Q1 Q2 Q3 Q4 Q4 Q3 Q2 Q1 Q1 Q2 Q3 Q4 Q3 Q2 Q1 Q1 Q2 Q3 Q4 Q4 Q3 Q2 Q1

Q4 Q3 Q2 Q1 Q1 Q2 Q3 Q4 Q4 Q3 Q2 Q1 Q2 Q3 Q4 Q4 Q3 Q2 Q1 Q1 Q2 Q3 Q4

U.S. SOLAR MARKET INSIGHT

REPORT | Q4 2011 & 2011 YEAR-IN-REVIEW | FULL REPORT

SEIA Solar Energy Industries Association®

GTM RESEARCH A Greentech Media Company

U.S. Solar Market Insight™

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1. INTRODUCTION

The U.S. solar market is increasingly becoming a central focus of global industry attention, but state-by-state differences in regulations, incentives, utilities, and financing structures have introduced more complexities in comparison to other markets. As a result, it has long been difficult to track and understand the changing market dynamics for solar energy in the U.S.

The SEIA® /GTM Research U.S. Solar Market Insight™ report is our answer to this problem. Each quarter, we survey installers, manufacturers, utilities, and state agencies to collect granular data on photovoltaics (PV) and concentrating solar power (CSP). This data serves as the backbone of Solar Market Insight™, 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. As the U.S. solar market expands, we hope that Solar Market Insight™ will provide an invaluable decision-making tool for installers, suppliers, policymakers and advocates alike.

In this report, we have added analysis of an additional state market: Vermont. This extends our total coverage to the top 23 states. However, the national totals reported include all 50 states, Washington, D.C., and Puerto Rico. We expect to add additional state markets over the next year.

U.S. Solar Market Insight™

2. PHOTOVOLTAICS (PV)

For the U.S. solar industry, 2011 was an historic year. On the positive side, the market for solar installations continued to boom, as the U.S. installed 1,855 megawatts (MW) of photovoltaic (PV) solar systems, representing 109% growth over 2010. The fourth quarter of 2011 saw 776 MW of PV installed, by far the most of any quarter in U.S. market history (473 MW was the previous record, set in the third quarter of 2011). Growth occurred in every market segment—residential, non-residential and utility—and in 18 of the 23 states that are tracked individually. The dollar amount of project finance investments reached an all-time high and traditional energy companies such as MidAmerican Energy Holdings, Exelon and NRG Energy became equity investors in the largest planned solar projects in the country.

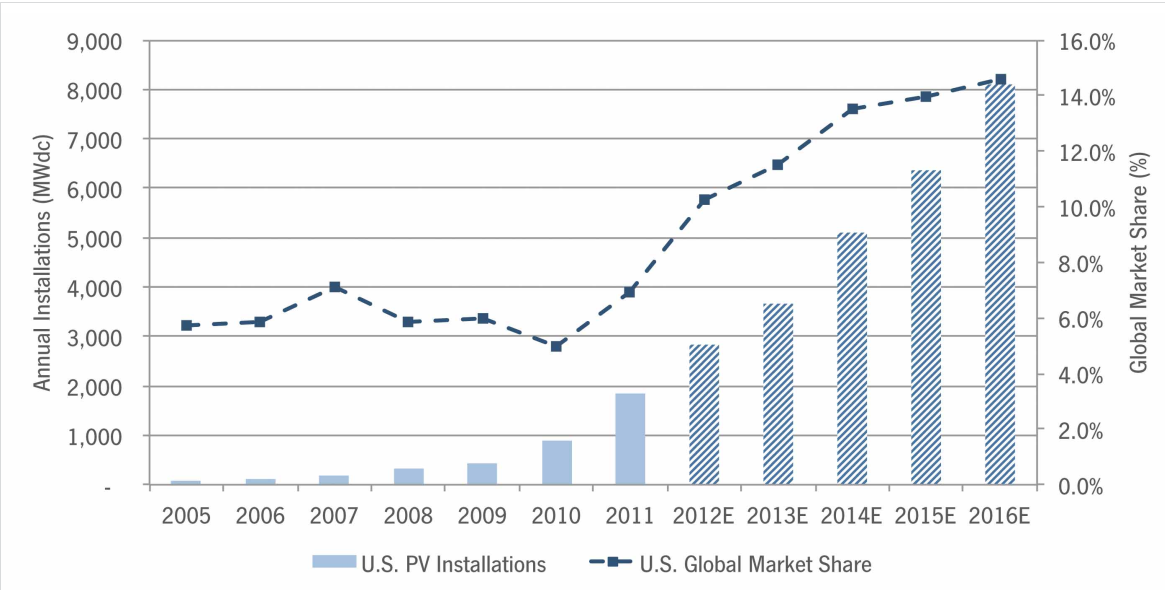
Not all developments in 2011 were positive. With regard to installations, the highly valued 1603 Treasury Program expired at the end of the year, subsequently complicating the financing of many new solar projects. As for manufacturing, though global PV module capacity grew more than 50% in 2011, throughout most of the year global demand remained slow as a result of regulatory changes in Italy and tepid growth in Germany. Solar panel prices went into free-fall in the second quarter and refused to stabilize until the last weeks of 2011, ultimately falling more than 50% during the year. This squeezed profit margins for every manufacturer, but it was particularly damaging for two types of companies: those that were less cost-competitive and those that were in the process of commercializing new technologies. As a result, multiple U.S. module manufacturing plants closed over the course of 2011. Despite these closures, U.S. module manufacturing capacity expanded 28% and production remained roughly flat for the year when compared to 2010. In the wake of precipitously falling module prices, SolarWorld, along with six unnamed partners, filed an anti-dumping/countervailing duty petition against Chinese crystalline silicon cell and module manufacturers in front of the Department of Commerce and the International Trade Commission. The petition alleges that Chinese suppliers benefitted from illegal subsidies and dumped product into the U.S. market. The outcome of the petition remains to be seen. However, it has already begun to impact procurement patterns and complicate the overall supply picture in the U.S.

Only a month prior to the trade case being filed, Solyndra, a CIGS module manufacturer, filed for bankruptcy and brought with it a storm of negative attention to the solar industry. While Solyndra was never a significant player in the global solar industry, its default on a federal loan guarantee brought a high-profile political element that was absent for the other two U.S. solar bankruptcies in 2011 (Spectrawatt and Evergreen Solar). As a result, an industry blessed with overwhelming public support suddenly became a target for those who sought to admonish the loan guarantee program or clean energy policy in general.

While it is easy to brush aside the more outlandish claims made in response to Solyndra's failure regarding solar technology in general, the Solyndra story has brought a number of valuable questions to the forefront. First, has the support that has been given to the solar industry, both at the state and federal level, been successful? The market's impressive recent growth points to yes. Installations are booming, jobs are being added, and solar has proven itself as a reliable technology to meet growing energy demand. Second, is there a role for U.S. solar manufacturing? Here, there is reasonable debate on both sides. We continue to believe that the U.S. can maintain a presence in manufacturing innovative, proprietary technologies—particularly those in their early stages of commercialization. Apart from this, the U.S. can remain home to the bulk of innovations that drive down the cost of solar power for years to come. That being said, it would be unreasonable to expect all (or even most) solar manufacturing to come from the U.S. The solar industry is global, and subject to the same economic forces as manufacturing in other sectors. Undoubtedly, some portions of the value chain will find domestic manufacturing attractive while others will not. The U.S. certainly has a role to play, but it will be over the next decade that the nature of that role will be determined. As the industry continues to mature, successful and sustainable companies will be separated from hopeful but ultimately unsuccessful ventures.

After a recording-breaking 2011, the U.S. has proved itself as a viable market for solar on a global scale. In 2011, the U.S. market's share of global PV installations rose from 5% to 7% and should continue to grow. We forecast U.S. market share to increase steadily over the next five years, ultimately reaching nearly 15% in 2016 – at which point we anticipate the U.S. and China will be the leading markets in the world as European markets slow down. Given that solar installations in the U.S. have more than doubled each of the past two years, and that the project pipeline far exceeds installation levels, this is a highly probable outcome.

Figure 2-1: U.S. PV Installations and Global Market Share, 2005-2016E

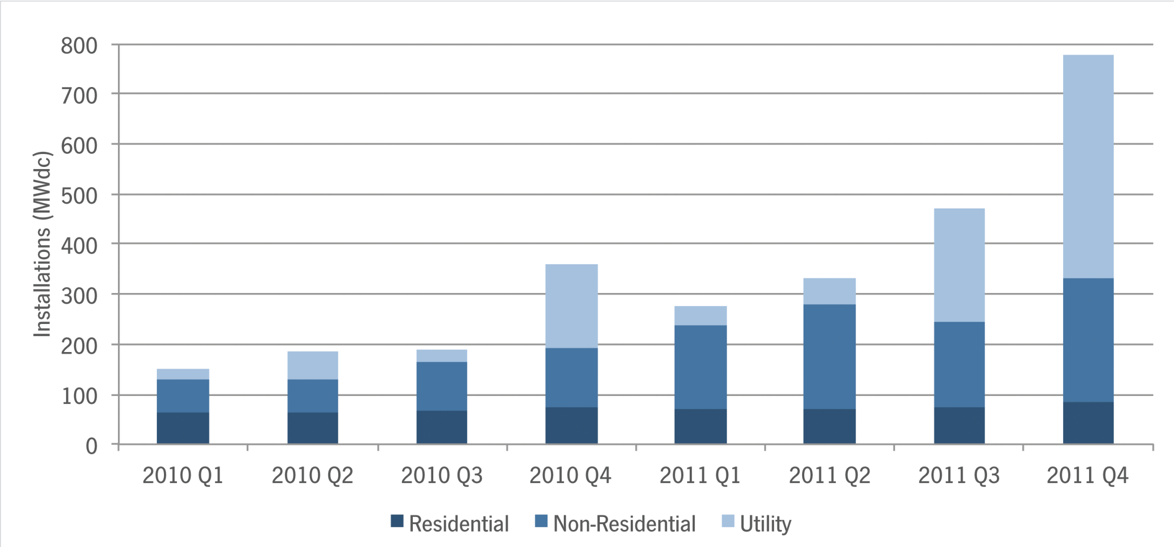


2.1 INSTALLATIONS

The U.S. installed 776 MW in Q4 2011, up 64% over Q3 2011 and up 115% over Q4 2010. Every market segment had a record quarter, as did ten individual states. The following three factors were the primary contributors to the quarter's impressive growth figures:

1. **Seasonality** – The fourth quarter is usually the strongest in the U.S. as developers often rush to finish projects for tax accounting purposes and to qualify for incentives that function on a calendar-year basis.
2. **Looming Expiration of the Section 1603 Treasury Program** – As was true in 2010, most installers were working under the assumption that Section 1603 would not be extended. Although we expect that more developers elected to safe-harbor product in 2011 (which enabled projects completed after the December 31, 2011 deadline to qualify for the program), many projects were still completed in Q4 in order to eliminate the risk and transaction costs of safe harboring.
3. **Utility Project Completions** – There were 443 MW of utility PV installed in Q4 2011, by far the highest of any quarter for this market segment.

Figure 2-2: Quarterly U.S. PV Installations by Market Segment, 2010-2011



	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Residential	62.4	62.5	68.4	74.6	72.0	68.7	72.7	83.4
Non-Residential	67.3	68.7	96.9	119.3	166.0	211.7	172.9	249.5
Utility	22.3	55.3	22.0	166.9	38.0	50.1	227.1	443.3
Total	152.0	186.5	187.3	360.8	276.0	330.5	472.6	776.2

2.1.1 Shipments vs. Installations

This is the seventh edition of the U.S. Solar Market Insight report, and throughout the period in which we have been publishing the report, one of the most common questions has been how to reconcile shipments with installations. Specifically, module suppliers report their shipments into the U.S. market and, in aggregate, shipment totals often appear to greatly exceed the total installation numbers that we report for the same period. There are two obvious reasons why shipment and installation numbers might not be perfectly aligned. First, installations trail shipments; in other words, a shipped product does not immediately result in a completed installation. Second, there is always some volume of downstream channel inventory, that is, product sitting in the warehouses of distributers, installers and EPCs. Still, even accounting for those factors, the differential between shipments and installations appears striking.

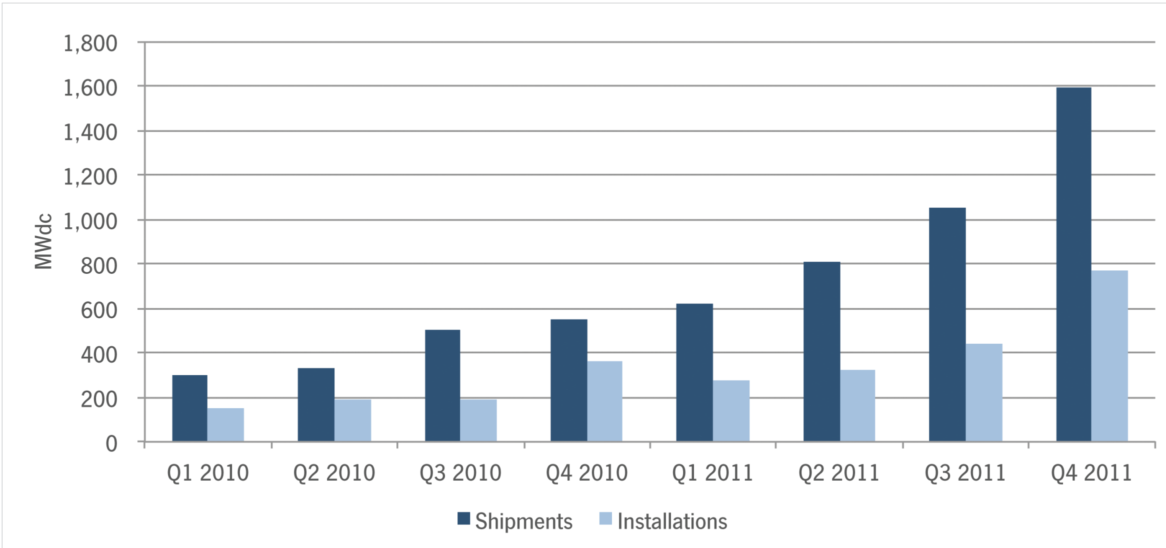
Using a combination of import data provided by the International Trade Commission and proprietary GTM Research data, we have estimated shipments into the U.S. market by quarter in the figure below. Note that our estimates include shipments from manufacturers in the U.S. as well as those coming from abroad.

It is clear that shipments in each period have greatly exceeded installations. We point to three reasons for this:

- The U.S. market is growing rapidly, and shipments in any given period ultimately align with installations in later periods. This accounts for a portion of the difference.
- Shipment numbers into the U.S. market are becoming increasingly skewed by utility installations, for which we can see significant shipments well in advance of a completed installation. There are over 3 GW of utility projects currently in construction, many of which are currently taking on module shipments.
- Shipment numbers in late 2011 are particularly abnormal. Toward the end of the year, the desire to safe-harbor product in advance of the 1603 Treasury Program's expiration created a shipment boom which may continue into 2012, given program rules.

In contrast to our installation figures, our shipment estimates should not be taken as exact. However, they do tell a story of a market with enormous near-term growth expectations. We will continue to build out our analysis of shipment trends in coming quarters.

Figure 2-3: U.S. PV Shipments (Estimated) vs. Installations (Actual), 2010-2011

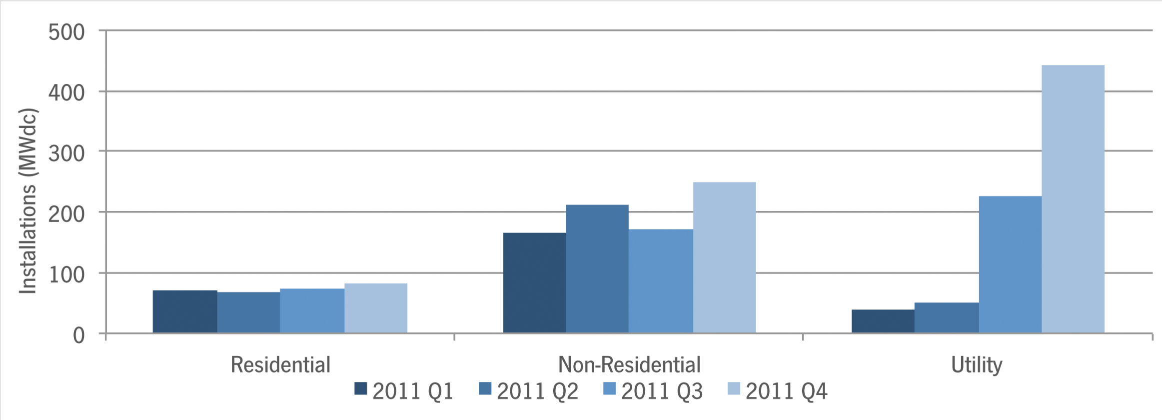


Source: GTM Research, International Trade Commission

2.1.2 By Market Segment

For the past several years, the U.S. market has been driven primarily by the non-residential sector, which accounted for more than 50% of installations through 2008. However, the utility sector has been gaining ground, while the residential market has remained relatively steady. In 2011, the dynamic amongst market segments shifted substantially throughout the year, but the overall trend has been toward the growth of the utility market. Meanwhile, the residential market showed marginal overall growth, and the commercial market was heavily dependent on state-level dynamics in California and New Jersey. The utility market, however, showed real strength for the first time, with 28 projects over 10 MW each installed in 2011 – up from just two in 2009.

Figure 2-4: Quarterly PV Installed Capacity by Market Segment, 2010-2011



	Residential	Non-Residential	Utility
2011 Q1	72.0	166.0	38.0
2011 Q2	68.7	211.7	50.1
2011 Q3	72.7	172.9	227.1
2011 Q4	83.4	249.5	443.3

Residential

The residential market grew 15% in the fourth quarter to reach 83 MW. California was the primary driver of this growth, installing 34 MW in Q4 up from 27 MW in Q3. Within California and an increasing number of other markets, residential growth has been driven by third-party ownership. For the first time, in Q4 2011, more third-party-owned systems were installed in California Solar Initiative territory than host-owned systems. Over the past two years, while direct-owned systems have largely stagnated, third-party sales grew outside of California as well. At least 16 firms offer residential PPAs, leases, or both in eight states and that number continues to grow. Access to residential financing solutions remains a necessity for residential installers in most major markets.

Figure 2-5: California Solar Initiative Residential Installations by Ownership Type, 2009- 2011

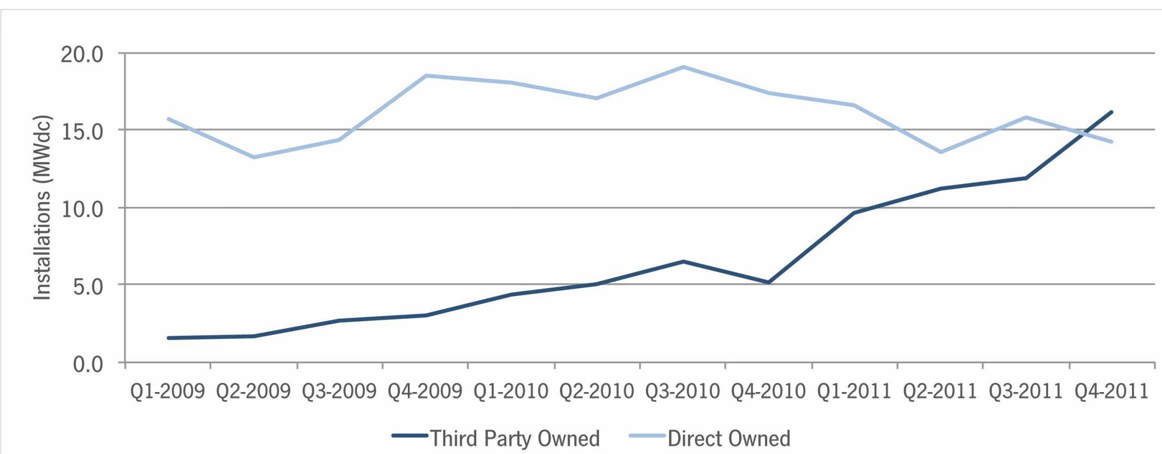


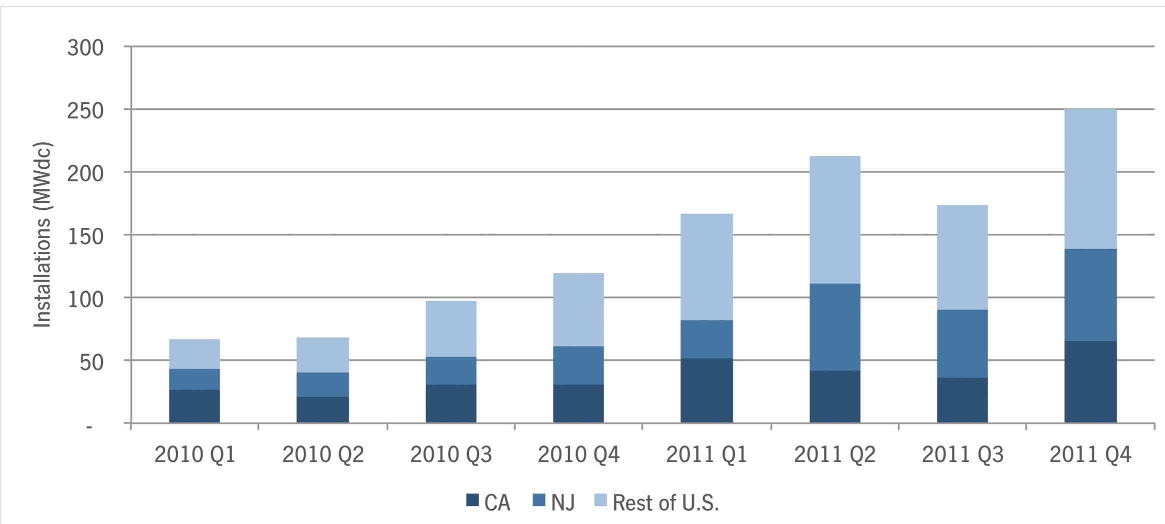
Figure 2-6: State-by-State Residential Installations, 2011

Non-Residential

The non-residential market grew 44% to 249 MW in Q4 2011, the largest quarter ever for this market segment. In large part, this growth was due to two states, California and New Jersey, which contributed 56% of the national total. Both these states should also show strong installation numbers early in 2012, but could taper off somewhat in Q2/Q3. While a number of other markets should see growth (Massachusetts, Maryland, North Carolina, Arizona), national figures will still be heavily dependent on the two largest states. For this reason, our 2012 growth expectations for the non-residential market are relatively sober: we are currently forecasting 12% annual growth. However, a number of factors could lead us to increase these expectations in 2012:

- New Jersey installations levels remaining high throughout the year, either in the face of increasingly catastrophic oversupply or as a result of market-correcting legislation
- California installations surprising to the upside, including a large quantity of non-residential projects outside the CSI program
- Faster-than-expected growth of smaller markets such as New York and Massachusetts

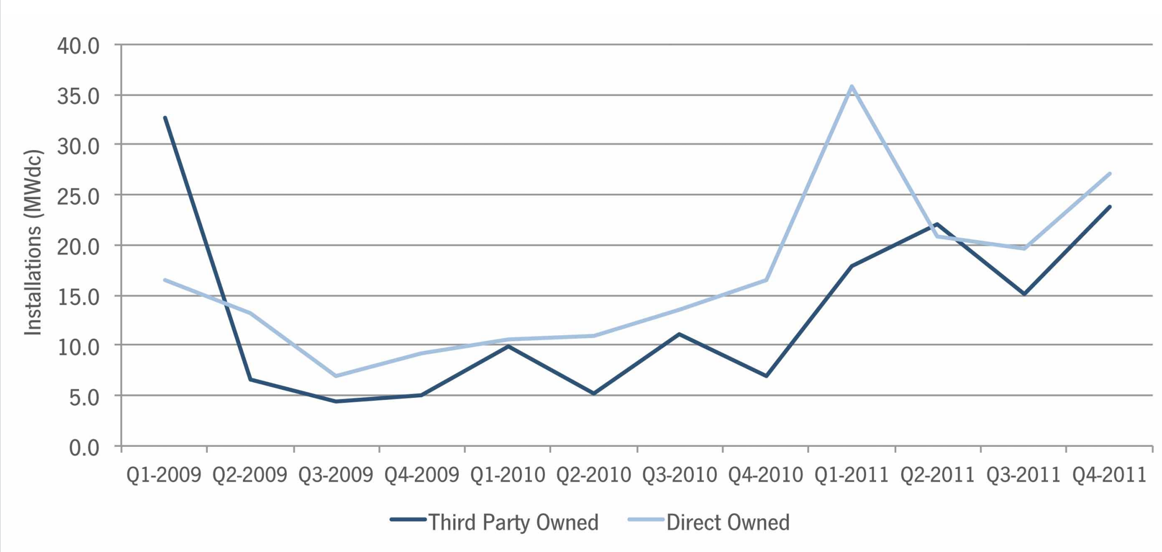
Figure 2-7: U.S. Non-Residential PV Installations, 2010-2011



	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4
California	26.0	21.0	31.0	31.0	52.0	42.0	36.0	65.0
New Jersey	17.0	20.0	22.0	30.0	30.0	69.0	54.0	74.0
Rest of U.S.	24.0	28.0	44.0	58.0	84.0	100.0	83.0	111.0

In terms of ownership, the non-residential market has seen less of a consistent trend. Third-party ownership in California fell below direct ownership in Q3 and remained below it in Q4 despite an uptick in both segments. We anticipate that 1603 Program expiration will push the market further toward third-party-owned systems in 2012. Since many site hosts do not have sufficient internal tax appetite to monetize the ITC in the first year of service, they will rely more on third parties to internalize the benefit of the ITC.

Figure 2-8: California Solar Initiative Non-Residential Installations by Ownership Type, 2009-2011



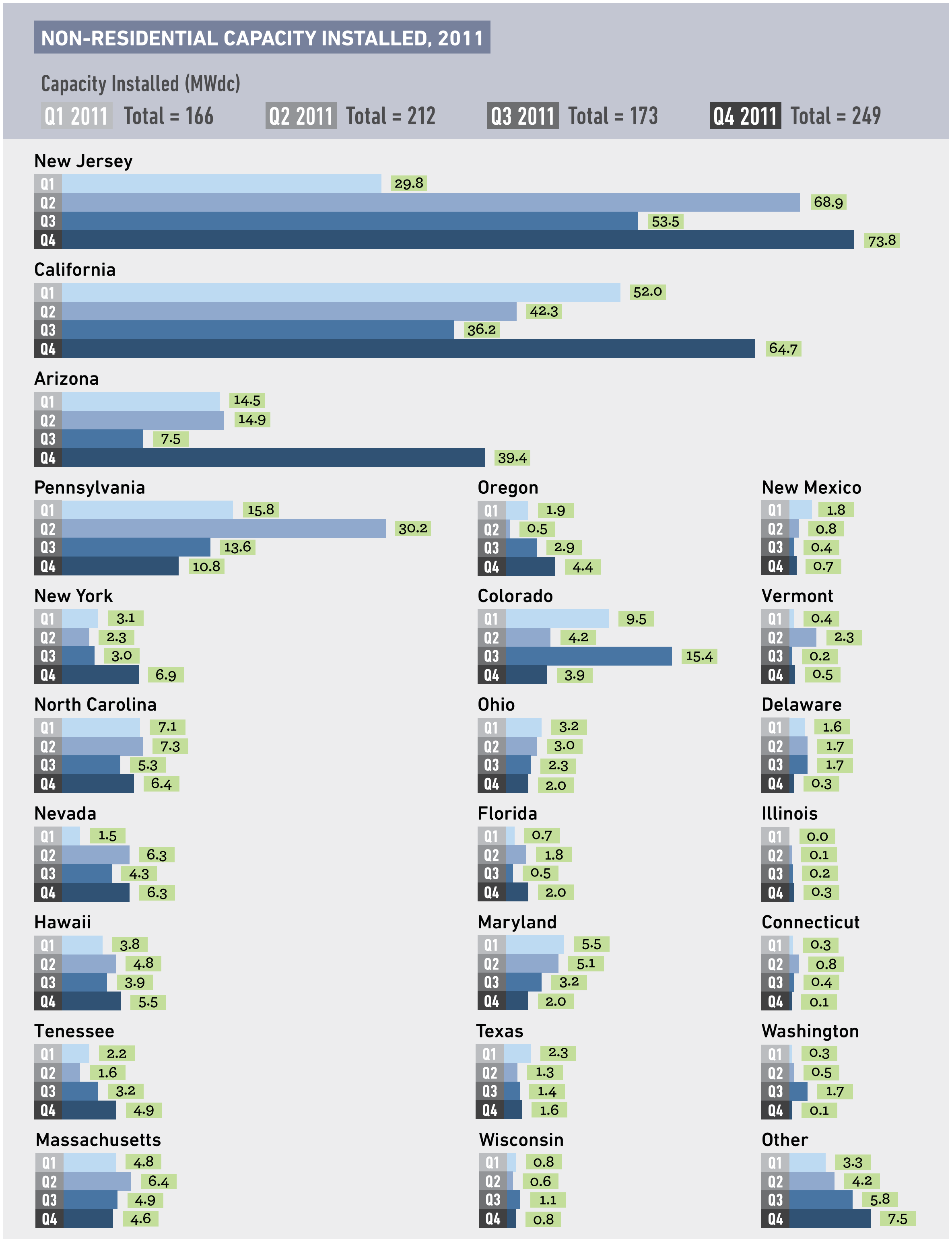


Figure 2-9: State-by-State Non-Residential Installations, 2011

Utility

2011 was a breakout year for the U.S. utility PV market. In 2009, only two projects over 10 MWdc were completed in the U.S. In 2010, eight such projects were completed. In 2011, the number rose to 28. Over the course of the year, 758 MW of utility PV became operational – nearly three times the 267 MW installed in 2010.

The largest project completed was Mesquite Solar, a 48 MWdc (42 MWac) project that is the first phase of a 150 MW project under construction in Arizona. Apart from this, projects over 25 MW were completed in Colorado, New York, Texas, California, and New Mexico, indicating the geographic spread of a market that used to be heavily concentrated in just California and Arizona.

Growth prospects for the utility market remain strong. More than 9 GW of projects with signed utility power purchase agreements (PPAs) await completion over the next five years. Over 3 GW of these projects have already been financed and are in construction. Beyond this, there are at least 30 GW of earlier-stage projects actively seeking permits, interconnection agreements, PPAs, and financing. Utilities continue to procure (and in some cases to develop) new projects, and the expansion into new utility markets remains the most valuable opportunity in the sector. There are, after all, more than 3,000 utilities in the U.S., of which less than 100 have been active in large-scale solar procurement.

Figure 2-10: Top Ten PV Projects Completed in the U.S. in 2011

Rank	Project Name	Developer	Cap. (MWdc)	State	Power Purchaser	EPC Firm
1	Mesquite Solar I - Phase 1	Sempra Generation	48	AZ	Pacific Gas & Electric	Zachry
2	San Luis Valley Solar Ranch	Iberdrola	38	CO	Xcel Energy - Colorado	SunPower
3	The Long Island Solar Farm	BP Solar	37	NY	Long Island Power Authority	Blue Oak Energy
4	Webberville Solar	SunEdison	34	TX	Austin Energy	RES Americas
5	Stillwater Solar-Geothermal Plant	Enel Green Power	27.6	NV	NV Energy	Bombard Renewable Energy
6	Roadrunner Solar Electric Facility	NRG Energy	25	NM	El Paso Electric	First Solar
7	PG&E UOG Program - Stroud Solar Station	Cupertino Electric	25	CA	Pacific Gas & Electric	Cupertino Electric
8	Copper Crossing Solar Ranch	Iberdrola	23	AZ	Salt River Project	Fluor Corp.
9	Sun City	Eurus Energy	23	CA	Pacific Gas & Electric	Ryan Company
10	Sand Drag	Eurus Energy	21.8	CA	Pacific Gas & Electric	Ryan Company

We are very bullish on overall growth in the utility market, but our outlook for individual players in the sector differs dramatically. We count over 100 individual project developers seeking to serve the utility PV market in the U.S. – far more than current procurement patterns will support. There has already been a fair amount of M&A activity, but further consolidation among developers is a near certainty in the absence of an explosion of new demand. We expect to see further downstream moves from suppliers (to follow those already taken by companies such as SunPower, First Solar, LDK Solar, MEMC, and more), as well as more acquisitions from traditional energy players playing more heavily in solar (such as NRG's acquisition of Solar Power Partners). While the market will not have fully consolidated by the end of 2012, we expect a dramatically different project development landscape within the next two years.

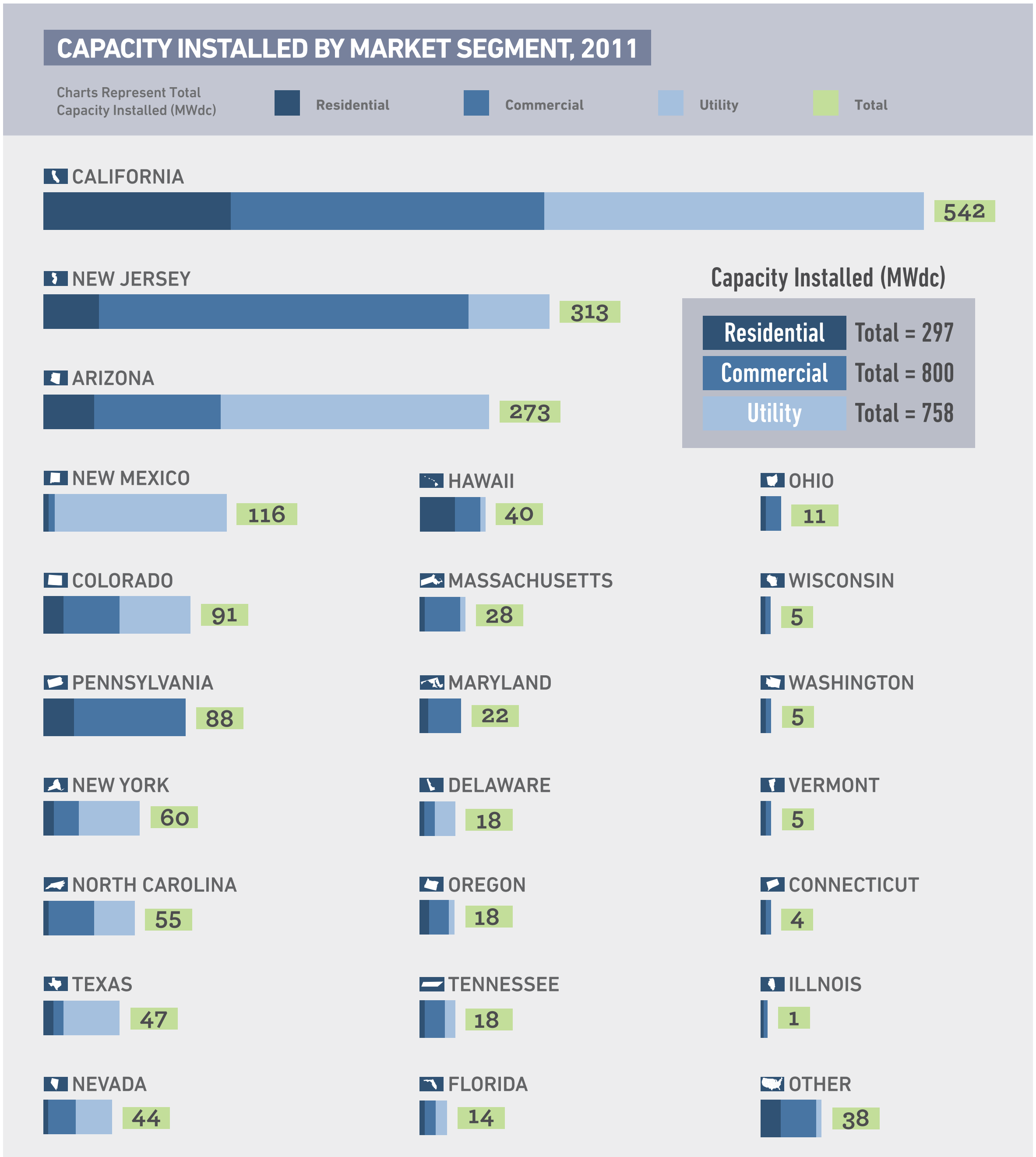
2.1.3 By State

All States

Figure 2-11: U.S. PV Installations by State and Market Segment, Q3 2011, Q4 2011 and Cumulative

Capacity Installed (MWdc)	Q3-2011				Q4-2011				CUMULATIVE			
	Residential	Non-Residential	Utility	Total	Residential	Non-Residential	Utility	Total	Residential	Non-Residential	Utility	Total
AZ	7.8	7.5	28.7	44.0	8.6	39.4	133.1	181.1	87.5	116.9	178.8	383.2
CA	27.0	36.2	122.7	185.9	34.0	64.7	72.3	171.0	487.5	742.0	283.9	1,513.4
CO	3.6	15.4	-	19.0	3.1	3.9	38.0	45.0	48.1	79.3	71.3	198.6
CT	0.5	0.4	-	1.0	0.5	0.1	-	0.5	11.5	14.2	-	25.7
DE	0.4	1.7	-	2.2	0.6	0.3	-	0.9	3.4	8.9	11.2	23.6
FL	0.1	0.5	-	0.6	0.1	2.0	8.2	10.3	7.5	16.9	62.7	87.1
HI	5.3	3.9	-	9.2	5.6	5.5	-	11.1	37.4	41.5	2.4	81.3
IL	0.1	0.2	-	0.2	0.2	0.3	-	0.5	2.2	3.6	10.0	15.8
MD	0.8	3.2	-	4.0	1.8	2.0	-	3.8	9.9	24.9	-	34.8
MA	1.2	4.9	-	6.1	1.5	4.6	2.6	8.6	12.9	44.8	7.9	65.5
NV	0.2	4.3	-	4.5	0.1	6.3	24.2	30.7	6.3	30.1	104.7	141.0
NJ	9.9	53.5	5.0	68.4	10.6	73.8	34.1	118.5	81.2	442.4	78.1	601.7
NM	1.1	0.4	64.3	65.8	1.6	0.7	35.2	37.5	8.4	10.5	142.0	160.9
NY	1.6	3.0	-	4.6	2.2	6.9	37.0	46.0	31.5	45.9	37.0	114.4
NC	0.9	5.3	3.3	9.5	0.5	6.4	17.8	24.7	6.0	38.0	53.2	97.2
OH	0.1	2.3	-	2.4	0.2	2.0	-	2.2	1.4	18.7	12.0	32.2
OR	0.5	2.9	-	3.4	1.9	4.4	3.4	9.8	13.4	23.2	5.8	42.3
PA	4.5	13.6	-	18.1	2.9	10.8	-	13.8	32.8	104.9	4.1	141.9
TN	0.2	3.2	1.1	4.5	0.2	4.9	3.4	8.5	2.2	15.5	4.5	22.2
TX	2.2	1.4	-	3.6	1.6	1.6	34.0	37.2	12.9	14.9	50.0	77.7
VT	0.5	0.2	-	0.8	0.5	0.5	-	1.0	1.9	3.3	-	5.2
WA	0.6	1.7	-	2.2	0.4	0.1	-	0.5	6.4	5.9	-	12.3
WI	0.3	1.1	-	1.4	0.4	0.8	-	1.3	4.5	8.4	-	12.8
Other	3.5	5.8	2.0	11.3	4.4	7.5	-	11.9	22.3	34.7	5.9	62.9
Total	72.7	172.9	227.1	472.6	83.4	249.5	443.3	776.2	939.0	1,889.3	1,125.5	3,953.8

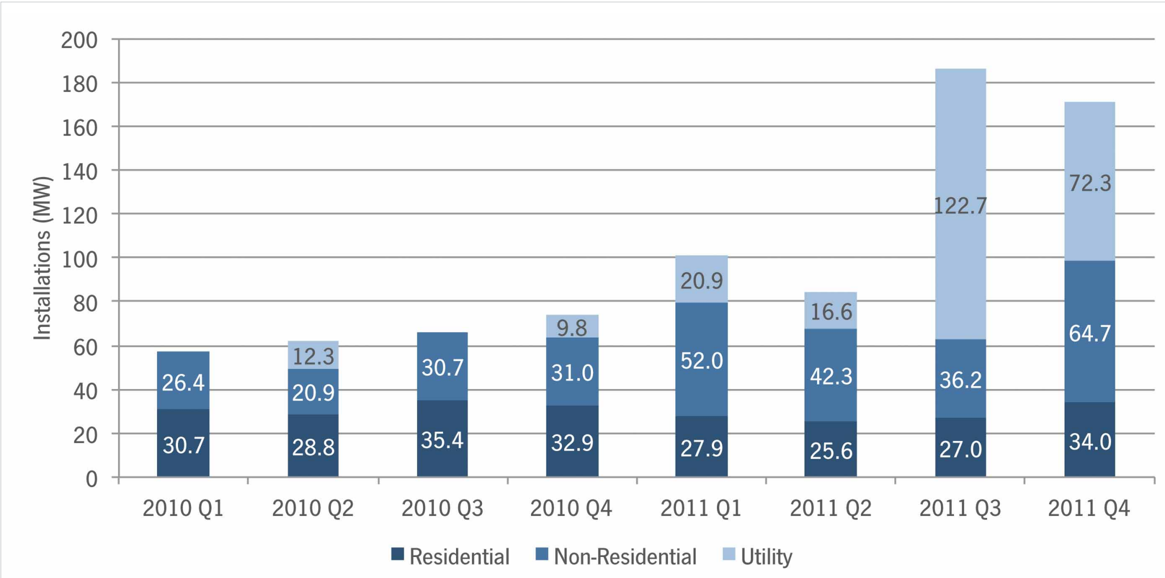
Figure 2-12: State-by-State Total Installations, 2011



California

The California market remains by far the most complex of any state in the U.S. Each market segment can boast a number of programs and incentives all running in parallel. In particular, the utility market is becoming even more complicated as a bevy of wholesale distributed generation programs take effect.

Figure 2-13: California PV Installations by Market Segment, 2010-2011



The California residential market is the steadiest in the state. The California Solar Initiative program has continued uninterrupted for residential installations and new programs, such as the one offered by the Los Angeles Department of Water and Power (LADWP), have supported additional demand. Still, growth has been somewhat limited overall and the clearest trend in the market remains the expansion of residential solar lease/PPA programs. Whereas there were only three companies with a residential lease product in 2009, there are over a dozen today. In fact, it has become a necessity for every major residential installer to either offer its own lease, partner with a financing provider such as SunRun, or white-label a lease product from a company such as Clean Power Finance. We anticipate steady, albeit moderate, growth in the residential segment throughout 2012.

The non-residential market had a volatile year in 2011, as California Solar Initiative incentives for non-residential systems were frozen throughout the majority of the year in two of the three IOU territories. Funding for the program was replenished late in 2011 and projects began to be accepted off the waitlist in December. In addition, the fourth quarter saw a substantial jump in completed installations, with 65 MW installed over the quarter (up from 36 MW in Q3). Indications in early 2012 are that the market appears relatively strong and deal-flow is steady. While we do not anticipate California to be the primary engine of growth for the national non-residential market overall, it should remain a large demand center throughout 2012. If module prices continue to decline, another freezing of the non-residential program in late 2012 would have a much smaller impact, as many projects would be feasible without state-level incentives.

There are two major structural risks in the California distributed generation markets. The first is the concept of a “network use charge” for net-metered systems. San Diego Gas & Electric proposed this in 2011 and was turned down by the California Public Utilities Commission (CPUC), but market players expect the California utilities to continue pushing for this in some form. At this point, however, any charge is likely to take effect no earlier than 2013.

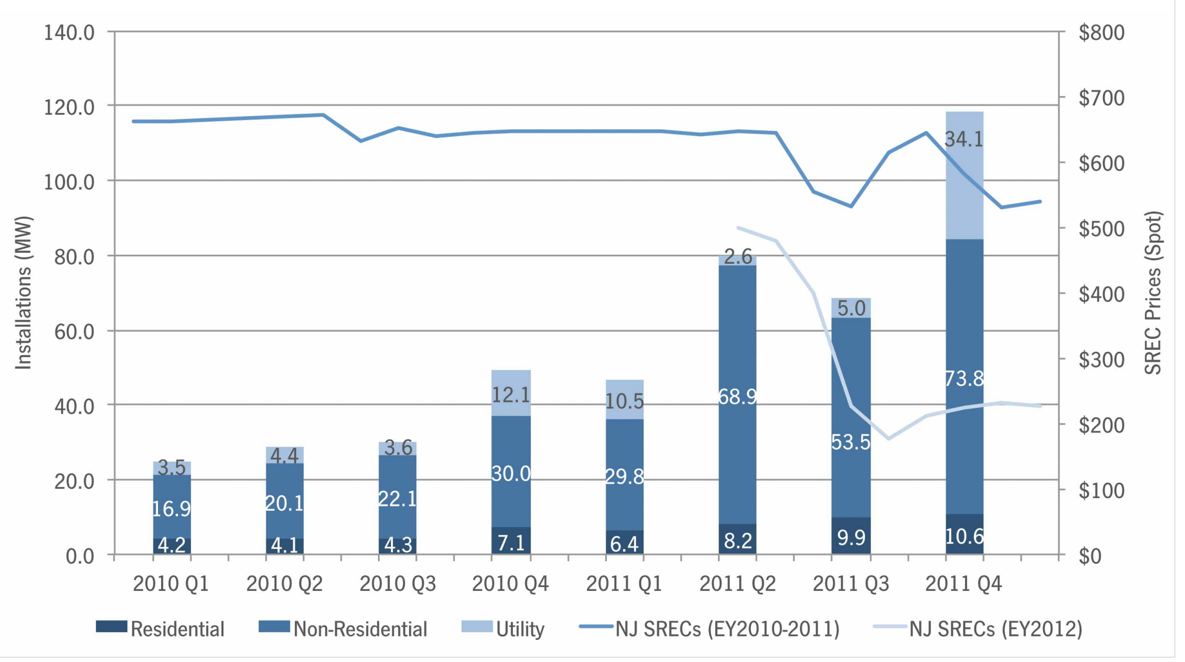
Of more immediate and serious concern is the state’s net metering cap. The cap is currently set at 5% and is expected to be reached in late 2012 for at least one utility. In the absence of an expansion or removal of this cap, the DG market could effectively be frozen. An alternative (albeit temporary) solution is to change the methodology for calculating the cap – a suggestion provided by solar industry advocates. Instead of calculating 5% of aggregate utility peak demand, the new methodology would calculate the cap based on 5% of aggregate customer peak demand. While this may seem like a small revision, it would add an estimated 2 GW of net metered system potential in California.

The utility market saw over 70 MW completed in California in the fourth quarter, bringing the annual total to 233 MW. Among these installations were five projects owned by Southern California Edison and eight projects in Sacramento Municipal Utility District (SMUD)’s territory. Looking forward, there is an enormous project pipeline to be built out over the next three years, so installation numbers will appear high. That said, the competitive landscape for new projects has deteriorated and many developers are currently finding difficulty signing up new contracts. We expect this to lead to further consolidation within the project development space in 2012.

New Jersey

Since early 2011, it has been clear that the New Jersey solar market was headed for an oversupply of solar renewable energy credits (SRECs), the tradable commodity that has enabled the vast majority of installations in the state for the past three years. Since the New Jersey market functions on a basis known as Energy Years, which run June-May, this impact was first felt in the spot market in mid-2011 when spot SREC prices began to plummet from their historical levels of greater than $600. By August, spot SREC prices had fallen to $225 and the oversupply had clearly taken hold.

Figure 2-14: New Jersey PV Installations & SREC Prices, 2010-2011



What much of the market did not predict, however, was the magnitude of the ultimate oversupply. Throughout most of 2011, many market participants anticipated a downturn in Energy Year 2012 to be replaced with a more stable growth market in Energy Year 2013 (beginning June 2012). However, installation rates continued to soar throughout 2011, reaching nearly 120 MW in the fourth quarter, up from a previous quarterly high of 80 MW. As it turned out, developers had amassed such a large pipeline of projects, and were so dependent on these projects, that a drastic reduction in spot prices did virtually nothing to slow down installations. While new project activity did gradually decrease, the market could easily spend the next year working through the existing project pipeline.

We anticipate a similar dynamic in early 2012. The combination of continued pipeline build-out, along with the impact of projects that have been safe-harbored to qualify for the 1603 Treasury Program grant, will keep installation levels high despite continued deterioration in the SREC market.

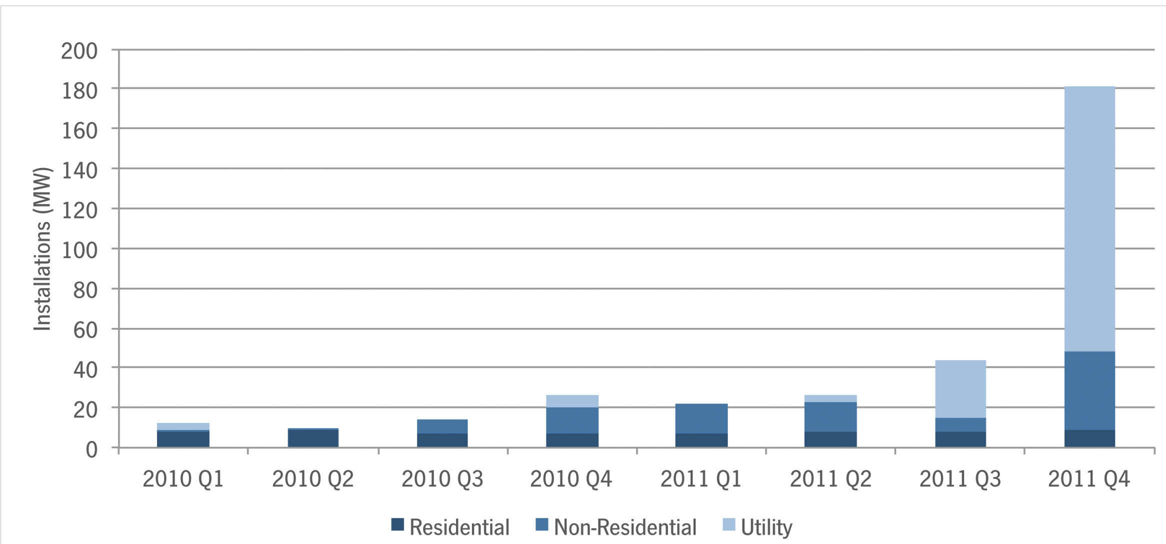
This has created a binary future for the New Jersey market depending entirely on whether some form of legislation is passed to shore up near-term demand for SRECs. In early 2012, spot SREC prices briefly jumped back over $225 in the hopes that S-2371, a state bill to increase near-term SREC requirements, would become law. When that bill did not pass, prices began to fall again and continue to decline. The situation is quite serious. Based on our assessment of supply and demand in New Jersey, we expect that the market will remain heavily oversupplied for at least three years if no new legislation is passed. While a few projects could still move forward (particularly those with a site host taking the SREC risk), this would effectively stall the New Jersey market. SREC prices might never fall to zero given that they carry a three-year life, but we would expect them to fall and remain low. On the other hand, there are a number of potential legislative solutions. While it is likely too late to completely shield the market from a downturn, there are still discussions of a bill that would pull in the near-term SREC requirement, reduce the alternative compliance payment (ACP), and expand long-term SREC procurement programs already in place (known as EDC financing programs). The next 12-18 months would still be painful for New Jersey market participants, but there would be a path to recovery.

Based on conversations with developers, EPCs and industry advocates in New Jersey, we remain cautiously optimistic that a bill will pass in some form and provide some much-needed relief to the market. In the meantime, we expect installation levels to remain high and SREC prices to remain low.

Arizona

In the Q3 2011 edition of this report, we noted that a number of commercial project developers in Arizona were bundling groups of projects to be commissioned together. This led to our prediction that the Arizona commercial market would recover strongly from a weak Q3 showing of 7.5 MW installed. As it turned out, our prediction was not even bullish enough – in the fourth quarter, 39.4 MW of commercial PV was installed in Arizona, more than five times the Q3 total, bringing the annual total to 76.3 MW. An additional 133 MW of utility installations was connected in Q4 (led by the first phase of the 150 MW Mesquite Solar project), leading to Arizona's first-ever quarter as the state market with the most capacity installed.

Figure 2-15: Arizona PV Installations, 2010-2011



	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Residential	8.1	8.8	7.4	7.4	7.6	7.7	7.8	8.6
Non-Residential	1.0	1.3	7.2	12.6	14.5	14.9	7.5	39.4
Utility	3.2	0.0	0.0	6.0	0.0	3.4	28.7	133.1

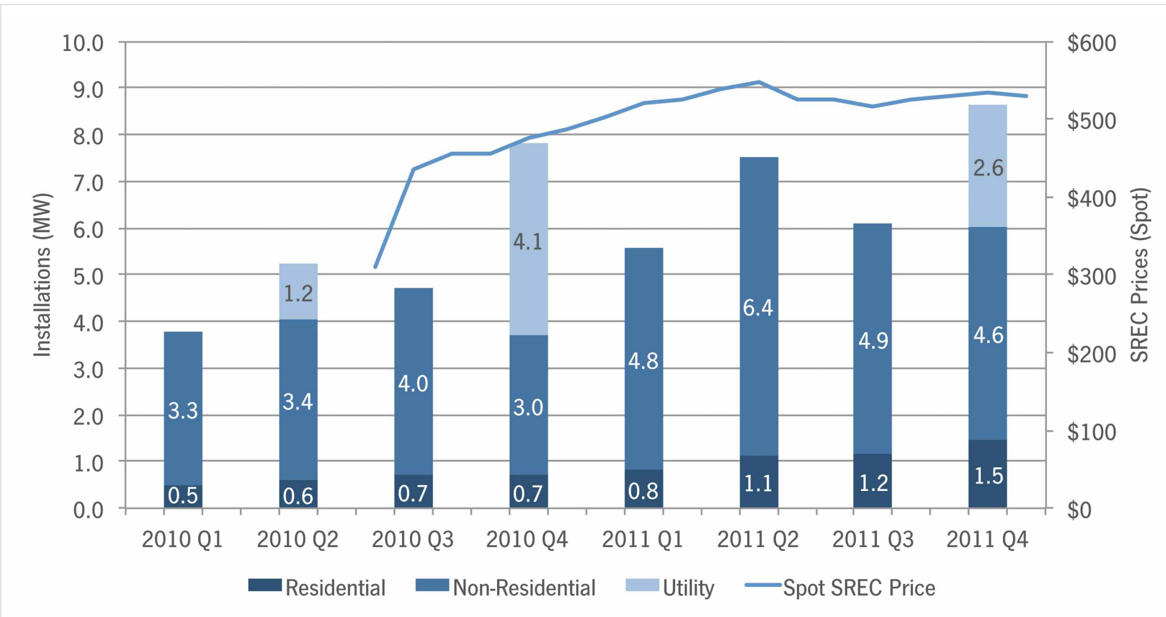
For 2012, the picture for Arizona is mixed. Residential rebate levels are falling quickly, taking already-low installed prices down even further. Some market participants have even suggested that residential rebates may be down to zero by the end of 2012. Commercial rebates generally remain attractive, but total program funding is limited. In both the residential and commercial markets, Arizona may ultimately be an early test of whether project economics are sufficient without significant state-level incentives. Some developers are optimistic about this prospect, but it will depend in part on broader market dynamics (e.g., module price trends and utility rates).

In the utility market, Arizona will continue to show impressive installation numbers. Apart from a bevy of 10-20 MW projects currently in development, the 260 MWac Agua Caliente project and the 150 MW Mesquite Solar project are both in construction, as are at least another 400 MW of utility PV projects.

Massachusetts

We have been bullish on the prospects for the Massachusetts market for a number of quarters. As we have noted previously, the Massachusetts market is driven by a more complex version of the SREC market that led New Jersey to prominence. In an attempt to create a relatively stable market with longer-term visibility, the Massachusetts Department of Energy Resources (DOER) instituted market mechanisms designed to keep the market from going long or short for extended periods of time.

Figure 2-16: Massachusetts PV Installations and SREC Prices, 2010-2011



As the New Jersey and Pennsylvania markets began to dry up for new project activity in 2011, many developers turned their attention and resources toward Massachusetts. In general, they found it more difficult to finance projects given the relative lack of long-term SREC contracts, but with SREC prices consistently above $500, the returns were there. The market was slow to pick up in 2011, with installations never exceeding 10 MW in a single quarter. Still, the pipeline is robust and market players continue to flock toward Massachusetts seeking growth.

Developers active in Massachusetts report two primary concerns for 2012. The first is the state's net metering cap, currently set at 1% for private-sector projects and 2% for public-sector projects. The public sector cap does not pose an immediate concern. However, the 1% cap looms near. For example, in National Grid's territory, there were 29.2 MW operating under the 1% cap as of January 6, 2012, and the 1% cap amounts to 51.3 MW. While this allows for another 22 MW of capacity, there are currently over 176 MW with net metering applications in the process of being interconnected in the utility's territory. Suffice it to say that the cap will pose a barrier at some point in 2012. There is cautious optimism among market participants that the cap will ultimately be expanded, but this will be an absolute necessity in order to keep the market strong.

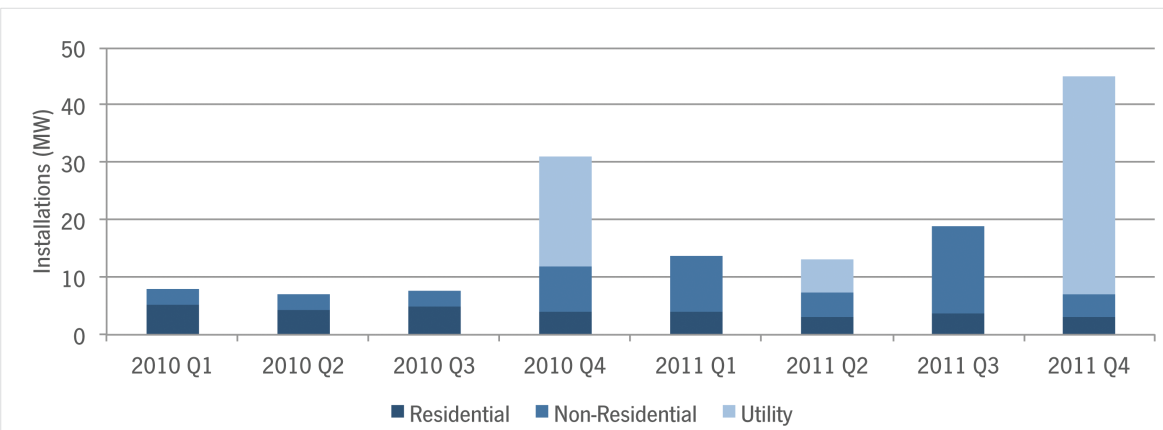
The second concern is the potential for oversupply. All the activity in 2011 has resulted in a robust pipeline. At the same time, the market was undersupplied in 2010 and given the market's self-adjustment mechanisms, this resulted in nearly flat demand in 2011. This has raised the possibility that a short-term burst in installations (as we expect in 2012) will create an oversupply and, subsequently, falling SREC prices. There is an auction program designed to serve as a de facto floor price for SRECs, but it is important to understand that the auction is not a true floor – and SREC prices could fall below the $285 auction price in a substantially oversupplied market. While the market does have the capability to self-correct in these situations through demand adjustment, it takes at least a year to stabilize – and the mechanism's effectiveness has not yet been proven.

In short, we expect installation levels to be high in Massachusetts this year, but new development activity may see a setback if the market overshoots.

Colorado

The Colorado market is driven primarily by incentive programs from Xcel Energy, the state's largest utility. In particular, the SolarRewards program had been the source of most residential and commercial demand in Colorado. In early 2011, Xcel shocked the market when the utility froze the program and stated that it had essentially reached its solar targets. After a period of negotiation and an eventual settlement, the SolarRewards program reopened with lower incentives intended to bridge the gap between that time and Xcel's 2012 RPS compliance plan, which would set out a longer-term strategy for solar generation.

Figure 2-17: Colorado PV Installations, 2010-2011



	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Residential	5.3	4.3	4.9	4.1	4.1	3.0	3.6	3.1
Non-Residential	2.5	2.7	2.7	7.9	9.5	4.2	15.4	3.9
Utility	0.0	0.0	0.0	19.1	0.0	6.0	0.0	38.0

The results of this settlement differed by market segment. The residential market became tight because the incentive had been reduced so heavily, but projects continued to move forward at a steady pace. In the commercial market, residential and commercial integrators jumped to confirm applications under the settlement right after it was announced. As a result, total capacity for incentives under the settlement agreement ran out in the second half of 2011 and new project activity slowed down substantially.

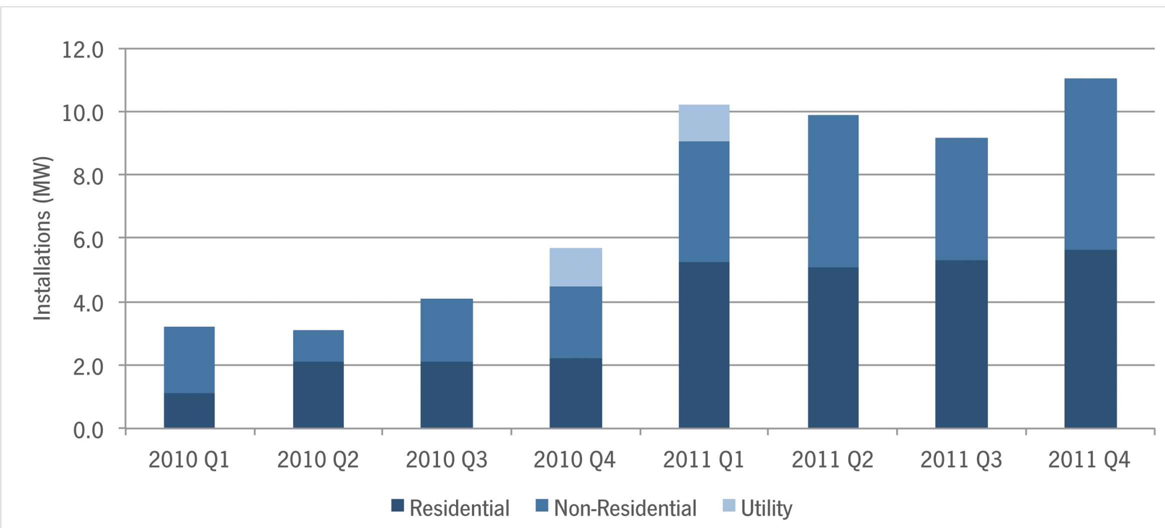
As it stands today, there are roughly 20 MW left in the residential portion of the program – although the market remains somewhat constrained by tight project economics, particularly in the host-owned segment. The third-party-owned segment still appears a bit more robust. In the commercial market, the majority of projects being completed are those that signed up applications in early 2011. These projects have one year to be completed, so we anticipate installation levels to remain relatively steady through early 2012.

The biggest remaining question is the ultimate outcome of Xcel's 2012 compliance plan. The first filing in this plan is expected in March/April of 2012, and the proceeding could extend throughout the rest of the year. As a result, we anticipate a meaningful, if temporary, slowdown in Colorado commercial installations in mid-2012 as the Compliance Plan is being negotiated.

Hawaii

Hawaii had an extremely strong year in 2011, with installation rates consistently around 10 MW each quarter, up from less than 5 MW in 2010. High electricity prices and insolation rates have always made the fundamentals of the Hawaiian market extremely attractive – it has been external barriers such as interconnection that have kept the market from growing by orders of magnitude.

Figure 2-18: Hawaii PV Installations, 2010-2011



	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Residential	1.1	2.1	2.1	2.2	5.3	5.1	5.3	5.6
Non-Residential	2.1	1.0	2.0	2.3	3.8	4.8	3.9	5.5
Utility	0.0	0.0	0.0	1.2	1.2	0.0	0.0	0.0

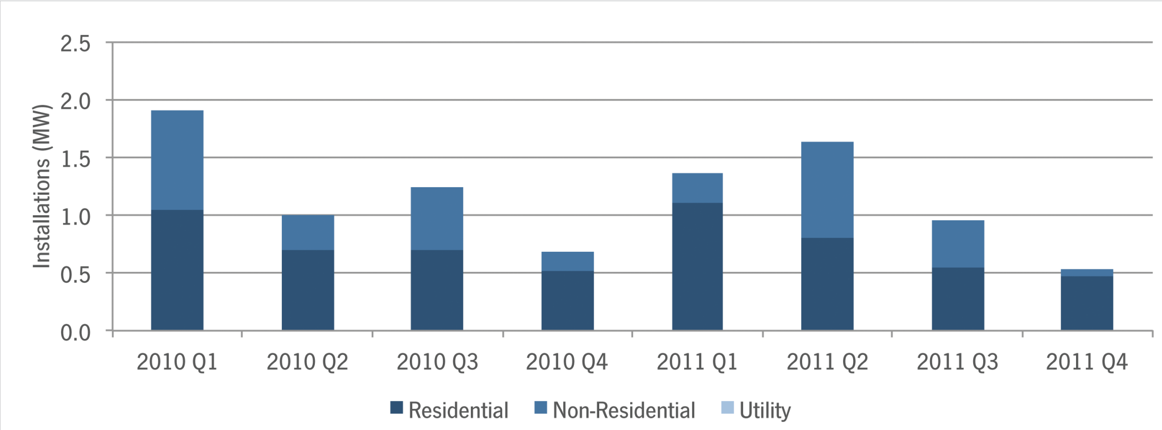
Market participants in Hawaii note that there was a substantial volume of projects signed up in late 2011, creating the likelihood that installation growth will continue to be impressive in 2012. One prominent developer predicted that the Hawaii market, as measured by completed installations, will more than double this year. However, significant barriers remain in place in Hawaii. Most notable among these is interconnection difficulties. Hawaiian utilities continue to impose circuit restrictions in order to avoid solar generators exceeding 15% of load on their systems – a number which has come very close to being reached in a number of areas. For example, according to an article in the Star Advertiser, as of December 2011 there were 950 streets in 25 zip codes on Oahu where installed PV capacity exceeded 15% of peak circuit load. Ultimately, this may be the limiting factor in the Hawaiian market. Were it not for interconnection difficulty, the attractive economics of a solar project relative to high grid prices could easily create a near-term boom in the Hawaiian market. Still, despite utility-imposed barriers, we expect to see large installation figures emerging from Hawaii throughout 2012.

Connecticut

Although Connecticut installed only 4.5 MW in 2011, the market should become a strong second-tier demand center in 2012. In August 2011, Public Act 11-80 passed, setting a new market structure for the next few years. Key elements of the program include (currently proposed by the utilities and subject to change):

- Development of a residential incentive program to support at least 30 MW of residential PV by 2022
- A requirement for utilities to enter into 15-year contracts for RECs from projects on the retail side of the meter (likely to be nearly all PV) that are less than 1 MW. Utilities will spend $8 million in the first year, rising by another $8 million each year until the fourth year, after which point there will be a program review. The proposed law sets an initial ceiling price of $350/MWh.
- A requirement for utilities to enter into 15-year contracts for customer-side RECs from facilities up to 2 MW. The required spending for these projects is lower: $4 million in year one, increasing by $4 million each year thereafter. The ceiling price for this program begins at $200/MWh.

Figure 2-19: Connecticut PV Installations, 2010-2011



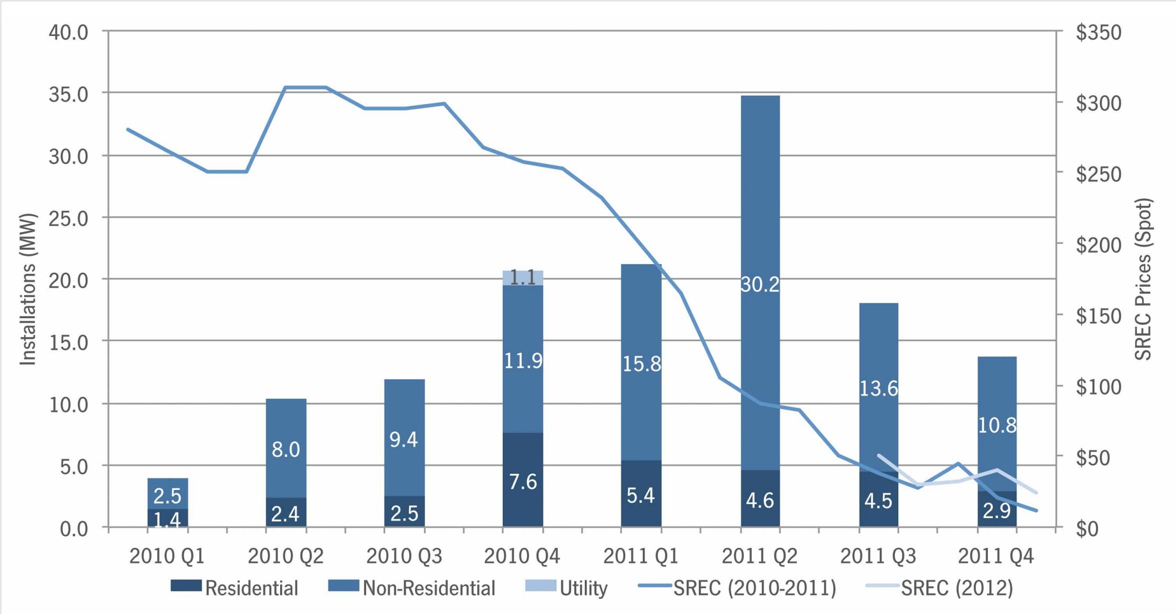
	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Residential	1.0	0.7	0.7	0.0	1.1	0.8	0.5	0.5
Non-Residential	0.9	0.3	0.5	0.2	0.3	0.8	0.4	0.1
Utility	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

While Connecticut will never be another New Jersey, the state will provide an attractive opportunity for developers with deep roots in eastern states and the willingness to commit resources to a smaller market.

Pennsylvania

The Pennsylvania market continued its downward slide in the fourth quarter, installing 13.8 MW – down from a peak of nearly 35 MW in the second quarter. Without a legislative fix to correct the current SREC oversupply, the Pennsylvania market will remain slow until the end of 2012 at the earliest. Most Pennsylvania-based developers have already expanded their business to nearby markets such as New Jersey (despite that state's own SREC woes), Maryland and Massachusetts. The Pennsylvania market situation is even direr than that of New Jersey. Unless legislation is passed to significantly increase the near-term SREC procurement requirement, the Pennsylvania market will remain essentially void of new development activity for at least the next two years.

Figure 2-20: Pennsylvania PV Installations and SREC Prices, 2010-2011



Notable Other States

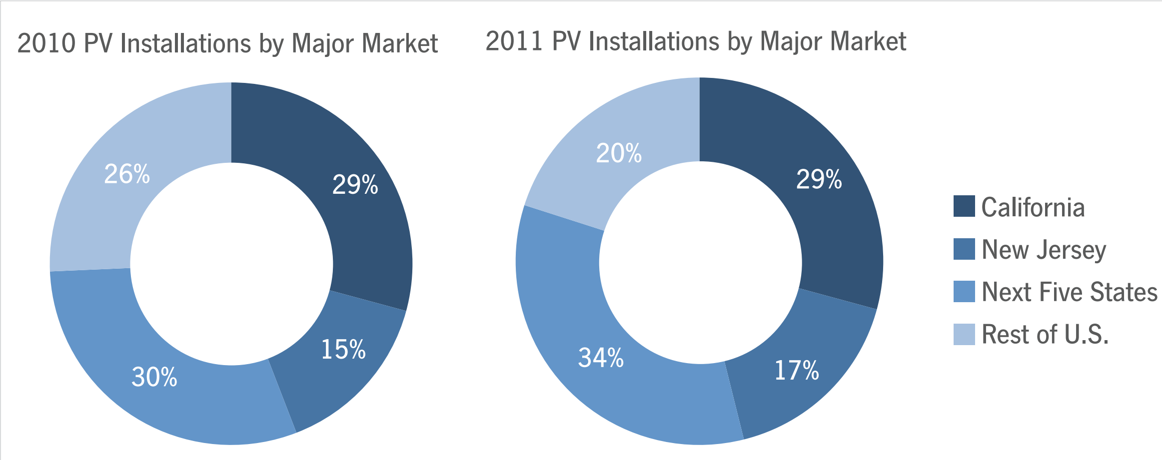
Our coverage has extended to include 23 individual states, but as the U.S. market diversifies, it will be important to look beyond these markets. As such, we provide the following list of a few key states/territories outside our individual coverage that warrant attention:

- District of Columbia: 7 MW in 2011
- Michigan: 6 MW in 2011
- Puerto Rico: ~8 MW in 2011
- Indiana and South Carolina: 3 MW each in 2011

Status of Market Diversity

Although the domestic PV market has experienced rapid geographic expansion over the past few years, it remains relatively concentrated in a few key states. Whereas California accounted for around 80% of total installations in 2004-2005, by 2010 it made up less than 30% of the national market. In 2011, California's market share remained remarkably steady at 29%. The next six states, however, grew to encompass 51% of the national market, up from 45% in 2010. In other words, while the market is shifting away from California alone, it is still concentrated in a relatively small set of secondary markets as opposed to full diversification across the U.S. In 2012, given difficulty in major markets such as New Jersey and Colorado, the "Rest of U.S." category may have an opportunity to increase its market share.

Figure 2-21: PV Installations Breakdown by Major Market, 2010 vs. 2011



Number of Installations

There were a total of 18,108 PV installations in Q4 2011, leading to a total of 61,606 throughout 2011. This brings cumulative PV installations in the U.S. to 214,157. In the residential sector alone, there are over 189,000 installations operating.

Figure 2-22: Number of PV Installations by State and Market Segment, Q4 2011, Full Year 2011 and Cumulative

	Q4 2011				Annual 2011				Cummulative			
	Res.	Comm.	Util.	Total	Res.	Comm.	Util.	Total	Res.	Comm.	Util.	Total
AZ	1,372	113	6	1,491	5,310	389	10	5,709	13,888	1,101	16	15,005
CA	7,091	1,061	14	8,166	21,036	4,200	37	25,273	106,272	11,083	46	117,401
CO	559	88	1	648	2,452	341	2	2,795	9,253	891	4	10,148
CT	67	2	-	69	410	17	-	427	2,098	158	-	2,256
DE	82	9	-	91	233	46	1	280	742	102	1	845
FL	10	50	2	62	63	74	2	139	1,707	307	5	2,019
HI	1,369	91	-	1,460	5,186	299	1	5,486	9,232	606	2	9,840
IL	33	9	-	42	99	25	-	124	589	83	1	673
MD	279	31	-	310	862	127	-	989	1,731	224	-	1,955
MA	257	30	1	288	825	224	1	1,050	2,657	578	6	3,241
NV	9	59	1	69	139	266	1	406	1,274	458	5	1,737
NJ	1,254	319	12	1,585	3,962	1,341	29	5,332	12,717	2,995	48	15,760
NM	315	10	4	329	1,014	84	11	1,109	1,862	146	12	2,020
NY	365	170	1	536	1,170	514	1	1,685	5,738	1,252	1	6,991
NC	21	13	5	39	94	58	23	175	1,068	157	33	1,258
OH	26	54	-	80	130	128	-	258	332	174	2	508
OR	568	73	2	643	1,326	148	2	1,476	3,988	396	3	4,387
PA	368	141	-	509	2,205	1,010	-	3,215	4,634	1,723	2	6,359
TN	33	51	1	85	123	186	2	311	123	186	2	311
TX	256	61	1	318	1,089	206	1	1,296	2,460	410	2	2,872
VT	107	19	-	126	369	72	-	441	369	72	-	441
WA	118	8	-	126	523	62	-	585	1,371	138	-	1,509
WI	92	54	-	146	268	214	-	482	906	374	-	1,280
Other	812	78	-	890	2,288	269	6	2,563	4,735	597	9	5,341
Total	15,463	2,594	51	18,108	51,176	10,300	130	61,606	189,746	24,211	200	214,157

2.2 INSTALLED PRICE

Quarter-over-quarter, the national weighted-average system price fell by 7.5% between Q3 2011 and Q4 2011, moving from $4.41/W to $4.08/W. Year-over-year, average installed costs declined by 19.9%. This average number is heavily impacted by the large volume of utility-scale and megawatt-plus commercial systems installed in in Q4 2011. It should be noted that prices reported in this section are weighted averages based on all systems that were completed in Q4 in many locations.

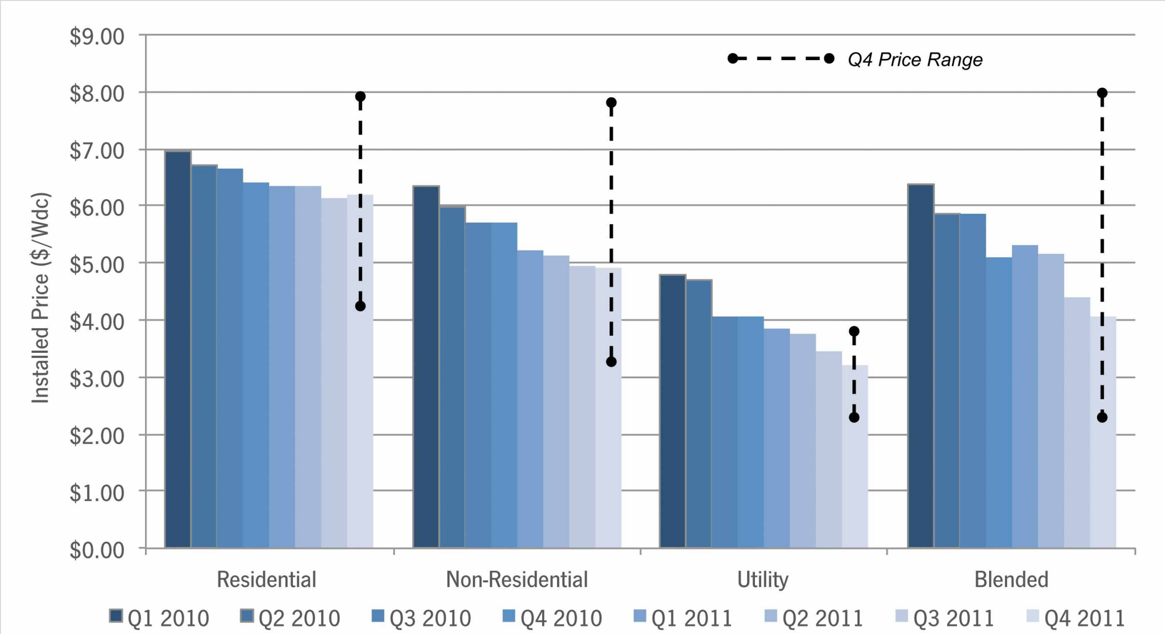
- **Residential** system prices increased by 0.7% from Q3 2011 to Q4 2011, as the national average installed price rose slightly from $6.14/W to $6.18/W. Year-over-year, installed costs declined by 3.6%. This quarterly increase is largely a result of relatively small price reductions in the major states markets of California and New Jersey while many secondary, high-cost markets grew in the fourth quarter. With a glut of cheap panels still flooding the market, it was not uncommon to find direct-owned residential systems being installed for less than $5.00/W in larger markets. However, low module prices were counteracted by an uptick in third-party-owned systems (see Figures 2-5 and 2-8), as these installations are reported as costing more than direct-owned systems.

- **Non-Residential** system prices fell by just 0.4% quarter-over-quarter, going from $4.94/W to $4.92/W. Year-over-year, installed costs declined by 13.9%. Higher average prices in Arizona, which had a large amount of non-residential capacity installed in Q4, negated lower costs in New Jersey and Hawaii, which also had impressive quarters. California saw almost no change. As in Q3, aggressive bidding was a major factor in lower prices in the East Coast markets. With SREC prices continuing to fall, developers are constantly bidding lower to keep projects attractive to investors. For larger, well-established installers and integrators, buying significant quantities of modules on the spot market or via short-term supply agreements helped them leverage low prices during the Q4 installation rush.

- **Utility** system prices declined for the seventh consecutive quarter, dropping from $3.45/W in Q3 2011 to $3.20/W in Q4 2011. Year-over-year, installed costs declined by 21%. The 7.2% reduction in costs in Q4 is a result of a historic free fall in the global price of solar modules. A number of large projects, including a few 20 MW-plus installations, came on-line in Q4, which further emphasized economies of scale and drove the average installed price to its lowest point in the history of this report series.

On the whole, however, installed PV prices vary greatly not only state-to-state, but also project-to-project. Figure 2-23 displays this wide range of installed prices in Q4 2011. Residential system prices ranged from below $5.00/W to just over $8.00/W. Non-residential prices were as low as $3.00/W and as high as $8.00/W. Utility prices also display high variability as a percentage of average cost, largely due to the choice between low- and high-efficiency modules and between fixed and tracking mounting structures. Note that the lowest installed cost does not necessarily yield the lowest levelized cost of energy (LCOE), an important metric for measuring project returns.

Figure 2-23: National Weighted Average System Price, 2010-2011



	Residential	Non-Residential	Utility	Blended
Q1 2010	$6.97	$6.34	$4.80	$6.37
Q2 2010	$6.72	$6.00	$4.70	$5.86
Q3 2010	$6.65	$5.70	$4.05	$5.86
Q4 2010	$6.42	$5.72	$4.05	$5.09
Q1 2011	$6.35	$5.22	$3.85	$5.33
Q2 2011	$6.36	$5.12	$3.75	$5.17
Q3 2011	$6.14	$4.94	$3.45	$4.41
Q4 2011	$6.18	$4.92	$3.20	$4.08

Reviewing system prices on a state-by-state basis further displays just how fractured the domestic market is in terms of pricing. Even within one state, installed cost can vary by more than $1.50/W. There is also a substantial differential in pricing between installers offering third-party owned systems with a PPA or lease and those installing systems paid for in-full by the homeowner. A large proportion of residential and non-residential PV installations are still conducted by smaller integrators. Therefore, it should be noted that systems have been installed in each state for well below (and above) the average pricing displayed in Figure 2-24. Generally, overall trends between states can be discerned from quarter to quarter.

Figure 2-24: Average PV Installed Price by State and Market Segment, Q3 2011 – Q4 2011

	Q3 2011			Q4 2011		
Average Installed Price ($/Wdc)	**Residential**	**Non-Residential**	**Utility**	**Residential**	**Non-Residential**	**Utility**
Arizona	$6.34	$5.23		$6.68	$5.91	
California	$6.64	$5.17		$6.48	$5.14	
Colorado	$5.89	$4.83		$5.90	$5.05	
Connecticut	$5.78	$5.18		$5.08	$6.06	
Delaware	$5.64	$4.81		$5.54	$5.08	
Florida	$5.60	$4.90		$5.75	$4.27	
Hawaii	$5.83	$4.78		$5.75	$4.54	
Illinois	$5.25	$8.97		$6.78	$5.16	
Maryland	$5.24	$5.46		$6.37	$4.96	
Massachusetts	$6.11	$4.73		$5.95	$5.13	
Nevada	$5.68	$5.82		$6.82	$5.87	
New Jersey	$5.51	$4.45	$3.45	$5.42	$4.02	$3.20
New Mexico	$6.85	$5.31		$5.41	$4.50	
New York	$5.28	$6.70		$5.52	$6.05	
North Carolina	$5.85	$4.85		$6.43	$4.76	
Ohio	$6.11	$4.85		$5.86	$4.73	
Oregon	$6.62	$5.35		$6.72	$4.94	
Pennsylvania	$5.67	$4.77		$5.44	$4.65	
Tennessee	$5.76	$4.81		$5.70	$4.71	
Texas	$5.15	$6.32		$6.01	$6.46	
Vermont	-	-		$5.63	$5.34	
Washington	$6.60	$5.11		$6.70	$5.19	
Wisconsin	$6.51	$7.28		$5.84	$6.33	
Other	$6.99	$6.10		$6.67	$5.45	
Weighted Average	**$6.24**	**$4.94**		**$6.18**	**$4.92**	

Overall, Q4 average residential pricing ranged from $5.42/W to $6.68/W in established markets. Non-residential pricing generally ranged from $4.02/W to over $6.00/W, but with projects as small as sub-10 kW or in excess of a megawatt being installed and classified as non-residential, large, low-cost projects can significantly affect a particular state's average and vice versa.

There are four first-order drivers of state-level system pricing other than component costs: market maturity, labor costs, "soft" costs and system size.

- **Market maturity:** The more established and larger a state market is, the more likely it is to attract larger, experienced project developers that can offer lower system prices. Conversely, newer markets are generally more reliant on smaller integrators that purchase components through distributors and have less procedural standardization.

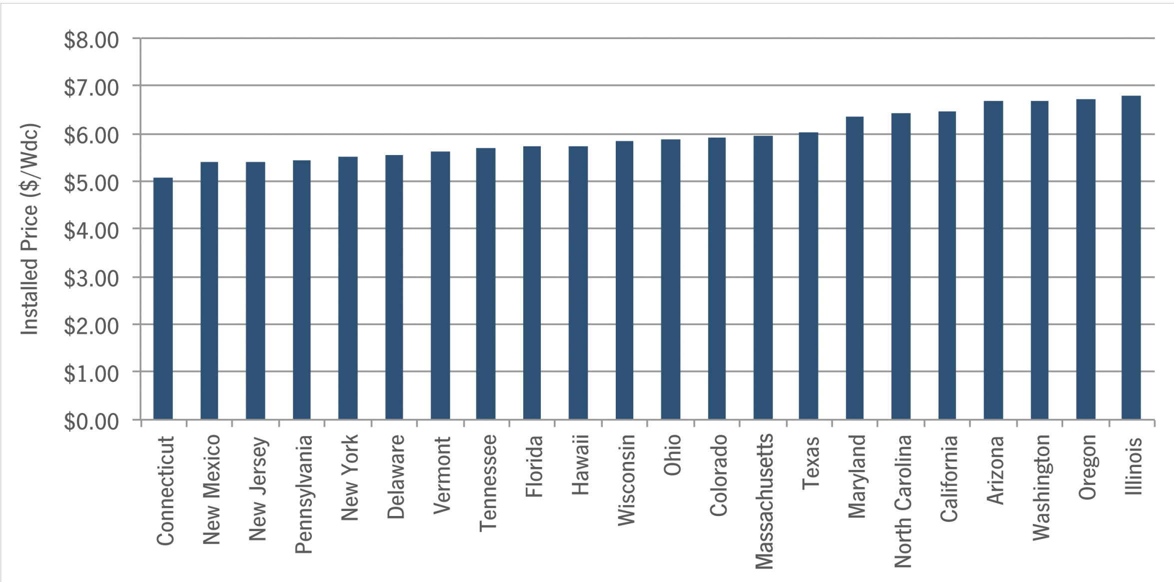
- **Labor costs:** States with higher labor costs will tend to have higher system costs, and vice versa. However, this variance is somewhat limited by the fact that labor currently constitutes less than 15% of total system prices.

- **Soft costs:** Factors such as permitting, interconnection, incentive applications, financing and other fees play a major role in determining system prices (some estimates have placed the impact for residential systems at about $0.50/W). The more complex and time-consuming these factors are in a given market, the more expensive system prices will be.

- **System size:** Larger average system sizes result in lower installed prices per watt. This is true in both the residential and non-residential segments.

In the residential sector, over half of the states that are tracked average installed costs of under $6.00/W. Unsurprisingly, many of these are East Coast SREC markets. With SRECs depressed by oversupply in Pennsylvania and SREC prices falling in New Jersey, installers and their financiers have hedged the cost of projects against a sustained period of low SREC prices. Many of these companies also operate in the neighboring states of Connecticut, New York and Delaware, which explains those states' relatively low prices as well.

Figure 2-25: Weighted Average Residential System Prices by State, Q4 2011

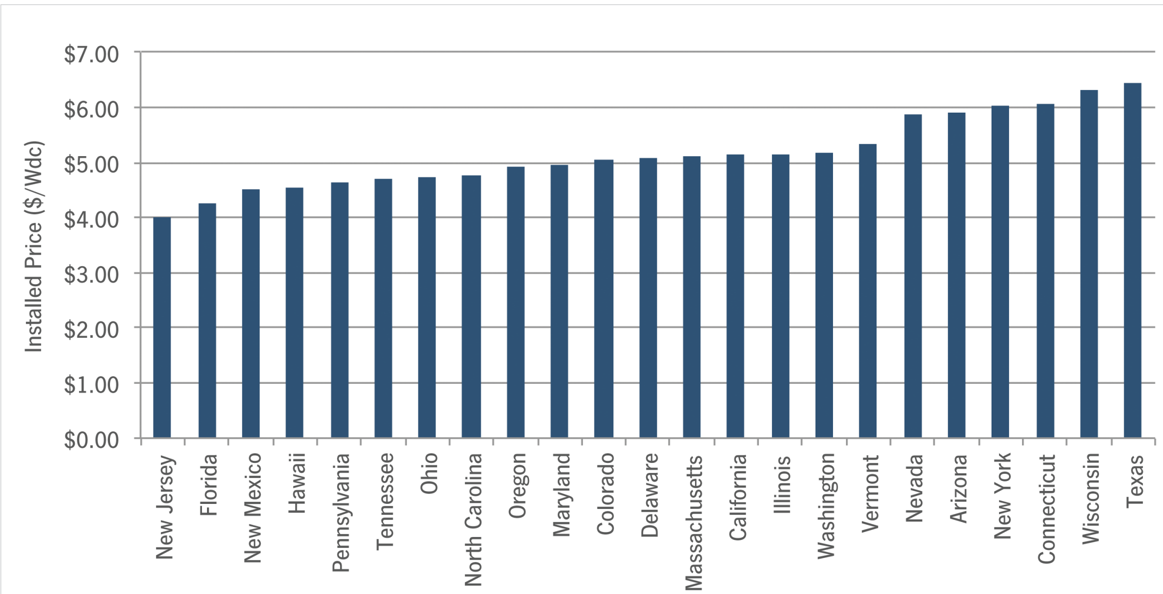


It is not surprising to see that in Q4 New Jersey led the charge in low-cost, non-residential systems. As previously mentioned, developers in SREC markets have had to bid ever lower on projects to ensure they provide an attractive return to investors. Ohio, which has a burgeoning non-residential market, has seen increased competition in the face of the state's rising RPS goals and a 50% in-state procurement requirement. The remaining capacity is typically sourced from neighboring Pennsylvania.

In addition to the SREC states are two growth markets: Hawaii and Tennessee. Hawaii benefits from a statewide feed-in tariff and 35% corporate tax credit, and Tennessee has a generous performance-based incentive, as well. These incentives attract experienced developers eager to establish themselves. While pricing typically declines quarter-over-quarter, installed costs can still be volatile and are easily affected by a large low- or high-cost system. Recently, low-cost modules have factored heavily into non-residential pricing, especially as developers purchase on the spot market for one specific project or a bundle of smaller projects.

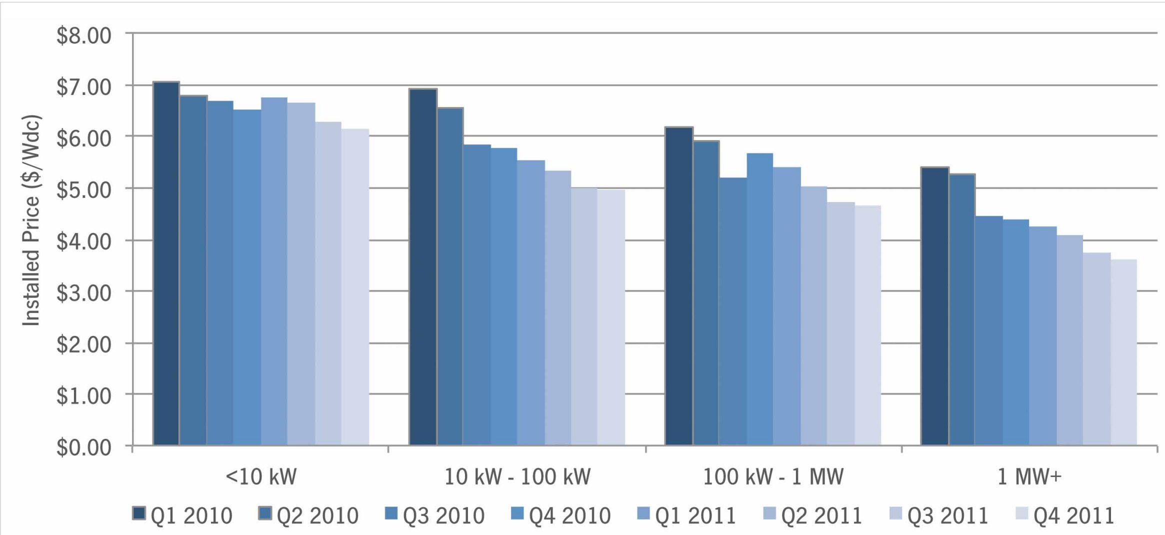
It should be noted that some states' non-residential costs are higher than their residential costs. In Q4, these states included Connecticut, New York, Texas and Wisconsin, none of which have a particularly robust non-residential solar market. Thus, in the case of less developed markets, companies that typically install residential systems will be tapped to undertake a non-residential project. In New York or Connecticut, congested metropolitan areas and high-rise buildings also add to the cost of projects even for the most experienced installers. Unfamiliar, industrial roofs and added regulations and engineering hurdles can add to project costs significantly. Moreover, the average system sizes for those states are relatively small (15 kW to 40 kW), limiting economies of scale.

Figure 2-26: Weighted Average Non-Residential System Prices by State, Q4 2011



Analyzing project costs by system size sheds light on how the different types of installations can affect a weighted-average price, especially in the non-residential market segment. Installed prices have declined across all market segments, but system prices for installations 10 kW or less in size decreased by just 9.9% on a year-over-year basis. Though module prices have been falling since the beginning of the year, it is only as of Q4 that the effects are really being felt in the sub-1 MW market. Smaller installers generally buy through distributors, which typically do not offer the lowest-cost products, and larger installers were likely locked into supply agreements set at higher costs. Projects in the 10 kW to 100 kW and 100 kW to 1 MW ranges have seen installed costs fall most dramatically since 2010, by 14.4% and 18.1%, respectively. Cheap modules that are readily available on the spot market have allowed developers to buy specifically for a particular project if it's large enough or a group of projects.

Figure 2-27: National Weighted Average System Prices by System Size, 2010-2011

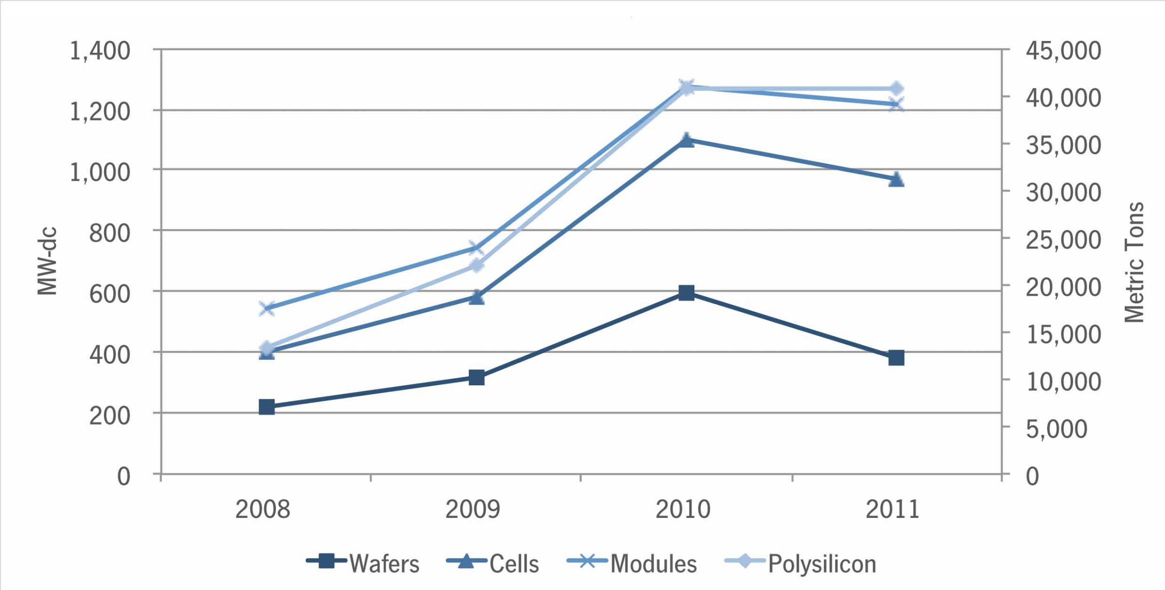


	<10 kW	10 kW - 100 kW	100 kW - 1 MW	1 MW +
Q1 2010	$7.07	$6.93	$6.20	$5.40
Q2 2010	$6.79	$6.55	$5.91	$5.26
Q3 2010	$6.70	$5.85	$5.21	$4.45
Q4 2010	$6.51	$5.78	$5.68	$4.40
Q1 2011	$6.75	$5.55	$5.41	$4.25
Q2 2011	$6.65	$5.35	$5.05	$4.09
Q3 2011	$6.27	$5.00	$4.72	$3.76
Q4 2011	$6.14	$4.95	$4.65	$3.62

2.3 MANUFACTURING

In total, the U.S. produced 40,658 MT of polysilicon, 384 MW of wafers, 969 MW of cells, and 1,219 MW of modules in 2011. In sharp contrast to 2010, which saw 100% growth in production across the PV value chain, 2011 saw production stay mostly flat for polysilicon and modules, and shrink significantly in the case of wafers and cells. Only inverters saw significant production growth in 2011. As shown in Figure 2-28, these relatively weak results came after a sustained period of robust growth for the domestic manufacturing industry.

Figure 2-28: U.S. PV Production, 2008-2011



Value Chain Component	Production Unit	2008	2009	2010	2011
Polysilicon	MT	13,384	22,120	40,715	40,658
Wafers	MW	220	317	595	384
Cells	MW	401	580	1,099	969
Modules	MW	545	742	1,273	1,219

2011 was arguably the PV manufacturing industry's most difficult and turbulent year to date. Around the globe, firms faced severe challenges in the form of record inventory build-ups, steeply falling prices, and heavy losses as the industry was plunged into a state of oversupply beginning in March 2011. It is now clear that the manufacturing industry has entered a consolidation phase, as persistent imbalance between supply and demand has induced voracious competition between producers and a phasing out of less competitive firms and facilities. Producers in high-cost locations such as the U.S. and Europe were especially hard hit, as evinced by a spate of plant closures and market exits throughout the year. Figure 2-29 summarizes recent developments in the domestic manufacturing space related to the global manufacturing downturn.

Figure 2-29: U.S. PV Manufacturing Plant Developments Related to Global Industry Downturn, Q3 and Q4 2011

Firm	Technology	Value Chain Participation	Plant Location	Plant Cap. (MW)	Action Taken	Date
SolarWorld	c-Si	Module	CA	150	Plant Closure	Sep 2011
SolarWorld	c-Si	Wafer/Cell/ Module	OR	250/ 500/350	Reduced workforce; idled facility for three weeks at the end of 2011	Nov 2011
Solon	c-Si	Module	AZ	80	Plant Closure	Aug 2011
Solyndra	CIGS	Module/System	CA	70	Plant Closure; filed for Chapter 11 bankruptcy; assets sold	Aug 2011
Spectrawatt	c-Si	Cell	NY	60	Plant Closure; filed for Chapter 11 bankruptcy; assets sold	Aug 2011
Uni-Solar (Energy Conversion Devices)	a-Si	Cell	MI	120	Temporarily idling facilities as inventory management measure; furloughing workers	Nov 2011
Solaicx (MEMC)	c-Si	Wafer	OR	180	Cutting production, laying off 100 of 140 workers	Dec 2011

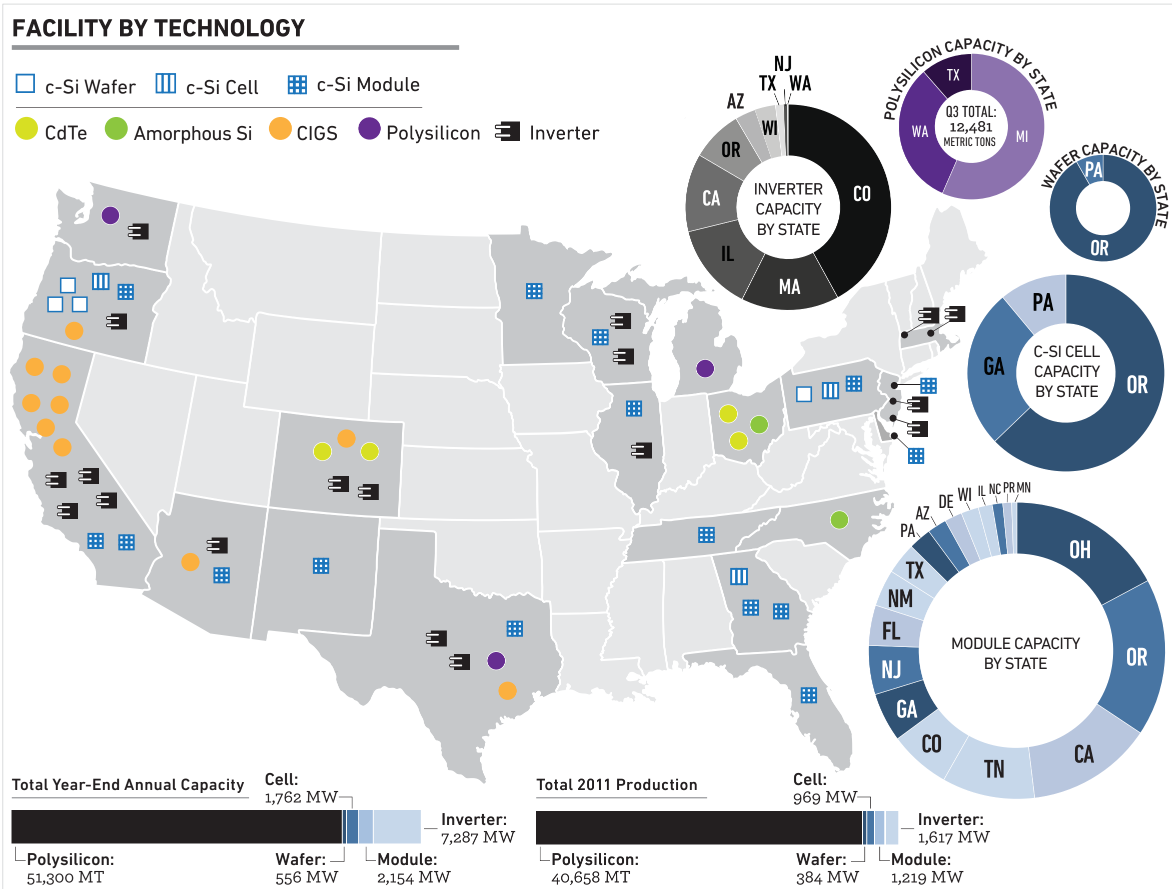
2.3.1 Active U.S. Manufacturing Plants

The figure below indicates the location of active domestic PV manufacturing facilities. There are at least 57 active facilities manufacturing PV polysilicon and components (wafers, cells, modules, inverters) spread across 21 states in the U.S. This does not include new plant announcements, as these facilities have yet to start operating. The following observations can be made here:

- A number of inverter facilities are located in California due to its leadership position as an end-market in the U.S.
- Thin film facilities tend to be located in close proximity to R&D resources, given their technology-intensive nature. This explains the high concentration of thin film plants in California (Silicon Valley) and Colorado (NREL).
- Oregon and Arizona also have a prominent manufacturing presence, due to their proximity to California and the existence of skilled labor and strong policy support for PV manufacturers.
- While the Midwest has historically been somewhat dormant on the PV manufacturing front, recent plant announcements in Wisconsin, Indiana, Minnesota and Illinois suggest that this is changing quickly. Most of these plants are module assembly facilities, suggesting that they rely on the growth of local end-demand and a lack of sophisticated distribution channels in these states.
- Numerous developments on the manufacturing front have also taken place in the Southeastern U.S. Recently, there has been new plant construction in Tennessee (polysilicon), Mississippi (polysilicon, CIGS), Florida (c-Si module), and Georgia (c-Si module).

- The geographic shift toward the Midwest and Southeast seems to be taking place at the expense of northeastern states such as Massachusetts, Maryland, New York, and New Jersey, which have seen a total of four plant closures in the last year and a half; most of these have been legacy plants that have been around since the mid-2000s. To the extent that end-demand in these states ramps up in the future, one can expect to see new module assembly facilities being constructed, a phenomenon which would gain further momentum were import duties on China-based manufacturers to be levied.

Figure 2-30: U.S. Manufacturing Facilities Map



2.3.2 New Plants in 2012 and 2013

While much of the recent news about domestic manufacturing has focused on plant closures, there has also been significant activity in terms of new plant announcements over the past two quarters. Figure 2-31 details new PV manufacturing plants coming on-line in the U.S. in 2012 and 2013; a number of these plants were announced in Q3, such as GE's CdTe plant in Colorado and Linuo's planned facility in upstate New York. Further upside to new plant activity exists if import duties were to be levied in the wake of the recently-filed trade petition, specifically in the area of c-Si module assembly.

Figure 2-31: U.S. PV Manufacturing Plants to Commence Operations 2012-2014

Company	Facility Location (State)	Comm. Op. Start Date (est.)	Tech.	Differentiator	Facility Value Chain Participation					Plant Size
					Crystalline Si				Thin Film	
					Polysilicon	Wafer	Cell	Module	Cell/ Module	
1366 Technologies	MA	2013	c-Si	Kerf-free wafering reduces wafer silicon utilization, reduces process steps in ingot/ wafer production		x				20 MW
1366 Technologies	TBD	2014	c-Si	Kerf-free wafering reduces wafer silicon utilization		x				1000 MW
Abound Solar	IN	Q4 2013/ 2014	CdTe	Fully automated, continuous production process has potential for low manufacturing cost					x	640 MW
CaliSolar	MS	2012	c-Si	Utilizes lower-cost, lower-purity upgraded metallurgical silicon (UMG) to produce 16%+ efficiency cells	x					16,000 MT
First Solar	AZ	Q3 2012	CdTe	Fully automated, continuous production process with minimal feedstock requirement drives industry-leading manufacturing cost					x	250 MW
GE	CO	2013	CdTe	Fully automated, continuous production process has potential for low manufacturing cost					x	400 MW
Linuo Solar	NY	2012	c-Si	None						Undis-closed
SoloPower	OR	Q1 2012	CIGS	Flexible, lightweight modules; deposition via electroplating					x	75 MW
Stion	MS	Q1 2012	CIGS	Tandem-junction CIGS/ chalcopyrite modules boost efficiency relative to single-junction technology					x	100 MW

As can be seen, there is a healthy spread across the value chain and technologies when it comes to these new plants, including polysilicon (CaliSolar), wafer manufacturing (1366 Technologies), CdTe (GE, First Solar, Abound), CIGS (Stion, SoloPower), and c-Si module assembly (Linuo Solar). At the same time, there is a disproportionately higher amount of thin film capacity coming on-line in the U.S relative to the global average. The key driver here is proximity to R&D resources (out of Silicon Valley/NREL). Thin film is highly IP-intensive and with regard to manufacturing parameters such as efficiency, yield, and throughput, tends to be optimized in the midst of commercial-stage production given significant differences between the performance of pilot and commercial-stage plants. This makes frequent and easy access to R&D personnel paramount. It is also worth noting that the same points hold for CaliSolar and 1366, which are attempting to commercialize innovative, differentiated technologies that are commercially unproven at scale.

2.3.3 Polysilicon

The global solar polysilicon industry is highly consolidated, and this applies to the U.S. as well, where there are only three facilities of major significance, located in Michigan (Hemlock), Texas (MEMC), and Washington (REC). Together, these three facilities were responsible for 40,658 MT of solar polysilicon in 2011. This was almost the same as 2010 production of 40,715 MT. Year-end capacity stood at 51,300 MW, which was also flat with respect to 2010. Given the inventory build-up across the value chain, the fourth quarter of 2011 saw lower overall utilization of capacity compared to historically high (90%-plus) levels for these facilities, which are believed to be highly competitive with respect to product quality and manufacturing costs.

Figure 2-32: U.S. Polysilicon Production by State, 2011

Polysilicon (Metric Tons)	Capacity						Production					
	Q1	Q2	Q3	Q4	2011 Annual (Year-end)	Y/Y	Q1	Q2	Q3	Q4	2011 Total	Y/Y
Michigan	6,519	6,788	7,056	7,325	29,300	17%	5,746	5,988	6,230	5,753	23,716	5%
Texas	1,275	1,350	1,425	1,500	6,000	25%	1,114	835	1,249	878	4,075	-10%
Washington	4,000	4,000	4,000	4,000	16,000	0%	3,636	3,151	2,921	3,159	12,867	-5%
Total	11,794	12,138	12,481	12,825	51,300	12%	10,496	9,974	10,399	9,789	40,658	0%

2.3.4 Wafers

After maintaining healthy production run rates for the first three quarters of 2011, plant utilizations in Q4 2011 dropped sharply, resulting in a steep quarter-over-quarter drop in overall wafer production from 102 MW to 52 MW. A total of 384 MW of wafers were produced in the U.S. in 2011, which represents a 35% decrease compared to 2010's figure of 594 MW. Year-end capacity for 2011 stood at 556 MW, which is a 24% drop. The main reason for this is the closure of Evergreen Solar's 160 MW wafer-cell-module facility in March. After Evergreen's closure only three wafer manufacturing facilities remain in the U.S. In two of these cases, the firm in question (both SolarWorld in OR and Solar Power Industries in PA) is fully vertically integrated, and a large proportion of wafer production is consumed internally for cell manufacturing. The lone exception is monocrystalline wafer producer Solaicx in Oregon (now a wholly owned subsidiary of MEMC).

Figure 2-33: U.S. Wafer Production by State, 2011

Wafer (MW)	Capacity						Production					
	Q1	Q2	Q3	Q4	2011 Annual (Year-end)	Y/Y	Q1	Q2	Q3	Q4	2011 Total	Y/Y
Massachusetts	0	0	0	0	0	-100%	13	0	0	0	13	-92%
Oregon	125	125	125	125	500	0%	103	95	95	49	342	-17%
Pennsylvania	14	14	14	14	56	0%	10	8	7	4	29	6%
Total	139	139	139	139	556	-24%	126	104	102	52	384	-35%

2.3.5 Cells

As in the case of wafers, cell manufacturers cut production sharply in Q4 2011 to manage excessive inventories that had been building up for much of the year. Utilization rates for cell plants in Q4 2011 dropped to around 33% after hovering around the 60% mark in prior quarters. Overall, U.S. cell production across all technologies was 969 MW in 2011, which represents a 12% year-over-year drop. Annual year-end cell capacity stood at 1,762 MW, which is a 1% increase over 2010's figure of 1,740 MW. Aside from the notable exception of Georgia-based Suniva (which also owns module manufacturing capacity), there are no pure-play cell manufacturers remaining in the U.S., which means that all cell manufacturing firms use their cell output internally for the purpose of module production.

In contrast to polysilicon and wafers, cell manufacturing is currently distributed across 11 states, with a total of 18 active facilities in the U.S. Oregon in particular has emerged as the leader in PV manufacturing, with a combination of wafer, cell, and module facilities located in that state, due to the presence of generous state incentives, proximity to California, a highly skilled labor force, and cheap hydroelectric power.

Figure 2-34: U.S. Cell Production by State, 2011

Cell (MW)	Capacity						Production					
	Q1	Q2	Q3	Q4	2011 Annual (Year-end)	Y/Y	Q1	Q2	Q3	Q4	2011 Total	Y/Y
Arizona	10	10	10	10	40	0%	3	1	1	1	6	-70%
California	55	61	67	55	220	13%	26	27	25	7	85	-5%
Colorado	35	38	42	45	180	42%	14	12	14	10	50	57%
Georgia	43	43	43	43	170	0%	36	32	32	15	115	-33%
Massachusetts	0	0	0	0	0	-100%	12	0	0	0	12	-92%
Michigan	38	38	38	38	150	0%	26	6	4	0	36	-70%
New Jersey	5	5	5	5	20	0%	0	0	0	0	0	-100%
North Carolina	7	8	8	9	35	40%	2	2	2	2	8	650%
Ohio	74	80	86	92	367	34%	66	63	65	42	236	6%
Oregon	128	128	128	128	510	0%	120	107	107	63	397	59%
Pennsylvania	13	13	13	13	50	0%	9	8	6	3	26	-26%
Texas	5	5	5	5	20	0%	0	0	0	0	0	NA
Total	411	427	442	441	1,762	1%	312	257	256	144	969	-12%

2.3.6 Modules

Domestic module production in Q4 2011 amounted to 199 MW, which represents a quarter-over-quarter drop of 36%. As was the case with wafers and cells, plant utilizations dropped sharply in Q4 to 37% after being in the 60% range for much of the year prior. Overall, 1,219 MW of modules were produced in the U.S. in 2011, which is 4% lower than the 1,273 MW produced in 2010. Year-end module capacity stood at 2,154 MW, which is 2% higher than 2010's figure of 2,120 MW. Export-oriented firms and facilities witnessed a significant slowdown in production due to the global demand slump and inventory pile-up. While domestically oriented producers were marginally better off, they too experienced challenging circumstances related to the decline in market share of the U.S. non-utility market segment and increasing competition from foreign suppliers. Much like cells, the module manufacturing landscape is quite fractured, with 30 active facilities in 18 states having some share of capacity and production. The most prominent of these are California (8), Ohio (3), and Oregon (home to SolarWorld's giant vertically integrated wafer-cell-module facility).

There is a high degree of overlap between the list of states containing cell plants and those containing module facilities, given the high concentration of thin film in the U.S. and the integrated nature of most thin film manufacturing, where cell definition and module assembly are performed in a continuous process. Oregon and Ohio led U.S. states in module production output, accounting for 89 MW, or 45% of the national total. Other notable states included Tennessee (37 MW) and California (34 MW).

Figure 2-35: U.S. Module Production by State, 2011

Module (MW)	Capacity						Production					
	Q1	Q2	Q3	Q4	2011 Annual (Year-end)	Y/Y	Q1	Q2	Q3	Q4	2011 Total	Y/Y
Arizona	29	30	11	13	50	-55%	21	18	8	7	54	-34%
California	67	78	88	81	325	25%	32	33	35	21	122	-8%
Colorado	31	35	40	45	180	75%	14	12	14	10	50	57%
Delaware	10	10	10	10	40	0%	6	5	5	3	18	-25%
Florida	20	22	23	25	100	33%	13	13	11	6	43	NA
Georgia	18	23	28	33	130	136%	12	14	17	10	51	243%
Illinois	4	4	5	5	20	67%	2	2	2	1	8	5%
Massachusetts	0	0	0	0	0	-100%	12	0	0	0	12	-92%
Minnesota	3	3	3	3	12	0%	2	2	2	2	7	NA
New Jersey	21	21	21	21	85	0%	11	9	8	4	32	3069%
New Mexico	21	21	21	21	85	0%	14	11	11	6	41	-52%
Michigan	0	0	0	0	0	NA	0	0	0	0	0	-100%
North Carolina	6	6	6	6	25	0%	2	2	2	2	8	650%
Ohio	74	80	86	92	367	34%	66	63	65	45	239	7%
Oregon	118	109	90	90	360	-29%	116	95	83	44	338	56%
Pennsylvania	13	13	13	13	50	0%	9	8	6	3	26	-15%
Puerto Rico	5	5	5	5	20	0%	4	3	3	0	9	-25%
Tennessee	53	53	53	53	210	0%	42	37	37	29	144	13%
Texas	10	11	13	14	55	57%	2	3	3	3	11	175%
Wisconsin	10	10	10	10	40	NA	1	3	2	2	8	NA
Total	512	534	525	539	2,154	2%	378	330	312	199	1,219	-4%

In terms of technology trends, the dominant majority of modules produced in the U.S. in 2011 were crystalline silicon (68%) and cadmium telluride (23%), with small amounts of CIGS (7%) and amorphous Si (1%). Overall U.S. thin film production share stood at 32%, but is expected to increase over the course of 2012 and 2013 as numerous thin film facilities come on-line and ramp up production. Overall, c-Si module production grew by 4% and CdTe grew by 12% year-over-year; however, CIGS production declined by 2%, a result of Solyndra's market exit. Similarly, the shifting of module assembly for Michigan-based United Solar's amorphous silicon laminates led to a-Si production registering a 92% annual reduction for 2011. Like Solyndra, United Solar's parent company (Energy Conversion Devices) has also filed for bankruptcy protection, raising questions about its still-active cell plant in Michigan though the company has said it will try to sell its solar division.

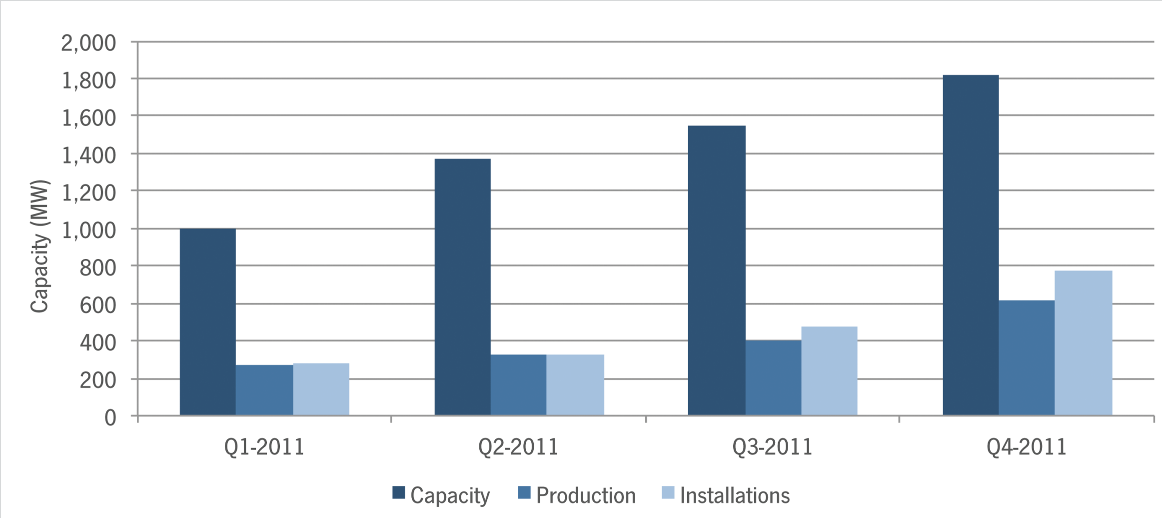
Figure 2-36: U.S. Module Production by Technology, 2011

Module Manufacturing by Technology	Capacity						Production					
	Q1	Q2	Q3	Q4	2011 Annual (Year-end)	Y/Y	Q1	Q2	Q3	Q4	2011 Total	Y/Y
Crystalline Si	334	339	314	328	1,312	-11%	270	225	205	134	834	4%
CdTe	96	106	116	126	502	46%	76	75	78	55	284	12%
CIGS	65	72	78	68	270	13%	29	28	26	8	91	-2%
Amorphous Si	18	18	18	18	70	0%	3	2	2	2	10	-92%
Total	512	534	525	539	2,154	2%	378	330	312	199	1,219	-4%

2.3.7 Inverters

As has been the consistent trend, the announced manufacturing capacity for inverters rose again on a quarter-over-quarter basis to a final year-end capacity total of 1.8 GW. While much of this capacity comes from expansion of domestic and European suppliers, the actual utilization of these facilities remained low at just 33%. Many of these facilities are neither fully staffed nor ramped up. Excess manufacturing capacity continues to be cheap, with facility depreciation representing less than 1% of the typical inverter's cost structure. The flexibility to respond to an unexpected upwards shift in inverter demand more than pays for carrying additional manufacturing capacity, which really only represents a combination of space, capacity for additional shifts of temporary laborers, and testing equipment. Regardless, the growth of actual production from 404 MWac in Q3 2011 to 615 MWac in Q4 2011 shows continued momentum in domestic manufacturing. Much of the Q3 and Q4 growth in inverter production came with the rush of commercial and utility projects in anticipation of the expiration of the Section 1603 Treasury Program.

Figure 2-37: Domestic Inverter Manufacturing Capacity, Production and Installations, 2011



	Q1 2011	Q2 2011	Q3 2011	Q4 2011
Capacity	994	1,371	1,546	1,822
Production	272	326	404	615
Intallations	276	330	472	777

Q3 and Q4 saw some slight uncertainty in domestic inverter production as major domestic manufacturer Advanced Energy and supplier Satcon announced staff layoffs and restructurings. In fact, Advanced Energy announced its intention to move much of its inverter sub-assembly process to its Chinese facility and hinted at consolidating its legacy Oregon PV Powered facility. As we have noted previously, domestic suppliers are overexposed to the North American market and turmoil in European markets has created a difficult environment in which to expand.

Nevertheless, as the utility PV sector continues to boom, near-term domestic manufacturing – or at least final assembly of inverters – will remain strong, as large-scale inverter solutions are too large to be economically shipped overseas at current cost points. In the medium- and long-term, a growing acceptance of low-cost Asian products remains a looming threat to domestic production of inverters, especially in the string inverter sector.

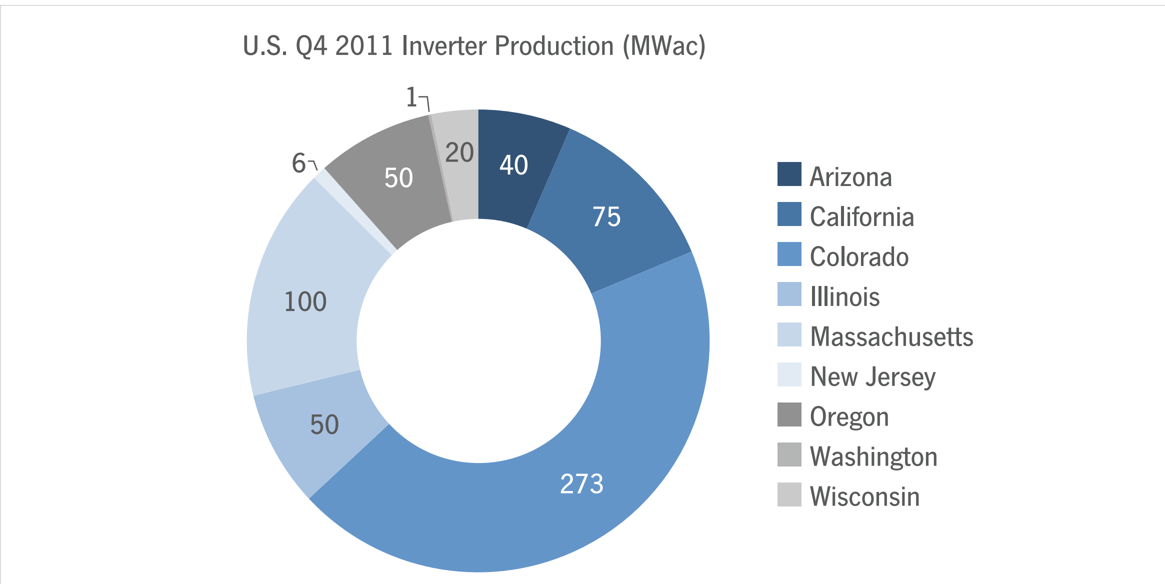
On a state level, manufacturing capacity and production remained relatively consistent, with new capacity growth as the result of Delta Energy/LTi Reenergy's announced plant in California being the only major expansion of note. In mid-2012, European manufacturers Fronius and RefuSol will establish manufacturing facilities in Indiana and South Carolina, respectively.

Figure 2-38: Domestic Inverter Manufacturing Capacity and Production by State, 2011

State	Q1-2011		Q2-2011		Q3-2011		Q4 2011	
	Capacity	Production	Capacity	Production	Capacity	Production	Capacity	Production
AZ	25	15	50	15	50	30	50	40
CA	163	25	190	43	190	45	440	75
CO	375	125	650	140	650	180	650	273
IL	38	15	38	10	213	20	213	50
MA	238	35	238	50	238	50	238	100
NJ	9	6	8	6	8	6	9	6
OR	125	50	125	60	125	62	125	50
TX	20	0	20	0	20	0	20	0
WA	3	1	3	1	3	1	3	1
WI	0	0	50	0	50	10	75	20
Total	994	272	1371	326	1546	404	1822	615

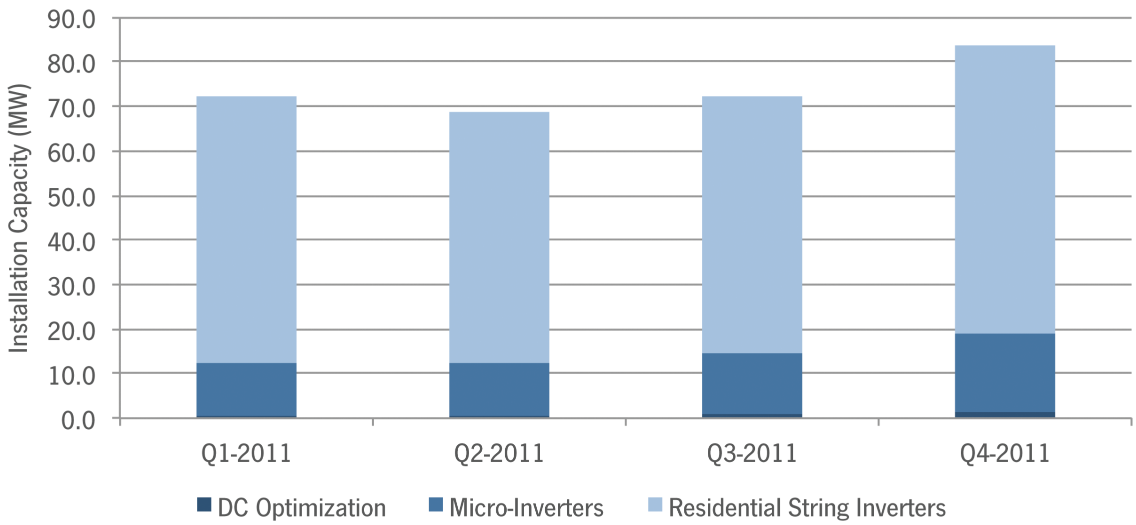
Colorado continues to be the U.S.'s primary manufacturing site of PV inverters, representing nearly 44% of domestic production. The state's inverter production is powered by Advanced Energy's 2 GW+ factory and SMA's facility, which could eventually be expanded to 1 GW.

Figure 2-39: Domestic Inverter Manufacturing Production by State, Q4 2011



One of the unique opportunities in the U.S. market – in fact, a large threat to European entrants that are heavily invested in residential string inverters – is the growing acceptance and adoption of distributed optimization, which includes low-voltage inverters, microinverters, and DC power optimizers. As a whole, the distributed optimization space rose to 18.9 MW, accounting for 21.6% of residential installations. While microinverters represent 93% of distributed optimization right now, acceptance of DC optimizers is continuing to grow.

Figure 2-40: Residential Inverter Installations by Type, 2011



	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Residential String Inverters	59.7	56.1	57.6	64.9
Micro-Inverters	11.7	12.1	13.6	17.4
DC Optimization	0.6	0.5	1.0	1.5

Venture capital and other investment continues to pour into the distributed optimization space, with SolarEdge closing an additional $37 million round and Tigo recently closing on an additional $18 million. Venture capital into the space now exceeds $500 million, in addition to an unknown amount of corporate funding. GTM Research's estimate for total market value of distributed optimization as a whole amounts to only $1.2 billion in 2015, meaning that many of these potential suppliers will likely see painful exits. Furthermore, financing for new suppliers will be difficult to come by, as leading manufacturers already have sizeable war chests and supply agreements to work off.

Figure 2-41: Major Investments in Distributed Optimization Companies

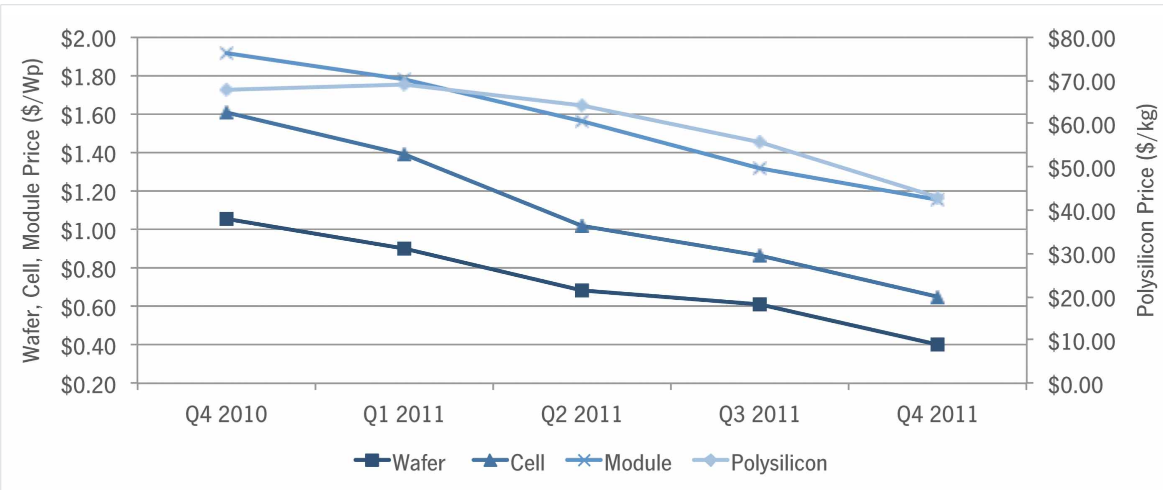
Company	Technology	Fundraising	Rounds	Grants	OEM	Notes
Ampt	Module-level DC	---	---	---	[Tier 1 Contract Manufacturer]	Targets only junction box providers, currently solutions with Amphenol, Huber+Suhner, Multi-Contact and Shoals
Azuray	Module-level DC	$13.0	1	---	[OR-based Contract Manufacturer]	Two-part round between 2008 and June 2010, partnership with Renhe, targeting OEM supplier to junction box suppliers
Delphi	Microinverter	---	---	$1.9	[Self]	Auto parts manufacturer entering the solar market through distributed optimization, SunShot Initiative Awardee
Direct Grid	Microinverter	$4.7	1	---	SRI	Private Equity Investment, targeting only utility-scale systems
eIQ	Parallel DC/DC	$14.0	2	---		Parallel DC solution, has 1 MW+ systems planned and reportedly in construction
Enecsys	Microinverter	$55.3	2	---		UK-based microinverter manufacturer, claims higher reliability due to removal of electrolytic capacitors
Enphase Energy	Microinverter	$107.0	4	---	Flextronics	filed S-1 on 6/15/2011, planned $100M IPO; looking for $51M round, market share leader in microinverters and starting to target European end markets
General Electric	AC Module	---	---	$2.1		SunShot Initiative Awardee, has also invested in to SolarEdge through its investment arm
GreenRay	AC Module	$2.0	1	$3.3		Investors include Quercus Trust, 21Ventures
Involar	Microinverter	$10.0	1	---		Chinese microinverter company
Nextronex	Distributed MPPT	$1.5	pre-seed	$0.2		Ohio-based distributed inverter company; focuses on small power inverters installed within footprint of the array
Petra Solar	Smart Grid-enabled Microinverter	$54.0	2	$8.9		Targeting "smart grid" applications with pole-mounted solar and voltage regulation; prospective end markets include NJ, CA, FL and the Middle East
SolarBridge	OEM Microinverter	$46.0	3	$3.8	Celestica	OEM microinverter company selling directly to module suppliers, Grant includes $2.3M SunShot Initiative award, claims higher reliability due to removing electrolytic capacitors
SolarEdge	Module-level DC	$97.0	4	---	Flextronics	Israel-based DC/DC optimizer solution, builds compatible inverters that are optional, also has $8M credit facility from Silicon Valley Bank, supplies some SolarCity installations as well as other 3rd party residential model installers
TenKSolar	Embedded DC	$7.1	1	---		Full system solution with reflective racking system, purchases and cuts PV cells in half and has contract module assembly as well as power electronics in the junction box, $1.5M is from convertible debt
Tigo Energy	Module-level DC	$54.0	4	$3.0	Inventec	Also $10M credit line from Climate Partner Solutions
Transphorm		$63.0	4	$2.9		Targeting GaN-based devices

2.4 COMPONENT PRICING

2.4.1 Polysilicon, Wafers, Cells and Modules

The clearest indication of just how tumultuous 2011 was for manufacturers comes from Figure 2-42 below, which illustrates quarterly prices for polysilicon, wafers, cells, and modules through 2011. Blended average Q4 2011 prices for polysilicon ranged from $43/kg, while those for wafers, cells, and modules were $0.40/W, $0.65/W, and $1.15/W, respectively. This is a far cry from 2010—as prices for polysilicon and modules experienced drops of 37% and 40%, respectively, from Q4 2010 to Q4 2011. On average, prices for crystalline silicon modules stood at $0.95/W to $1.25/W, compared to a year ago when they were closer to the $2.00/W mark. Price drops for wafers and cells were even steeper, at 62% and 60%, respectively. Looking ahead, prices are expected to continue to drop, as subsidy turbulence in much of Europe could lead to further disruptions in the balance between supply and demand. However, these price drops are not expected to be nearly near as steep as those witnessed in 2011, as prices are much closer to cash costs than they were a year ago.

Figure 2-42: U.S. Polysilicon, Wafer, Cell and Module (Factory Gate) Prices, Q4 2010 – Q4 2011

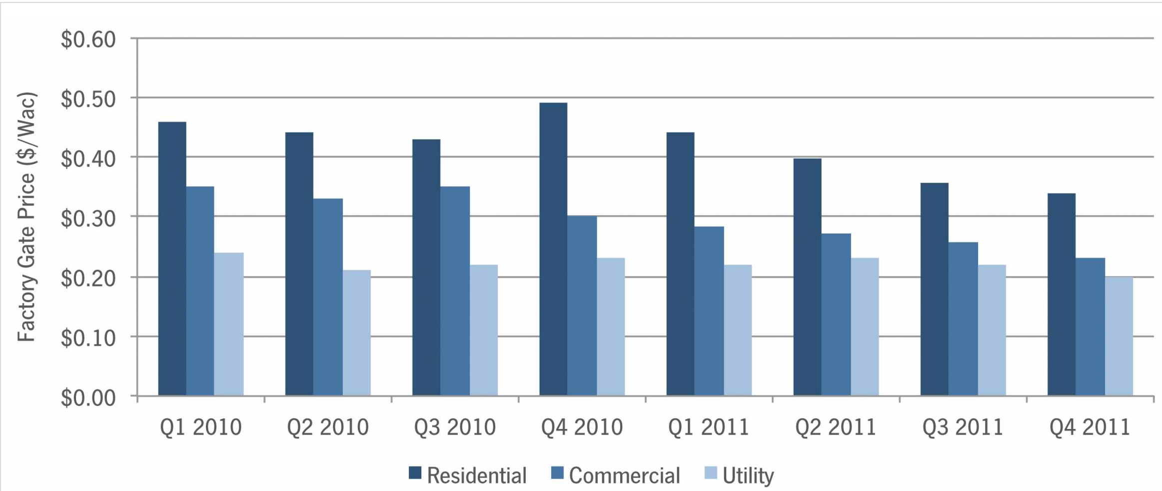


	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011
Polysilicon	$67.93	$69.00	$64.32	$55.54	$43.00
Wafer	$1.06	$0.90	$0.69	$0.61	$0.40
Cell	$1.61	$1.39	$1.02	$0.87	$0.65
Module	$1.92	$1.78	$1.56	$1.32	$1.15

2.4.2 Inverters

Factory-gate pricing for inverters continues to fall, with average blended pricing dropping from $0.25/Wac to $0.22/Wac from Q3 to Q4. The apparent drop of average pricing only comes as a result of product mix as the utility segment drove 57% of the market. Additionally, residential inverter pricing continues to plummet as soft European demand is driving more supply of residential inverters into the U.S. market. Furthermore, installers and local inspectors are becoming more comfortable with transformerless string inverter options, meaning a large savings in cost in conjunction with the uptick in performance efficiency. Utility inverter prices dropped to the $0.20/Wac mark as utility inverter providers saw an uptick in larger utility systems and an increasingly crowded supplier landscape.

Figure 2-43: Factory Gate Inverter Pricing by Market Segment and Quarter

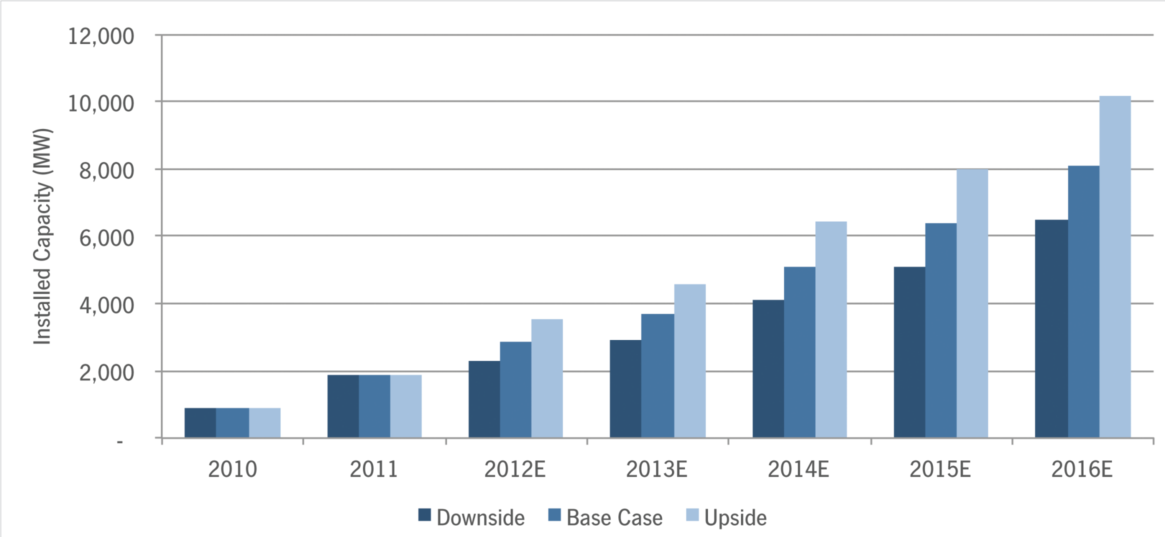


	Q1 2010	Q2 2010	Q3 2010	Q4 2010	Q1 2011	Q2 2011	Q3 2011	Q4 2011
Residential	$0.46	$0.44	$0.43	$0.49	$0.44	$0.40	$0.36	$0.34
Commercial	$0.35	$0.33	$0.35	$0.30	$0.29	$0.27	$0.26	$0.23
Utility	$0.24	$0.21	$0.22	$0.23	$0.22	$0.23	$0.22	$0.20

2.5 INSTALLATION FORECAST

We forecast U.S. PV demand according to three scenarios. The base case represents the market state we believe to be most likely over the next five years. In this scenario, PV demand is driven primarily by regulatory requirements and incentives over the near term, transitioning in the 2014-2015 timeframe to a more sustainable long-term market with less need for regulatory support. The downside case anticipates that regulatory requirements largely are not met, that PV component/system prices do not decline as expected, and that a number of planned large-scale projects never come to fruition. This scenario also incorporates the possibility of deteriorating macroeconomic conditions in the U.S. and a decline in the availability of project financing. The upside case assumes that most large-scale projects are executed on time and that grid parity is reached earlier than anticipated. As a result, demand exceeds RPS targets in a number of states beginning in 2012 and continues to grow rapidly thereafter.

Figure 2-44: U.S. PV Installation Forecast Scenarios, 2010-2016

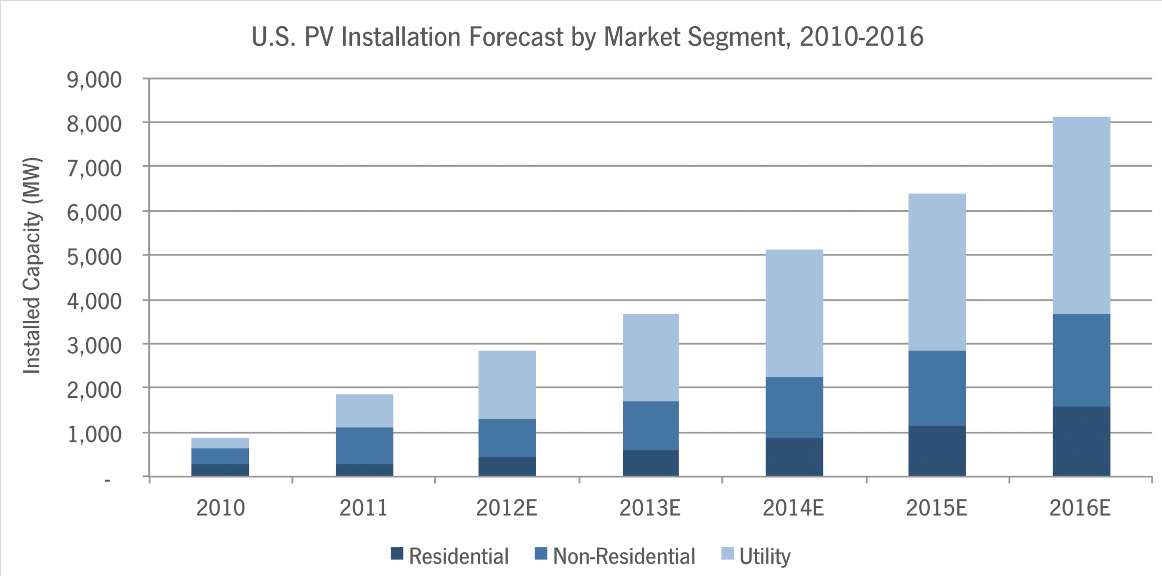


	2010	2011	2012E	2013E	2014E	2015E	2016E
Downside	887	1,855	2,267	2,930	4,085	5,094	6,476
Base Case	887	1,855	2,840	3,668	5,108	6,371	8,118
Upside	887	1,855	3,535	4,581	6,412	7,995	10,163

This quarter, we have increased our base case 2012 forecast from 2.5 GW to 2.8 GW as a result of the large quantity of safe-harbored product. Most of these projects will be completed in 2012 and will prop up installation totals throughout the year. In addition, we are more bullish on near-term growth prospects in the California commercial market and in the prospects for many of the utility-scale projects in the pipeline to attain financing. In truth, 2012 market size will still be heavily influenced by factors that have not yet been decided, such as the final outcome of the trade petition and market dynamics in Germany.

As can be seen, we expect growth to occur in every market segment, but the utility market will see the most rapid ascension. The commercial market will be somewhat dampened by weak demand in New Jersey (although Q1 installations in New Jersey could remain quite high) but should be supported in California, Massachusetts, Maryland, North Carolina and elsewhere. We have strong expectations for the residential market to show overall growth in 2012 (as opposed to its steadiness in 2011), as residential leasing and PPA programs continue to gain steam and public recognition.

Figure 2-45: Base Case Installation Forecast by Market Segment, 2010-2016



	2010	2011	2012E	2013E	2014E	2015E	2016E
Residential	268	297	425	588	856	1,150	1,579
Non-Residential	352	800	889	1,126	1,380	1,682	2,105
Utility	267	758	1,526	1,954	2,872	3,539	4,434

Figure 2-46: Top Market Predictions, 2012

Top States by Annual Installed PV - 2012E				
Rank	Residential	Non-Residential	Utility	Overall
1	California	California	California	California
2	Arizona	New Jersey	Arizona	Arizona
3	New Jersey	Arizona	New Jersey	New Jersey
4	Hawaii	Massachusetts	Nevada	Colorado
5	Colorado	Colorado	Colorado	Nevada
6	New York	Hawaii	New Mexico	Massachusetts
7	Texas	North Carolina	Florida	New York
8	Oregon	New York	New York	Hawaii
9	Pennsylvania	Maryland	Maryland	New Mexico
10	Maryland	Nevada	Massachusetts	Pennsylvania

Figure 2-47: Base Case Annual PV Installations Forecast by State, 2010-2016

Annual PV Installations by State (MWdc)	2010	2011	2012E	2013E	2014E	2015E	2016E
Arizona	63	273	322	349	410	473	546
California	259	542	1,351	1,772	2,600	3,058	3,603
Colorado	54	91	82	82	131	157	189
Connecticut	5	4	13	20	40	55	78
Delaware	2	18	13	18	30	43	64
Florida	35	14	40	56	82	112	169
Hawaii	16	40	64	82	102	124	160
Illinois	11	1	21	53	87	147	260
Maryland	8	22	50	53	63	68	74
Massachusetts	22	28	69	88	113	142	181
Nevada	61	44	80	118	148	200	271
New Jersey	132	313	265	303	350	409	481
New Mexico	43	116	55	60	74	111	167
New York	23	60	66	89	128	179	251
North Carolina	31	55	47	56	65	86	117
Ohio	19	11	32	41	54	81	123
Oregon	11	18	25	39	51	70	96
Pennsylvania	47	88	51	60	87	115	156
Tennessee	3	18	21	25	30	38	48
Texas	23	47	44	76	120	180	271
Vermont	1	5	9	16	28	39	58
Washington	3	5	7	16	26	37	53
Wisconsin	3	5	12	25	33	43	56
Other	16	38	101	171	256	404	645
Total	**887**	**1,855**	**2,840**	**3,668**	**5,108**	**6,371**	**8,118**

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3. CONCENTRATING SOLAR POWER (CSP)

In the U.S., concentrating solar, and in particular, concentrating solar thermal power (CSP) power plants, experienced a burst of project activity in California in the 1980s, and then went quiet for two decades. But in the last few years, there has been a resurgence of activity in this space. The great potential for CSP in the U.S. is reflected in the 9+ GWac project pipeline of CSP projects that are under development across the country.

In the past few years, there have also been exciting developments in the realm of concentrating photovoltaics (CPV). Rather than concentrating sunlight to heat water or another fluid and subsequently spin a turbine, these systems focus the sun's energy on a high-efficiency photovoltaic cell.

3.1 INSTALLATIONS

As shown in Figure 3-1, the concentrating solar industry in the U.S. was effectively dormant from 1992 to 2006. In 2007, there was one project of scale: a 64 MW trough plant in Nevada. The last three years have seen the construction of several small demonstration plants for various technologies: a 5 MW CLFR plant in California in 2008, a 5 MW tower plant in California in 2009, and a 1 MW micro-CSP plant in Hawaii in 2009. The 75 MW FP&L Martin Solar plant in Indiantown, Florida came on-line in the fourth quarter of 2010.

During 2011, ten CPV projects were completed for an annual total of 11.68 MWac. The majority of this capacity came on-line in Q2 2011, including Amonix's 5 MW Hatch project in New Mexico. Only two projects were interconnected in Q4 2011: 1 MWac in Arizona and 40 kWac in Texas. There were no CSP projects completed in 2011. While total capacity installed in 2011 was lower than previously expected, there was additional progress on several of the large concentrating solar projects under development.

Figure 3-1: Concentrating Solar: Annual Installed Capacity (1982-2011) and Base Forecast (2012-2016)

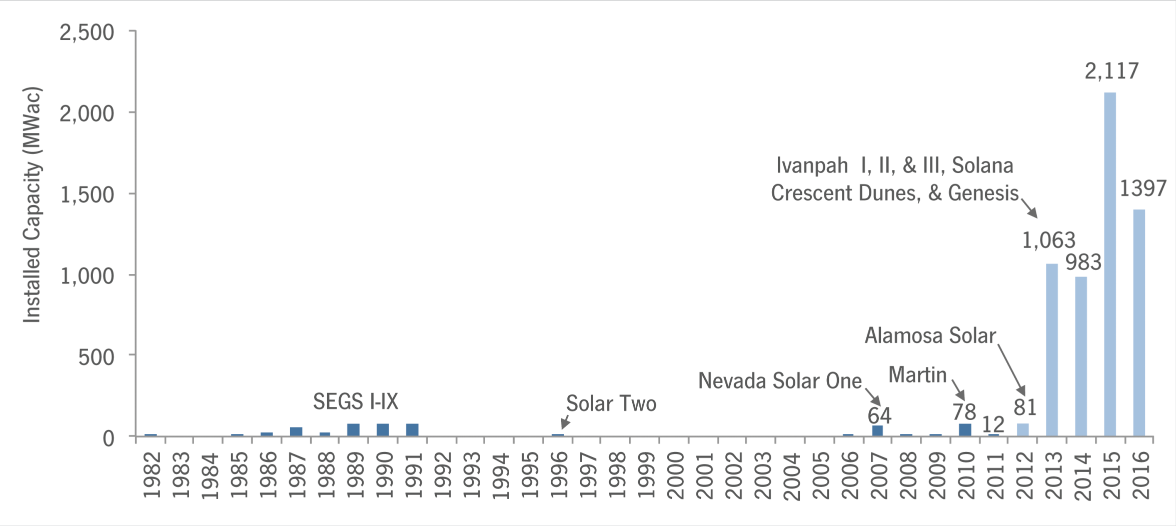


Figure 3-2: Select Concentrating Solar Project Development Highlights

Project	State	Tech.	Capacity (MW-ac)	Const.	Expected Completion	Project Status Update
CSP						
Blythe	CA	CSP/ PV	1000	Dec-10	?	Announced switch to PV from trough in August
Ridgecrest	CA	CSP/ PV	250		?	Announced switch to PV from trough in October
Palen	CA	CSP/ PV	500		?	Announced switch to PV from trough in October
Amargosa Farm Road	CA	CSP/ PV	500		?	Announced switch to PV from trough in October
Ivanpah	CA	CSP	370	Oct-10	2013	Closed DOE loan guarantee for $1.6 billion in April 2011
Solana	AZ	CSP	250	Dec-10	2013	December 2011: Banco Santander to buy 45% equity stake.
Mojave Solar Project	CA	CSP	250	Dec-10	2014	Approved by California PUC November 2011
Rice Solar Energy	CA	CSP	150	Sep-11	2014	Approved by California CEC December 2010
Crescent Dunes Solar Energy Project	NV	CSP	110	Jun-11	2013	DOE Loan Guarantee for $737 million closed in Sept 2011
Genesis	CA	CSP	250		2013/2014	Loan Guarantee closed September 2011
U. of AZ Tech Park	AZ	CSP	5		2013	
CPV						
Alamosa Solar	CO	CPV	30	May-11	2012	DOE Loan Guarantee for $90.6 million closed in Sept 2011
Hatch	NM	CPV	5		Jun-11	In Operation
Questa	NM	CPV	1		Apr-11	In Operation
Nichols Farm	CA	CPV	1		Apr-11	In Operation
U. of AZ Tech Park	AZ	CPV	2		Apr-11	The nation's largest CPV installation was completed at the University of Arizona's Solar Zone (Until Hatch is completed)
Imperial Solar Energy Center West	CA	CPV	150		2015	Long term PPA signed with California utility
Littlerock	CA	CPV	5		2012	Approved by California PUC December 2011
Garnet	CA	CPV	4.8		2013	Approved by California PUC December 2011
Blythe	CA	CPV	4.7		2013	Approved by California PUC December 2011
Lucerne Valley	CA	CPV	14		2014	Approved by California PUC December 2011
Rugged Solar	CA	CPV	80		2014	Approved by California PUC November 2011
Tierra Del Sol	CA	CPV	45		2014	Approved by California PUC November 2011
LanEast Solar	CA	CPV	22		2014	Approved by California PUC November 2011
LanWest Solar	CA	CPV	6.5		2014	Approved by California PUC November 2011
Desert Green Solar	CA	CPV	6.5		2014	Approved by California PUC November 2011

Though only 11.7 MWac came on-line in 2011, some significant developments occurred:

- The 484 MW Blythe Phase I CSP plant was offered a conditional $2.1 billion loan guarantee; this loan guarantee has since been relinquished.
- Solar Trust of America sold its 2.25 GW CSP pipeline to Solarhybrid, which plans to use PV for the four projects.
- Just after the close of Q1, the DOE finalized a $1.6 billion loan guarantee for the 370 MW Ivanpah CSP plant.
- Construction on the 30 MW Alamosa CPV plant began in the first half of 2011.
- Several concentrating solar projects closed DOE Loan Guarantees in Q3, including:
    - 250 MW Mojave Solar trough CSP project
    - 110 MW Crescent Dunes tower CSP project
    - 250 MW Genesis trough CSP project
    - 30 MW Alamosa CPV project
- Over 400 MWac of concentrating solar power purchase agreements were approved by the California Public Utilities Commission in Q4, including:
    - 250 MW Mojave Solar trough CSP project
    - 5 MW Littlerock CPV project
    - 4.8 MW Garnet CPV project
    - 4.7 MW Blythe CPV project
    - 14 MW Lucerne Valley CPV project
    - 80 MW Rugged Solar CPV project
    - 45 MW Tierra Del Sol CPV project
    - 22 MW LanEast Solar CPV project
    - 6.5 MW LanWest Solar CPV project
    - 6.5 MW Desert Green Solar CPV project

Figure 3-3: Concentrating Solar Capacity Installed by State: 2010, Q4 2011, 2011 & Cumulative

Capacity Installed by State (MWac)	2010 Total	Q4 2011	2011 Total	Cumulative
	MW-ac	MW-ac	MW-ac	MW-ac
Arizona	1.6	1.0	3.2	4.8
California	1.5	-	1.7	364.5
Colorado	1.6	-	0.8	2.4
Florida	75.0	-	-	75.0
Hawaii	0.0	-	-	0.8
Nevada	-	-	-	64.0
New Mexico	-	-	6.0	6.0
Other	0.1	0.0	0.0	0.1
Total	79.8	1.0	11.7	515.8

Figure 3-4: Number of Concentrating Solar Installations by State: 2010, Q4 2011, 2011 & Cumulative

Number of Installations	2010 Total	Q4 2011	2011 Total	Cumulative Total
Arizona	2	1	3	12
California	7	-	3	30
Colorado	4	-	1	5
Florida	1	-	-	1
Hawaii	1	-	-	3
Nevada	-	-	-	1
New Mexico	-	-	2	2
Other	3	1	1	8
Total	18	2	10	62

3.2 MANUFACTURING PRODUCTION

Receivers: There is one CSP receiver manufacturing facility in Albuquerque, NM with an annual capacity of 400 MW of receiver production. The other major receiver tube manufacturing facilities are in Germany and Israel.

Turbines: There were no turbines manufactured in the U.S. for solar projects. There are three U.S. manufacturers that have produced turbines for solar projects in the past (or will do so in the future). All three are located in Reno, Nevada.

Reflectors: The two primary CSP mirror manufacturers are both located in Europe, although Rioglass opened a facility in 2011 in Surprise, Arizona, to service the Abengoa Solana plant and other U.S. trough projects. A trough mirror supplier, Guardian Glass, is located in the U.S., as well.

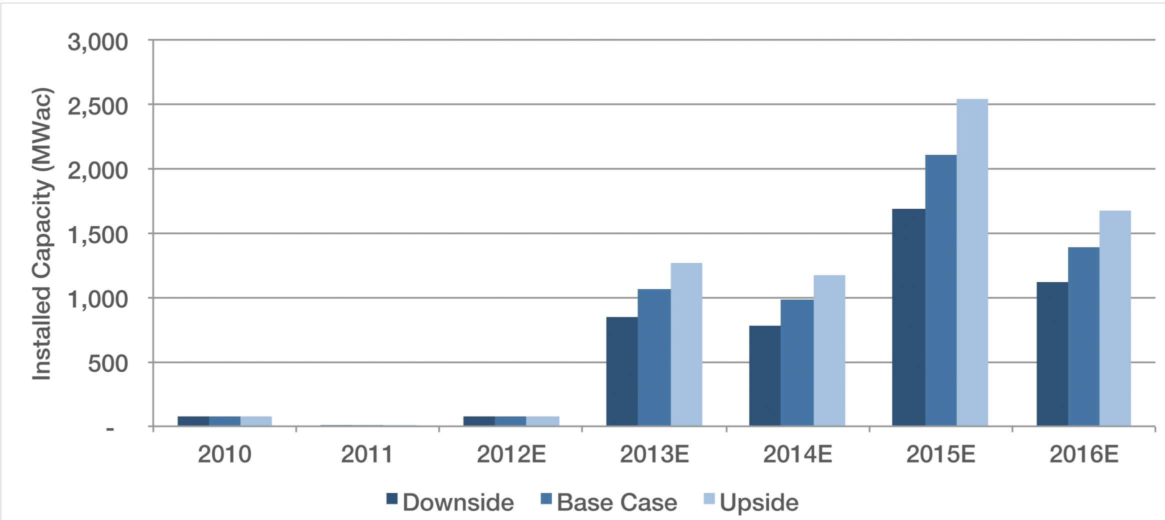
CPV modules/troughs: The main players in the U.S. CPV market are located in California. A French company is currently building a 200 MW manufacturing facility near San Diego at a cost of $160 million to support the development of CPV installations in the region. The facility will employ 450 workers, and production is scheduled to start in Q1 2013. A U.S. CPV system manufacturer has built a 240,000-square-foot facility in Nevada with 150 MW of annual production capacity though recently laid off portions of its workforce. Other small high-, mid-, and low-concentration manufacturers are located throughout the country, though most of these companies have little to no installed capacity.

3.3 DEMAND PROJECTIONS

GTM Research maintains a database tracking the progress of all planned CSP projects in the U.S. The pipeline currently contains over 5,000 MW of CSP projects with signed PPAs, as well as another 3,800 MW of projects under development that have not yet signed PPAs with utilities. These projects have expected completion dates between 2011 and 2017. The total capacity of CPV projects currently in development in the U.S. is over 400 MW. Our base case forecast has 2012 slightly up from 2011. Most of the capacity expansion will come from the 30 MW CPV Alamosa Solar project. In 2013, a massive wave of plant commissioning is expected, including: Abengoa's Solana, BrightSource's Ivanpah 1, 2 & 3, and SolarReserve's Crescent Dunes. In later years, greater uncertainty regarding financing, permitting and approvals surrounds the pipeline.

It should be noted that we have significantly reduced our concentrating solar forecast through 2016 in light of the announcement that the Blythe project would be switched from trough to PV for economic reasons. The dramatic improvements in PV panel costs have put trough at a significant cost disadvantage and puts many of the planned trough projects at risk, as they may be difficult to finance or fail to receive regulatory approval.

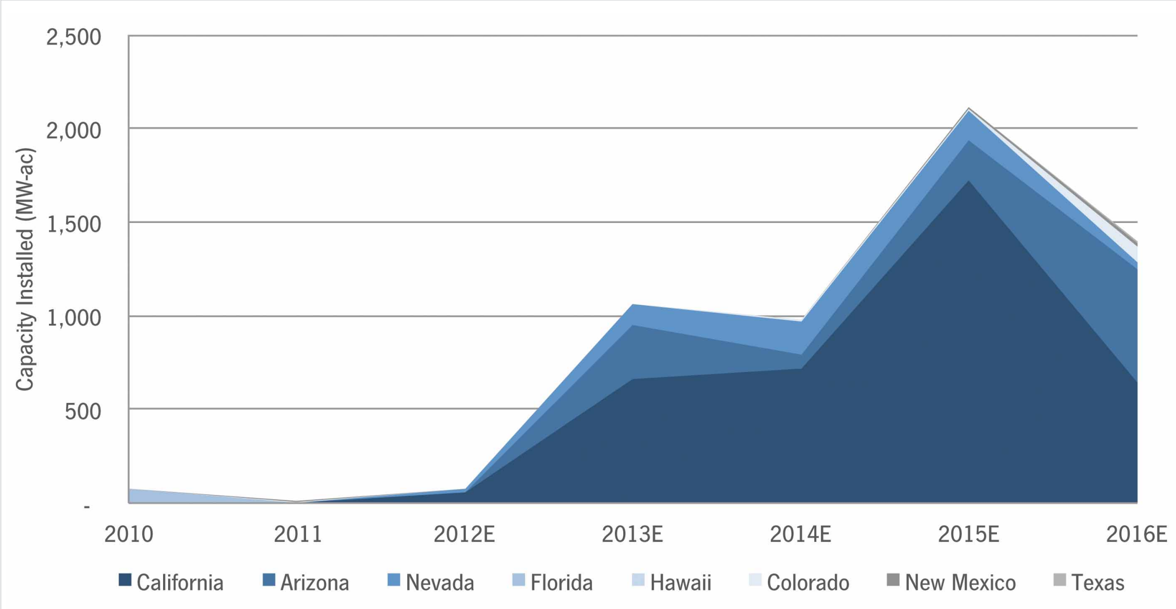
Figure 3-5: U.S. Concentrating Solar Demand Forecast, 2010-2016



	2010	2011	2012E	2013E	2014E	2015E	2016E
Downside	78	12	81	851	786	1,694	1,118
Base Case	78	12	81	1,063	983	2,117	1,397
Upside	78	12	81	1,276	1,180	2,540	1,676

The majority of concentrating solar projects scheduled through 2016 are sited in California, with 80% of the megawatts of capacity expected in 2015 slated to be located in the Golden State. Nevada and Arizona come in a distant second and third, respectively, in terms of concentrating solar projects under development.

Figure 3-6: Concentrating Solar Base Case Demand Forecast by State, 2010-2016



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APPENDIX A: METRICS & CONVERSIONS

PHOTOVOLTAICS

We report PV capacity data in watts of direct current (DC) under standard test conditions (STC). This is the metric most commonly used by suppliers, developers and program administrators. However, some program administrators report data in alternating current (AC) watts, and some utility-scale systems are measured in AC watts. In these cases, we assume an 87% DC-to-AC derate factor based on data from existing systems, conversations with installers, and averages from California Solar Initiative data.

CONCENTRATING SOLAR POWER

We report CSP capacity data in watts of alternating current (AC), which is the metric most commonly used in the CSP industry. As a result, capacity comparisons for CSP and PV should not be considered on an apples-to-apples basis.

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APPENDIX B: METHODOLOGY AND DATA SOURCES

N.B.: Please note that data from previous quarters is sometimes updated as a result of improved or changed historical data. GTM Research apologizes for any inconvenience caused.

Data for this report comes from a variety of sources and differs by data item, technology, and granularity. Below we outline our methodology and sources.

HISTORICAL INSTALLATIONS (NUMBER, CAPACITY, AND OWNERSHIP STRUCTURE):

PV: Quarterly state-by-state data on PV installations was collected primarily from incentive program administrators. These administrators included state agencies, utility companies, and third-party contractors. For larger projects not included in these programs, GTM Research maintains a database that tracks the status of all operating and planned utility PV projects in the United States. In some cases, program administrators report incentive application and award dates rather than installed dates. In these instances, we use the information that most closely approaches the system's likely installed date. For annual and cumulative installations prior to 2010, 2010 data for "Other States" and smaller utilities, GTM Research also utilized data collected by Larry Sherwood at the Interstate Renewable Energy Council (IREC).

CSP: GTM Research maintains a database that tracks the status of all operating and planned CSP projects in the United States.

SOURCES BY TECHNOLOGY

PV	State incentive program administrators
	Utility companies
	State public utilities commissions and PUC filings
	GTM Research Utility PV Project Database
	Larry Sherwood/IREC
CSP	GTM Research CSP Project Database
	Announcement Tracking
	State public utilities commissions
	Conversations with Developers/Manufacturers

AVERAGE SYSTEM PRICE:

PV: Average system pricing by state was estimated from two sources. First, many incentive program administrators track system pricing in addition to capacity data, and this information was collected where possible. GTM Research also conducted a PV installer/ integrator survey to determine average system pricing in states where incentive program data was unavailable. These results were checked against known prices for systems within the U.S. Treasury 1603 Grant database and verified through conversations with developers. Average system pricing reflects actual price for installed systems in the respective quarter, not forward pricing for systems to be installed in subsequent quarters.

CSP: Given the relatively miniscule number of CSP projects installed in any given quarter, we estimate pricing for individual projects based on discussions with manufacturers and developers, as well as by using GTM Research internal modeling processes. In some cases, pricing data is available from the Treasury Grant program award database. In other cases, the companies publicly report the estimated cost of the project.

SOURCES BY TECHNOLOGY

PV	State incentive program administrators Utility companies PV installer/integrator survey Treasury Grant Program award database
CSPV	Conversations with developers Treasury Grant Program award database Company announcements

MANUFACTURING CAPACITY

GTM Research maintains databases of manufacturing facilities for PV and CSP components.

SOURCES BY TECHNOLOGY

PV	GTM Research Manufacturing Facility Databases Announcement monitoring Conversations with manufacturers
CSP	Announcement monitoring Conversations with manufacturers

MANUFACTURING PRODUCTION & COMPONENT PRICING:

For all technologies, we report component pricing as factory-gate prices. In light of the markups commonly imposed by distributors and integrators, these prices may not reflect the price ultimately offered to end customers. However, they are the prices considered to be most important to suppliers and are the most easily comparable across markets, suppliers, and technologies.

It should also be noted that the component prices reported here do not necessarily line up directly with installed prices. We report component prices based on component sales in a given quarter, whereas system prices are reported based on systems installed in that quarter. Given a project's construction time, which can be upwards of three months for larger systems, installed prices may lag behind component prices.

GTM Research's manufacturing database tracks facility production and capacities for the PV module supply chain and inverters through company announcements, public filings, direct surveys, and interviews with manufacturers. Component pricing is acquired by tracking publicly available data, licensed news sources, interviews, and surveys with both component manufacturers and wholesale component purchasers.

CSP: Production is determined by conversations with manufacturers. CSP components are generally produced for delivery to individual projects.

SOURCES BY TECHNOLOGY

PV	Public company filings Channel checks with suppliers
CSP	Conversations with manufacturers

DEMAND FORECASTS

PV: Demand forecasts for PV were conducted using a dual bottom-up, top-down method. First, forecasts were created for each individual state based on incentive availability, regulatory requirements for solar/distributed generation, and the current pipeline of planned utility projects and programs. This was checked against analyses of national factors including availability of project finance, federal incentives and forecasted component pricing. The base case forecast contains the most likely scenario given current conditions and assumes PV installations remain largely a function of incentives and requirements over the near term, transitioning to a standalone competitive power source on a state-by-state basis beginning in 2014-2015. The upside and downside scenarios assume that positive or negative developments occur in the market relative to the base case forecast, such as price increases and incentive removal.

CSP: The CSP forecast was derived from the GTM Research U.S. CSP Project Tracker database. Each of the 46 projects under development is given an expected online date and a percent-based probability of reaching completion. The percent-based success rate is based on three factors: the expected online date, whether the project has a signed PPA, and the type of technology (trough, tower, or dish). The percent-base success rate is meant to account for all possible contingencies that could prevent a project from reaching completion, including: inability to obtain a PPA, inability to receive necessary permits, inability to raise project finance, etc. An additional calculation is made to reflect additional expected capacity that will come online from projects that have not yet been announced.

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