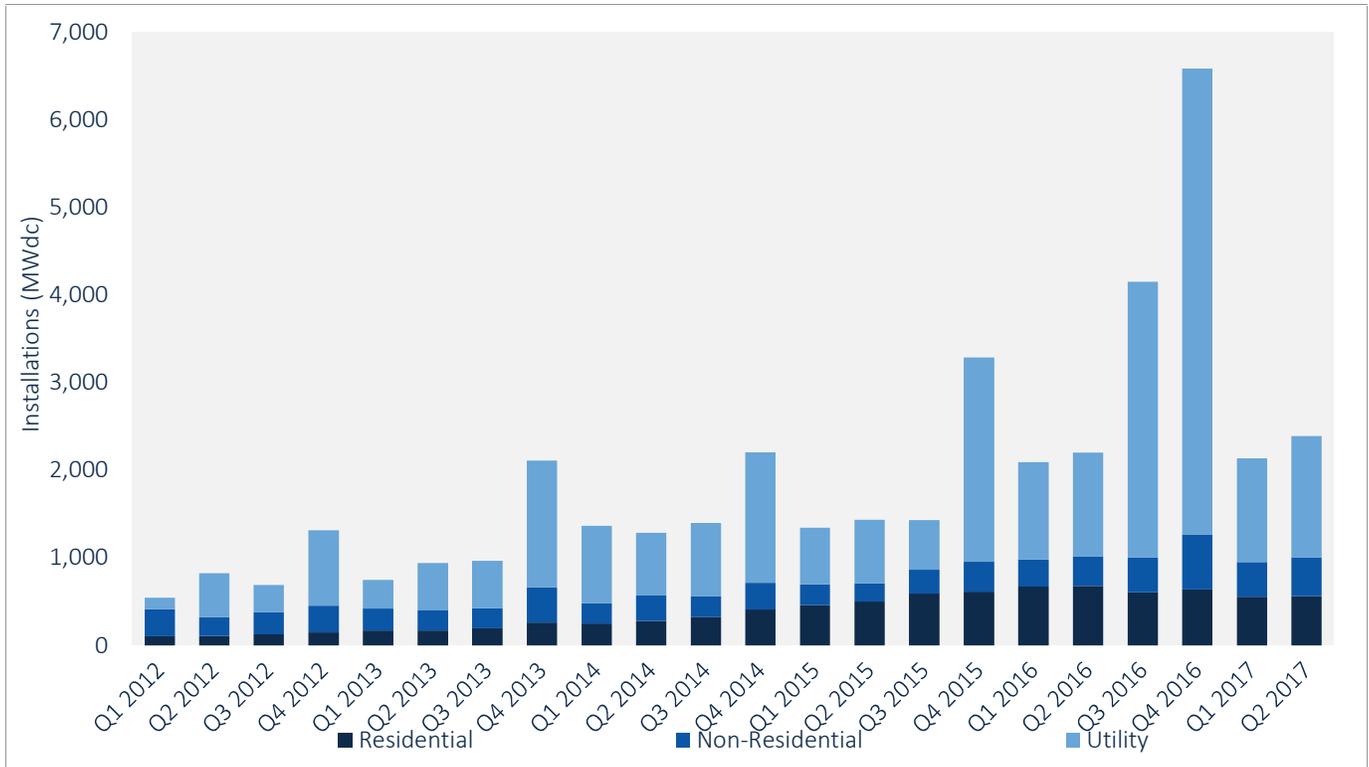
KEY FIGURES

-) In Q2 2017, the U.S. market installed 2,387 MW_{dc} of solar PV, an 8% increase year-over-year and the largest second quarter ever.
-) Through the first half of 2017, 22% of all new electric generating capacity brought online in the U.S. has come from solar, ranking second over that time-period to natural gas.
-) Suniva's filing of a Section 201 petition to impose trade remedies on foreign-manufactured cells and modules threatens to significantly reduce PV installations across all segments if accepted in its current form.
-) The residential PV sector grew 1% quarter over quarter. The slow growth rate is caused by relative weakness in the California market and a slowdown in Northeast markets, which are feeling the impact of pull-back from national providers.
-) In contrast to residential PV, the non-residential sector grew 31% year-over-year, primarily driven by regulatory demand pull-in from policy deadlines in California and Massachusetts.
-) Voluntary procurement has emerged as the primary driver of new utility PV procurement, accounting for 59% of new procurement through H1 2017.
-) Installed system prices remain low across all market segments, with fixed-tilt utility-scale systems remaining under the \$1/watt barrier for the second consecutive quarter.
-) GTM Research forecasts that 12.4 GW_{dc} of new PV installations will come on-line in 2017, down 17% from a record-breaking 2016.
-) Total installed U.S. solar PV capacity is expected to nearly triple over the next five years. By 2022, over 16 GW of solar PV capacity will be installed annually.

1. INTRODUCTION

In Q2 2017, the U.S. solar market installed 2,387 megawatts direct current (MW_{dc}), which ranks as the largest second quarter ever for U.S. solar. Utility PV accounted for 58% of Q2 2017 installations, which marks the seventh consecutive quarter that the utility-scale space added more than 1 GW_{dc}.

Figure 1.1 U.S. Quarterly PV Installations, Q1 2012-Q2 2017



Source: SEIA/GTM Research

Although all three segments of U.S. solar experienced quarter-over-quarter growth in Q2 2017, non-residential PV is the only segment expected to actually grow on annual basis this year.

Non-residential PV is expected to grow 9%, following a record-shattering 58% growth in 2016 after three consecutive years of flat demand before 2016. The continued growth in 2017 is partly due to community solar, which remains on track to add more than 400 MW_{dc}, nearly doubling community solar installations from 2016. Equally important, across major state markets, revisions to state incentive programs, virtual net energy metering rules, and solar-friendly rate structures have pulled in demand from the out years into 2017.

Meanwhile, residential PV is still expected to fall year-over-year for the first time ever, after falling year-over-year for the first time on a quarterly basis in Q1 and Q2 2017. There are several factors

behind this downturn. First, segment-wide customer acquisition challenges are constraining growth in major state markets. Second, national residential solar companies have slowed operations and pursued more profitable sales channels at the expense of growth. Meanwhile, growth in emerging state markets has not made up for weakness across the top 10 state markets, seven of which fell year-over-year in Q2 2017.

Finally, utility solar's downturn in 2017 has been softened by projects that pushed out their completion dates from 2016 as a result of the 30% federal Investment Tax Credit extension. These projects that have spilled over into 2017 represent more than 50% of this year's utility PV forecast. Looking ahead, the recovery for utility solar is primarily driven by procurement outside Renewable Portfolio Standards, with more than 75% of the current pipeline coming from voluntary procurement, PURPA, off-site corporate procurement, and California-based community choice aggregators.

Altogether, U.S. solar is expected to fall year-over-year in 2017 and 2018 before rebounding in 2019, in large part due to trends in utility PV procurement. Throughout H1 2017, the majority of utility solicitations have focused on projects that can come on-line with a 30% federal ITC in 2019 or later by leveraging commence-construction rules.

The return to growth in 2019 will also come from a growing number of state markets achieving scale. By 2019, more than half of all states in the U.S. will be at least 100 MW annual state markets. That demand diversification is a function of distributed and utility solar having reached tipping points in terms of economic attractiveness. For example, more than 30 states will have surpassed grid parity¹ (i.e., year 1 net savings) for residential PV. Meanwhile, over two-thirds of the utility PV pipeline comes from projects procured outside renewable portfolio standards, driven by the cost-competitiveness with natural gas alternatives.

Section 201 Update: Petition Scope, Regulatory Timeline and Market Impacts

The current trade dispute initiated by Suniva and SolarWorld serves as the primary downside risk to the base-case U.S. solar outlook.

In April 2017, domestic cell and module manufacturer Suniva filed a petition with the U.S. International Trade Commission (USITC) under Section 201 of the Trade Act of 1974. Suniva, now joined by SolarWorld as a co-petitioner, is requesting relief against crystalline silicon PV module and cell imports from *all* countries.

¹ "Grid parity" means the levelized cost of energy is below electricity bill savings in year 1 of system life. We model hourly bill savings based on rate structures across each state's largest utility. This methodology accounts for fixed charges, NEM reforms, and miscellaneous riders that impact savings

SEIA strongly opposes this petition and has been leading a [coalition effort](#) to defend the U.S. solar market.

Suniva's requests include, but are not limited to, a minimum price on crystalline silicon PV modules (initially \$0.78/W) and a tariff on crystalline silicon PV cells (initially \$0.40/W). These requirements would step down annually for three additional years. The tariff on imported cells would step down to \$0.37/W, \$0.34/W and then \$0.33/W, while the minimum module price would step down to \$0.72/W, \$0.69/W and then \$0.68/W.

In June 2017, Suniva publicly clarified that its intent is for the cell tariff to be included within the minimum price on module imports, though they made no changes to the petition to reflect the comments in the press.

The ITC will make a determination on injury by Sept. 22, 2017, and if it finds injury (or threat of injury), it will recommend remedies by Nov. 13, 2017. President Trump would then have 60 days to accept, modify or choose not to implement ITC's recommended relief measures. This means that any remedy recommendations approved by the President could go into effect as early as November 28, 2017 or as late as January 27, 2018. If the president orders remedies that are different from the ITC's recommendations or pursues separate agreements with individual countries, the remedy implementation could push out to April 2018.

In a June 2017 report, *U.S. Solar Outlook Under Section 201*, GTM Research found that U.S. solar demand would be reduced by 50% cumulatively over the next five years if the \$0.78/W minimum c-Si PV module price is accepted.

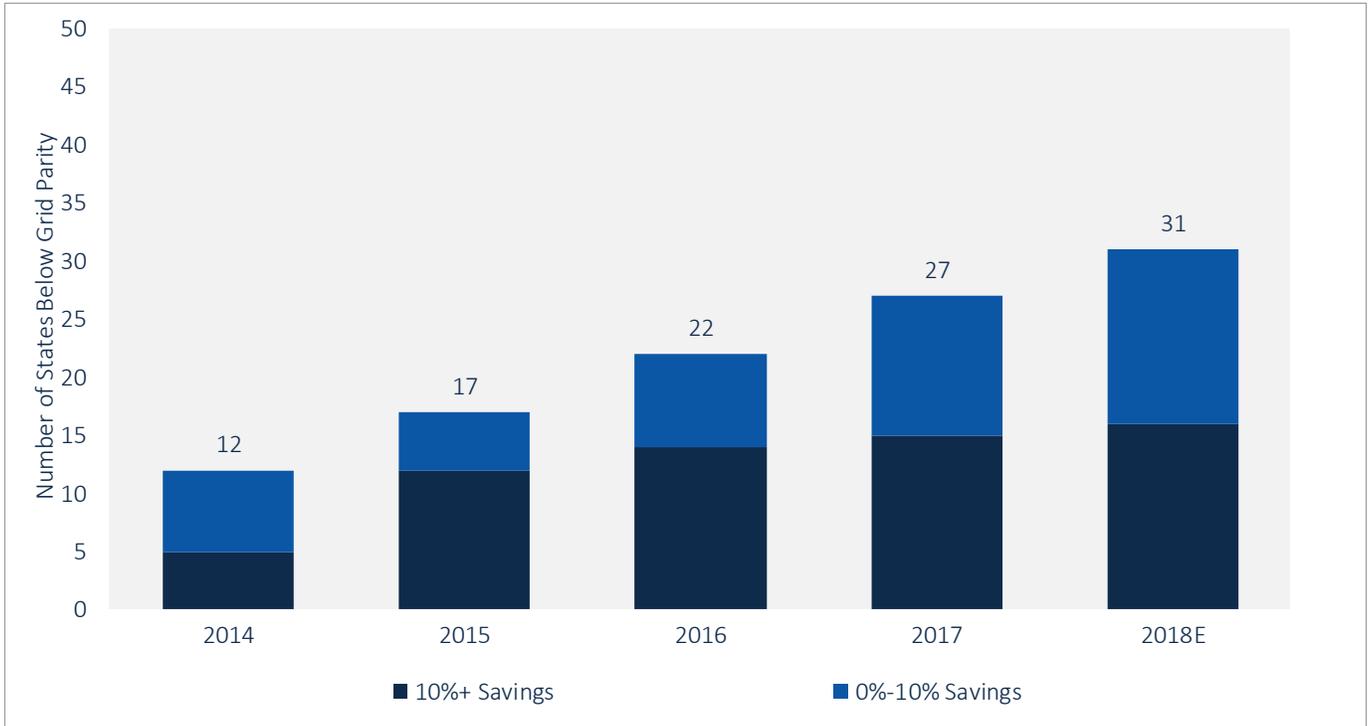
GTM Research is issuing additional analysis on Section 201 in a forthcoming report. Looking ahead, if the ITC issues a positive finding, then the next major question looming over the U.S. outlook is whether the ITC will recommend remedies that align with or deviate from the petition submitted by Suniva.

According to the ITC, the U.S. has implemented remedies via Section 201 19 times out of the 73 petitions submitted. Of the 19 petitions implemented, it is worth noting there has never been a minimum import price put into effect. Rather, tariffs, quotas on imports, or tariff-rate-quotas are the only three remedies ever implemented. As further clarification, a tariff-rate-quota is simply a two-tiered tariff with a lower tariff rate for an initial set volume of imports and a substantially higher rate for any additional imports.

With that history in mind, GTM Research's second research note focuses on the impact that various tariff scenarios would have on economic attractiveness and installation volumes by segment through 2022. The research note expands the scope of analysis to incremental tariff levels that would be applied to either c-Si PV module or cell imports.

As the below figure shows, there are 31 state markets expected to be below the grid parity threshold for residential PV in 2018 under base-case system price projections.

Figure 1.2 Number of State Markets Below Grid Parity in 2018 for Residential PV, Baseline Scenario



Source: GTM Research

For the residential PV segment, the largest reductions in demand are expected to come from state markets that fall below the tipping point (i.e., year 1 bill savings above 10%) or fall out of grid parity altogether (i.e., year 1 bill savings). State markets on the rise that have recently eclipsed the tipping point or are close to it, such as Florida and Utah, are the most sensitive to the introduction of new tariffs. Downturns are weakest (on a relative basis) across markets that can still offer year 1 savings above 10%, namely California and the other major state markets in the Northeast. However, on an absolute basis, relatively smaller percentage downturns in those major, high-volume markets add up to significant installations.

In addition to residential PV, impacts within the non-residential PV segment vary across project development opportunities with community solar being the most sensitive sub-segment to the proposed tariffs due to high subscriber acquisition and retention costs that lead to high costs of financing and tight economics. That said, large-scale 1 MW+ C&I projects prove to be just as sensitive to new proposed tariffs due to challenging rate structures with high demand charges that already pose downside risk to our non-residential forecasts under our long-term base-case projections.

Like non-residential PV, the impact of tariffs to utility PV varies across procurement drivers, though the utility PV segment is the most exposed of all segments to the proposed tariffs. In particular, growing areas of non-RPS utility PV procurement that are driven by cost-competitiveness as opposed to legislative or organizational mandates are also the most sensitive to new tariffs. Projects utilizing PURPA procurement, which requires solar to be priced at or below wholesale energy pricing or new-build natural gas pricing, and voluntary procurement, which is based on cost-competitiveness with natural gas and hedging against wholesale price volatility, account for more than half of the utility PV pipeline, leaving the utility PV segment particularly exposed to tariff impacts.

With the above in mind, it remains to be seen how the International Trade Commission will ultimately rule on the Section 201 filing, and how President Trump would respond to the ITC's recommendations if injury is found. But if Suniva's proposed minimum import price on modules and proposed tariff on imported cells are both approved, PV installations would significantly drop across all three market segments (details will be further outlined in a forthcoming research note from GTM Research).

2. PHOTOVOLTAICS

Figure 2.1 Q2 2017 State Solar PV Installation Rankings

State	Rank			Installations (MW _{dc})		
	2015	2016	Q2 2017	2015	2016	Q2 2017
California	1	1	1	3,268	5,212	751
Texas	9	6	2	213	676	378
North Carolina	2	5	3	1,140	995	227
Massachusetts	3	8	4			
Minnesota	28	14	5			
Arizona	5	7	6			
New York	7	12	7			
New Jersey	10	11	8			
Mississippi	37	36	9			
Nevada	4	4	10			
Michigan	34	32	11			
Florida	17	9	12			
South Carolina	36	20	13			
Maryland	11	13	14			
Utah	8	2	15			
Virginia	18	17	16			
Connecticut	14	21	17			
Colorado	12	10	18			
Hawaii	13	19	19			
Alabama	41	22	20			
Rhode Island	27	26	21			
New Mexico	15	15	22			
Delaware	24	30	23			
Washington	21	28	24			
Oregon	20	18	25			
Illinois	29	37	26			
Wisconsin	35	38	27			
Washington, D.C.	32	31	28			
New Hampshire	26	27	29			
Missouri	23	29	30			

Underlying data available in the full report

State	Rank			Installations (MW _{dc})		
	2015	2016	Q2 2017	2015	2016	Q2 2017
Iowa	33	34	31	Underlying data available in the full report		
Vermont	16	24	32			
Pennsylvania	40	39	33			
Idaho	38	16	34			
Georgia	6	3	35			
Indiana	22	23	36			
Louisiana	19	33	37			
Ohio	31	35	38			
Tennessee	30	25	39			
Montana	39	40	40			
Arkansas	25	41	41			

2.1. Market Segment Trends

2.1.1. Residential PV

Key Figures

-) 563 MW_{dc} installed in Q2 2017
-) Up 1% from Q1 2017
-) Down 17% from Q2 2016

Despite seeing limited growth quarter-over-quarter, weakness in established state markets continues to be the theme across the residential sector. While California has been the primary culprit of this slow-down in recent quarters, Q2 was the first in which major Northeast markets began to feel the impact of the reduced presence of top national installers as major TPO providers continue to scale back operations in an effort to prioritize profitability over growth. Massachusetts, New York and Maryland continue to struggle with installation volumes falling between 15-60% year-over-year, though New Jersey has shown relative stability amongst the Northeast landscape.

In contrast to major market slowdown, Arizona experienced its second-largest quarter ever in Q2 as installers completed installations under favorable grandfathered NEM rules. Additionally, emerging state markets such as Texas, South Carolina, and Florida continue to scale as national installers capture expiring incentives and tap into early-adopter customers. That said, continued emerging market growth was not enough to offset weakness across major state markets.

2.1.2. Non-Residential PV

-) 437 MW_{dc} installed in Q2 2017
-) Up 10% from Q1 2017
-) Up 31% from Q2 2016

Regulatory demand pull-in was the primary market mover in Q2, leading to the second-largest quarter for the nation's two largest non-residential markets – California and Massachusetts – as developers rushed to install projects under more favorable time-of-use periods and expiring incentive programs, respectively. Similarly, New York experienced its largest quarter on record due to the completion of its waning pipeline of remote net-metered projects.

2.1.3. Utility PV

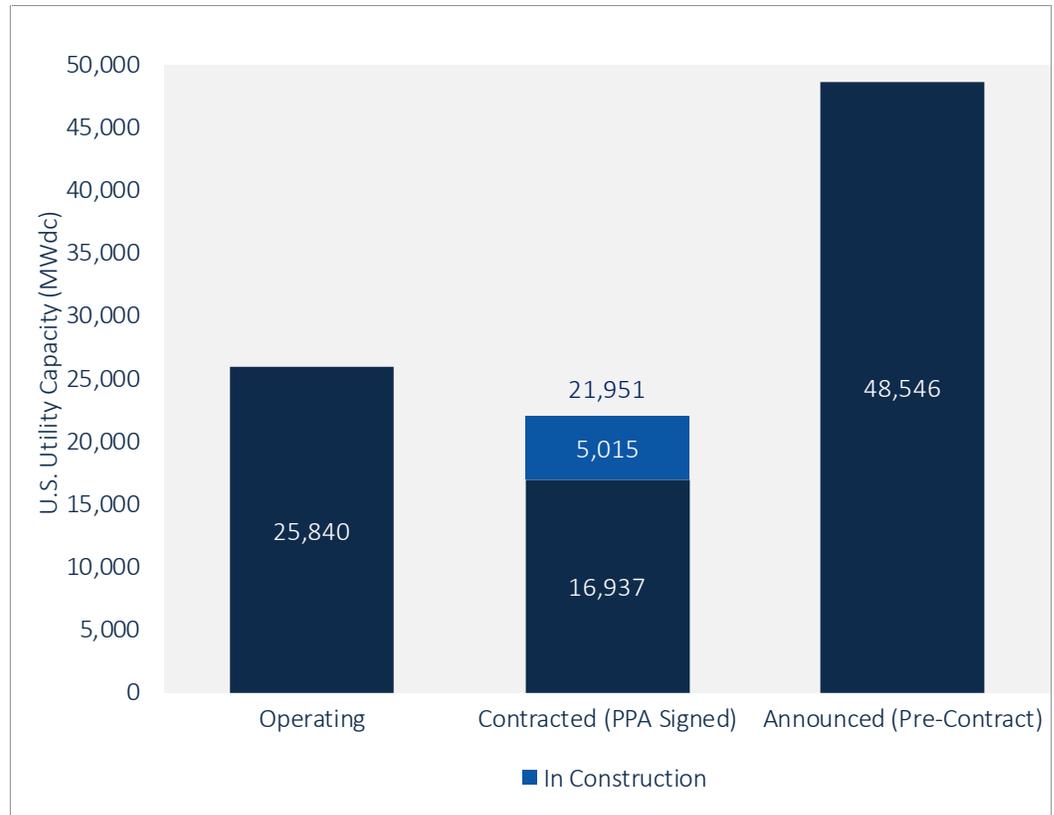
-) 1,387 MW_{dc} installed in Q2 2017
-) 7th consecutive quarter in which utility PV added over 1 GW_{dc}
-) Contracted utility PV pipeline currently totals 23.0 GW_{dc}

Utility PV continues to serve as the bedrock of the U.S. solar market. A total of 1.4 GW_{dc} of utility PV projects came on-line in Q2 2017, accounting for 58% of PV capacity installed this quarter. A total of 3.6 GW_{dc} of projects are in construction, and H2 2017 is expected to see over 5.6 GW_{dc} of capacity additions. While GTM Research anticipated close to 40% of 2017 capacity would come on-line in H1, the current 2.6 GW on-line represents only 32% of our 2017 forecast. This is due primarily to 2016 spillover projects that initially targeted Q2 completion dates but are now expected to reach commercial operation in Q3 or Q4.

In the near term, GTM remains confident in both its 2017 forecast of 8.1 GW_{dc} and our 2018 forecast of 6.5 GW_{dc}. Interconnection delays of PURPA projects has led to project spillover from 2017 into 2018. While this could potentially lower 2017 capacity additions, confidence in existing 2017 projects has increased leading to nearly net zero change to our 2017 forecast. The spillover of PURPA projects as well as announcements of several new projects with 2018 targeted COD has supported our 2018 outlook. As a result of more offtakers signing 2019 PPAs, additional procurement plans for 2019 and 2020, and developers looking to safe harbor projects to capture the full 30% ITC, GTM Research's 2019 forecast has risen 14% to 9.0 GW_{dc}.

With the recent passage of Bill 589, North Carolina has ended standard rate contracts and halted PURPA development in the second-largest state market for utility PV. While 5.7 GW of PURPA projects remain in development across nine states, few states offer attractive standard rate contracts. Voluntary procurement will now be the largest driver of new procurement and projects brought on-line as utilities opt for solar based on its economic competitiveness. We will see the largest volume of voluntary procurement in the Southeast and the highest rates of growth in the Midwest as utilities procure solar to pair with existing wind generation.

Figure 2.2 U.S. Utility PV Pipeline

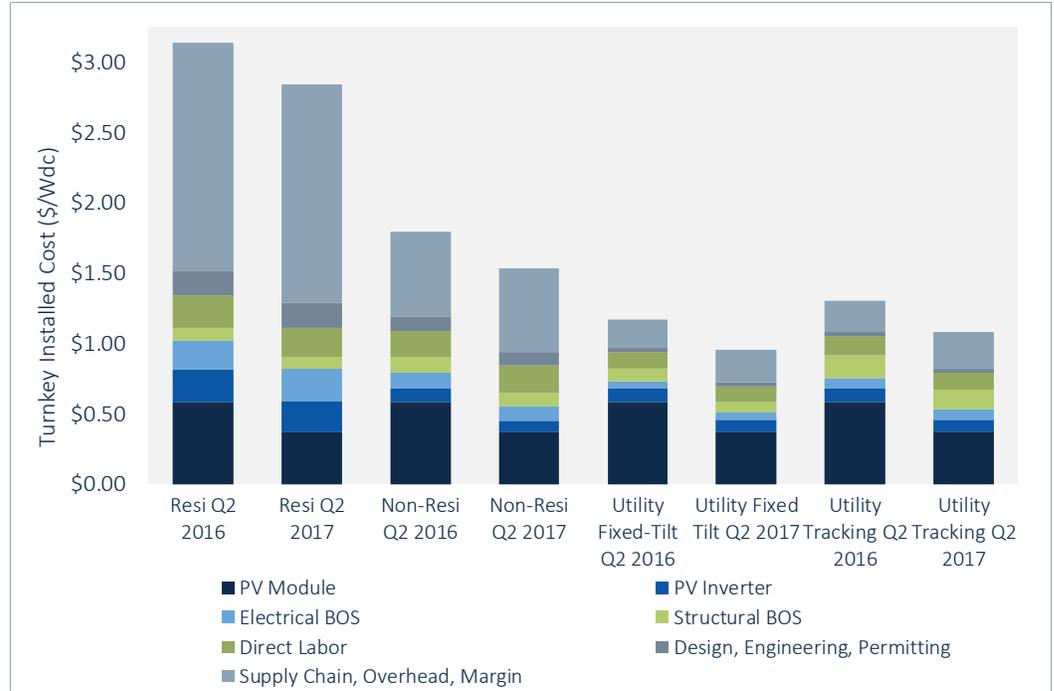


Source: GTM Research, U.S. Utility PV Market Tracker

2.2. National Solar PV System Pricing

We employ a bottom-up modeling methodology to track and report national average PV system pricing for the major market segments. Our bottom-up methodology is based on tracked wholesale pricing of major solar components and data collected from interviews with major installers.

Figure 2.3 Modeled U.S. National Average System Costs by Market Segment, Q2 2016 & Q2 2017



Note: Detailed information about national system prices by market segment and component is available in the full report.

This past quarter has seen the smallest price drop for most market segments since this report series' inception. In Q2 2017, system pricing fell by 0%, 0.3%, 2.9% and 0.9% in the residential, non-residential, fixed-tilt utility and single-axis tracking utility markets, respectively. This bucks the trend that we have seen for almost five quarters where at least one market segment has seen a greater than 5% quarterly decrease. It is also the lowest quarterly average decrease since this report series began tracking modeled pricing.

Fearing a potential negative ruling from the U.S. International Trade Commission review of Suniva's 201 petition, some EPCs and installers have begun procuring modules for projects in 2018 and beyond. Non-Chinese tariff free capacity is limited – at present, almost all tariff-free capacity has been allocated for the remainder of 2017. The U.S. demand rush with limited tariff-free supply is causing modules price to rise. This is the first time module prices have risen in the U.S. since Q3 2014.

Overall system prices continue to fall despite module price increases not seen since Q3 2014 helping to provide the smallest system price drop since this report series' inception. Competition amongst vendors across the balance-of-systems hardware landscape continues to generate extremely aggressive component pricing. This is particularly apparent in the inverter and utility-scale racking markets.

In terms of soft costs, the scale of cost reductions is split between distributed generation (DG) and utility-scale. The residential and non-residential markets only saw quarter-over-quarter cost reductions of 0.5% and 0%, respectively. Despite incremental increases in labor efficiency, the customer acquisition challenges that have dogged DG engineering, procurement and construction (EPC) providers for the past several quarters continue to limit soft-cost reductions. For utility-scale, margin compression is the key driver for lower soft costs. The smaller overall U.S. utility market, coupled with the rise in module pricing, is cutting into EPC margins.

2.3. Component Pricing

Price trends varied by component in Q2 2017, with differences driven by component level demand and inventory levels.

-) For polysilicon, the quarterly average price fell 12% quarter-over-quarter to \$14.9/kg in Q2 2017. The price decline was driven by lower demand, increased stockpiles, and wafer suppliers demanding lower prices.
-) Multi wafer prices fell 5% quarter-over-quarter to \$0.14/W, while multi cell prices stayed flat at \$0.21/W. Weak prices at the beginning of the quarter and slow demand buildup before China's June 30 FIT reduction (with prices only starting to show growth in mid-May) drove quarter-over-quarter trends for these components.
-) In the past few years, U.S. module price trends were largely driven by antidumping and countervailing duties on Chinese suppliers. But recently the main driver has shifted; current module price trends are largely a result of supply-demand tightness, with prices increasing to an average of \$0.39/W for standard multi modules as buyers build up inventory before the final results of the Section 201 petition are released.

2.4 U.S. Polysilicon, Wafer, Cell and Module Prices, Q2 2016-Q2 2017

	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017
Polysilicon (\$/kg)	\$16.44	\$15.29	\$14.98	\$16.93	\$14.90
Wafer (\$/W)	\$0.20	\$0.15	\$0.15	\$0.15	\$0.14
Cell (\$/W)	\$0.30	\$0.23	\$0.21	\$0.21	\$0.21
Module (\$/W)	\$0.59	\$0.49	\$0.39	\$0.37	\$0.39

Source: GTM Research

2.4. Market Outlook

The near term will see relatively constrained growth compared to what we've seen previously in both the utility and distributed generation sectors. DG continues to face an everchanging policy and customer-acquisition landscape, while the utility sector continues to reset as it builds out the post-ITC extension pipeline and restarts the origination process. Amidst all of this, the ongoing Section 201 proceeding concerning imported modules casts uncertainty across all solar PV segments.

Altogether, the overall U.S. solar market is expected to fall 17% on an annual basis, primarily driven by the decline in utility PV deployment relative to the massive utility PV pipeline build-out in 2016. DG markets, however, have a slightly different path. Residential PV is expected to fall 3% annually primarily due to weakness across major state markets, many of which are experiencing year-over-year decline for the first time in years. Despite relative near-term policy certainty, the industry is experiencing the impact of national installers scaling back operations, in addition to an increasingly challenging customer-acquisition landscape. Conversely, non-residential PV markets are expected to grow 10% as developers seek to complete installations ahead of regulatory changes in California, Massachusetts and New York. Despite build-out falling on an annual basis, the utility PV segment is still expected to see over 8 GW_{dc} in 2017 – nearly double what was installed in 2015 – as ITC spillover drives significant utility PV deployment.

In 2018, residential PV is expected to rebound at a limited pace as major market installers seek to find more efficient means of customer acquisition and large national players reorient sales strategies, while emerging state markets begin to contribute a growing share of the residential market. However, 2018 marks the year in which the non-residential market will begin to feel the effects of regulatory and policy constraints that will lead to an annual decline in non-residential deployment. Though 2018 will stand as a relatively low installation year for utility PV, project origination will benefit the post-2019 outlook as procurement mechanisms outside of renewable portfolio standards drive an increasing majority of the market.

By 2019, U.S. solar is expected to resume year-over-year growth across all market segments. And by 2022, 31 states in the U.S. will be 100+ MW_{dc} annual solar markets, with 25 of those states being home to more than 1 GW_{dc} of operating solar PV.

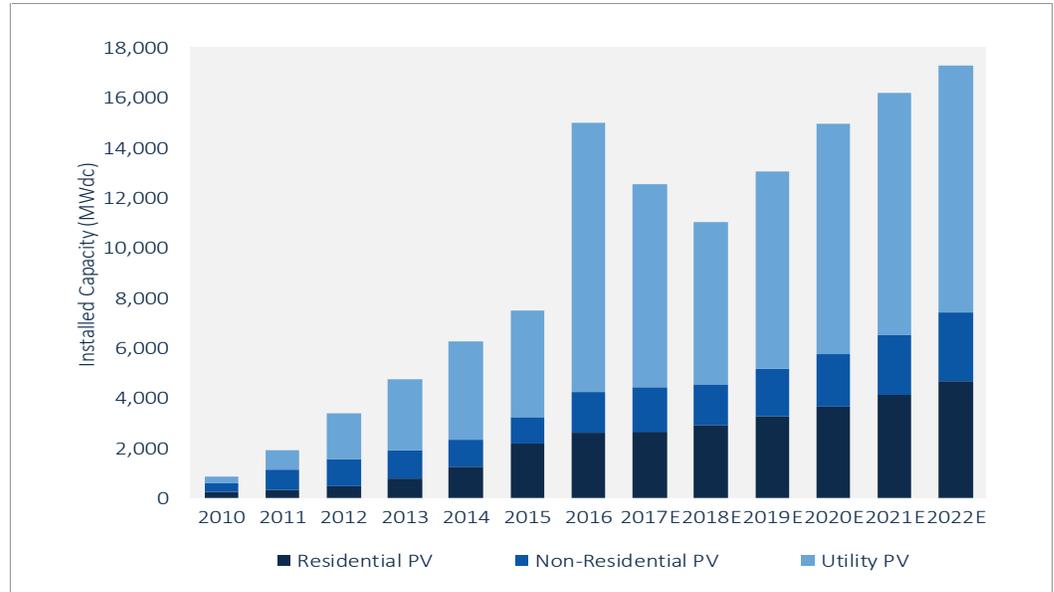
However, downside risk looms over the long-term outlook for U.S. solar, due to the trade dispute initiated by the domestic-based cell and module manufacturer Suniva, later joined by SolarWorld. As mentioned, Suniva's requests include a minimum price on crystalline silicon PV modules (initially \$0.78/W) and a tariff on cells (initially \$0.40/W).

While it remains unclear how the International Trade Commission will ultimately rule on this petition by Suniva, the approval of the petition as initially filed would result in substantial downside revisions to our forecast across all three segments. A \$0.78/W price on modules would match 2012 levels for imported Chinese modules and put system costs at 2015 levels. With a decision expected

as early as H2 2017, GTM Research will continue to monitor the outcome of this petition and its ultimate impact on solar deployment by state and segment.

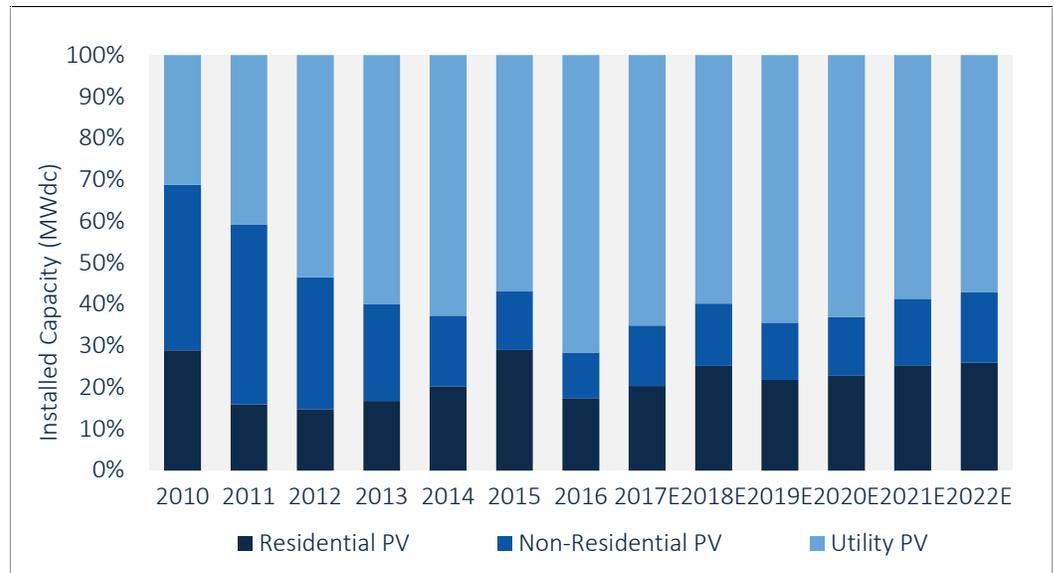
Forecast details by state (40 states plus Washington, D.C.) and market segment through 2022 are available in the [full report](#).

Figure 2.5 U.S. PV Installation Forecast, 2010-2022E



Source: GTM Research

Figure 2.6 U.S. PV Installation Forecast by Segment, 2010-2022E



Source: GTM Research



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*Please find a more detailed content and pricing matrix on the reverse side of this page.



FULL REPORT

- > Installations by market segment for the top 40 states and Washington DC
- > Installed cost by market segment for each state
- > State-by-state market analysis
- > Component pricing across the value chain
- > Manufacturing capacity & production by component
- > Demand projections out to 2022 by market segment & state



EXECUTIVE SUMMARY - FREE

- > National aggregate capacity additions
- > National aggregate number of installations
- > National weighted average installed price
- > National aggregate manufacturing production

Justin Freedman

Director, Research Sales
 freedman@gtmresearch.com
 + 1 617 500 6243

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Justin Freedman
 Director, Research Sales
freedman@gtmresearch.com
 + 1 617 500 6243