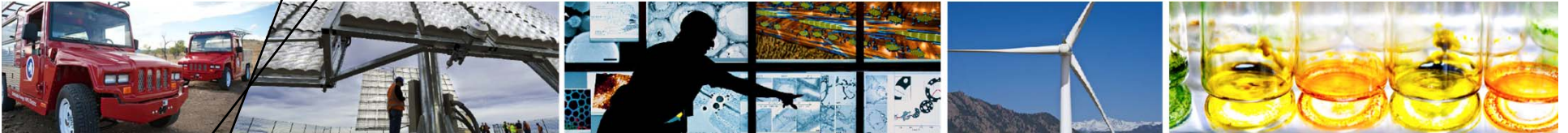


Solar Industry Update



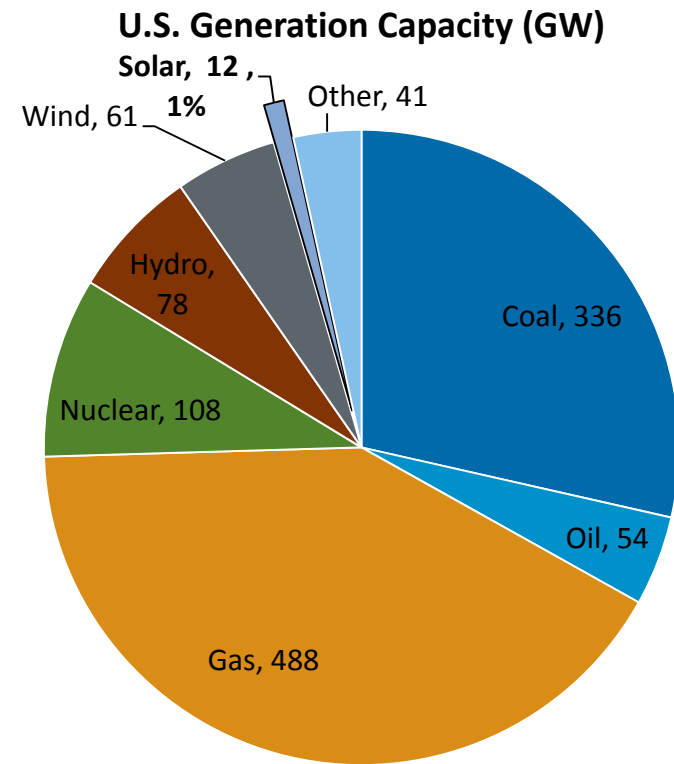
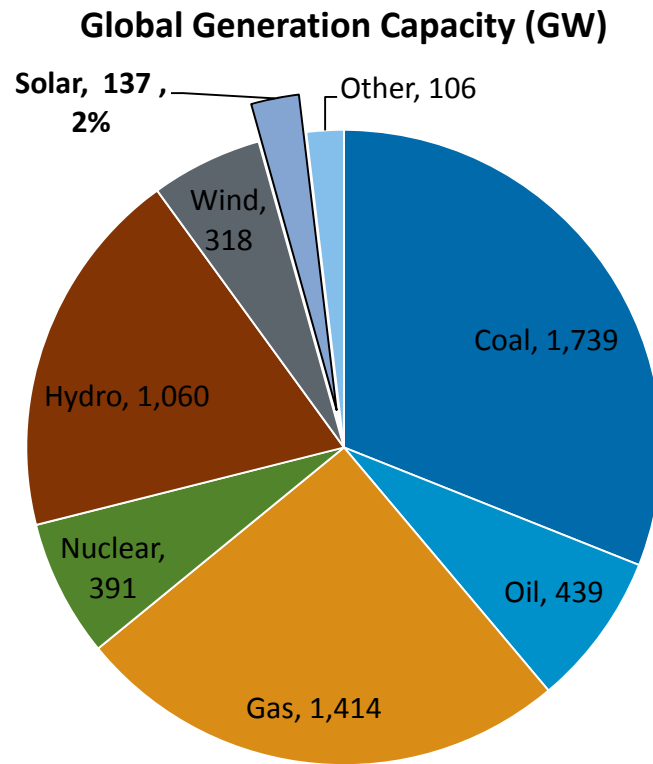
David Feldman
National Renewable Energy Laboratory

Coal Finance 2014

The current economics of solar, wind and energy efficiency alternatives to coal (domestic U.S. and international perspectives)

March 18, 2014

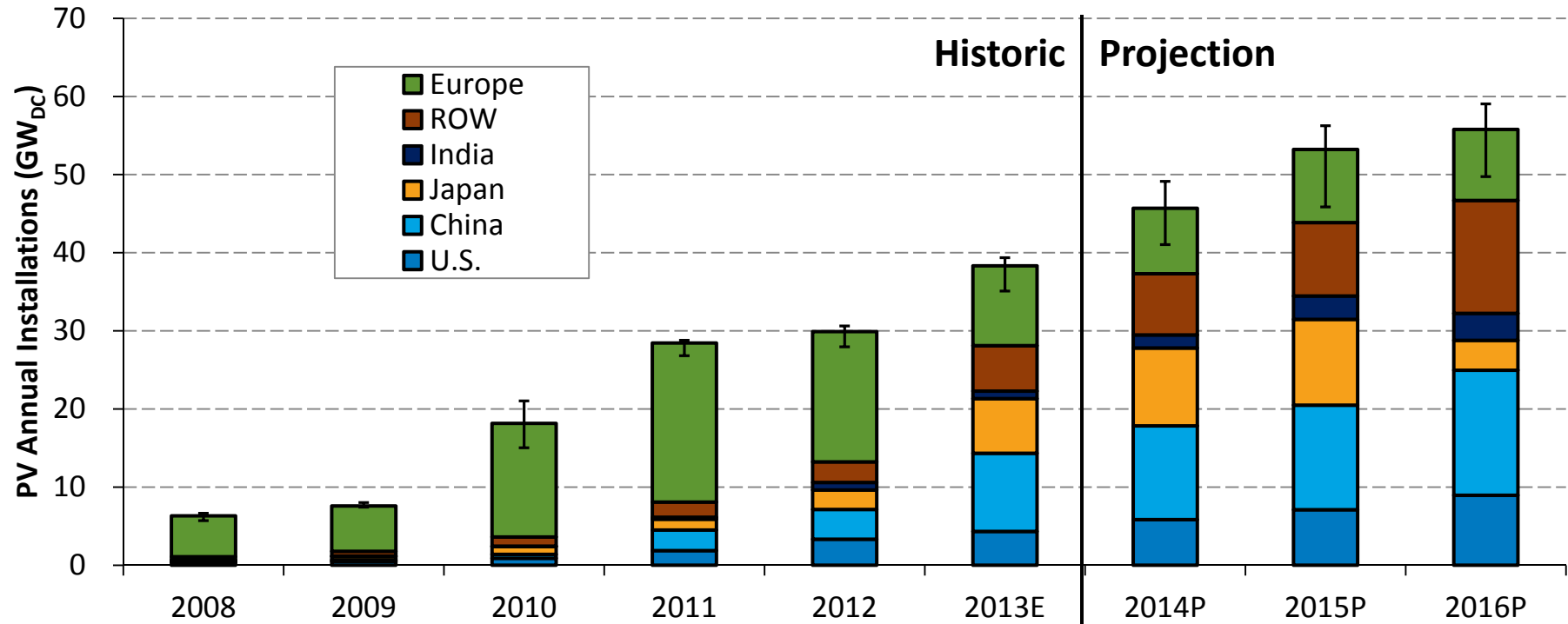
Current Electricity Capacity, by Source



- Solar is still a relatively small portion of the total energy mix
 - 2% of global capacity, or 137 GW
 - In U.S., only 1%, or 12 GW

Sources: Global installed capacity (except wind and solar), World Energy Outlook 2013, IEA (data as of 2011). U.S. installed capacity (except wind and solar), EIA, Annual Electric Generation Report (data as of 2012). Solar, GTM/SEIA, U.S. Solar Market Insight Q4 2013 (data as of 2013). Wind, GWEC, Global Wind Statistics 2013 (data as of 2013).

Global PV Demand

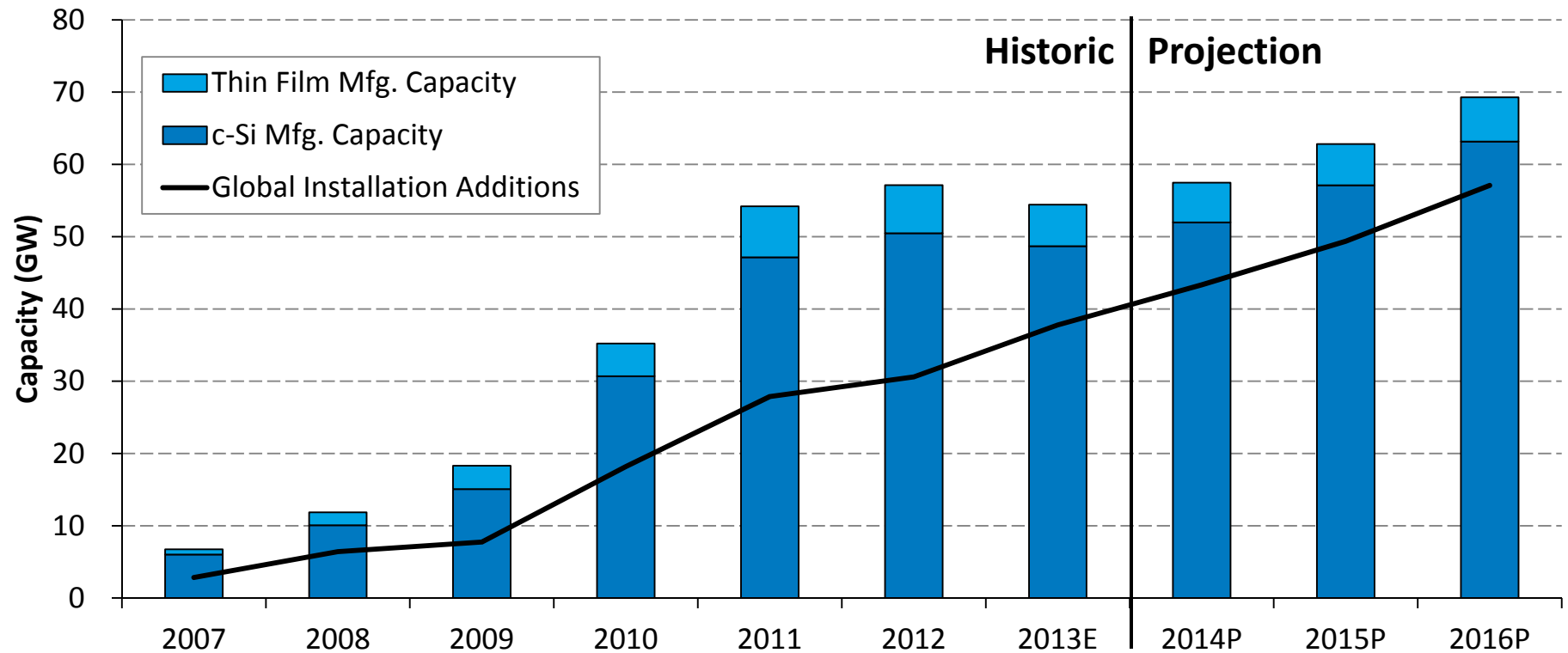


- In 2013, for the first time more PV will come on-line globally than wind – both around 35 GW
- Continued increase in global installations expected through 2016
 - As European demand declines, U.S. & developing world markets expected to grow

Note: E = estimate; P = projection.

Sources: data displayed represents the median figures from the following sources: BNEF (12/02/13), Deutsche Bank (01/06/14), Goldman Sachs (01/06/14), Stifel Nicolaus (01/03/14).

Global PV Manufacturing Capacity vs. Demand

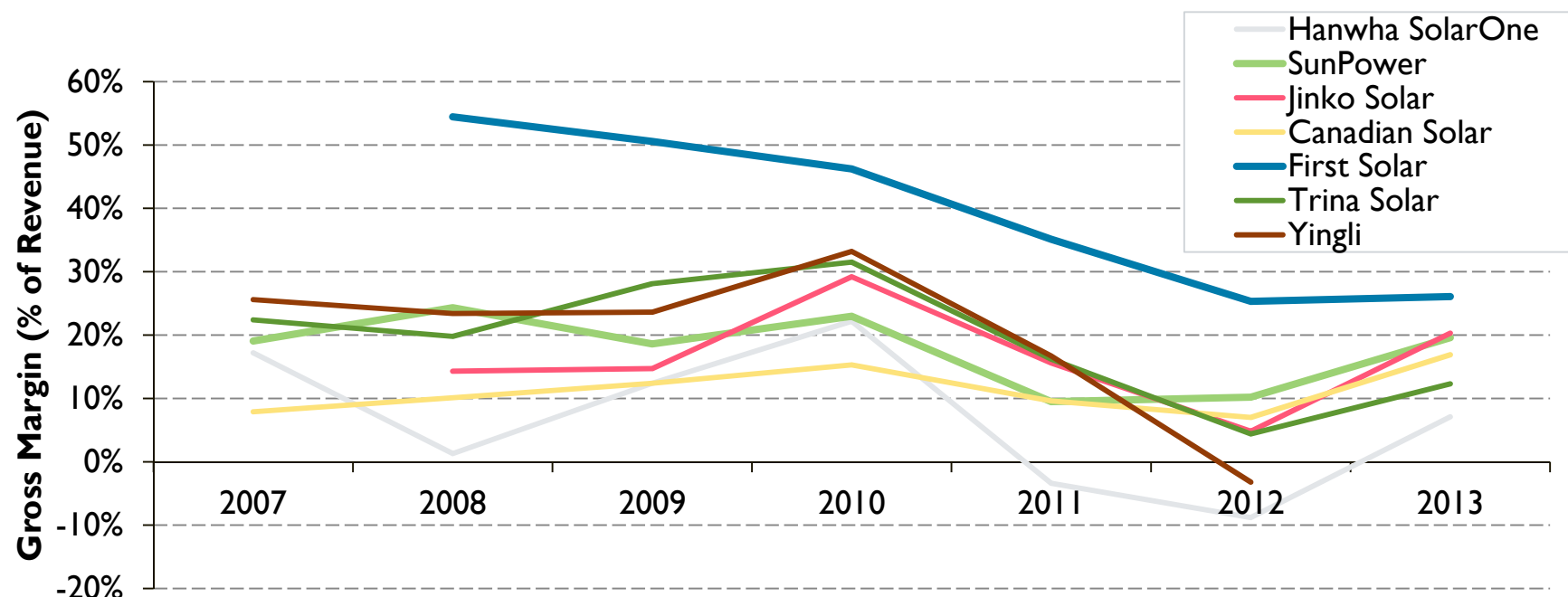


- Historically tightened supply/demand conditions have led to price increases ('07-'08) while oversupply has led to rapid price declines ('09, '11-'12)
- Near-term estimates predict a relatively balanced supply/demand

Note: P = projection

Sources: data displayed represents the median figures from the following sources: median of cell mfg. capacity: Goldman Sachs (01/06/14); GTM "WCM Database, September 2013." Demand: BNEF (12/02/13), Deutsche Bank (01/06/14), Goldman Sachs (01/06/14), Stifel Nicolaus (01/03/14).

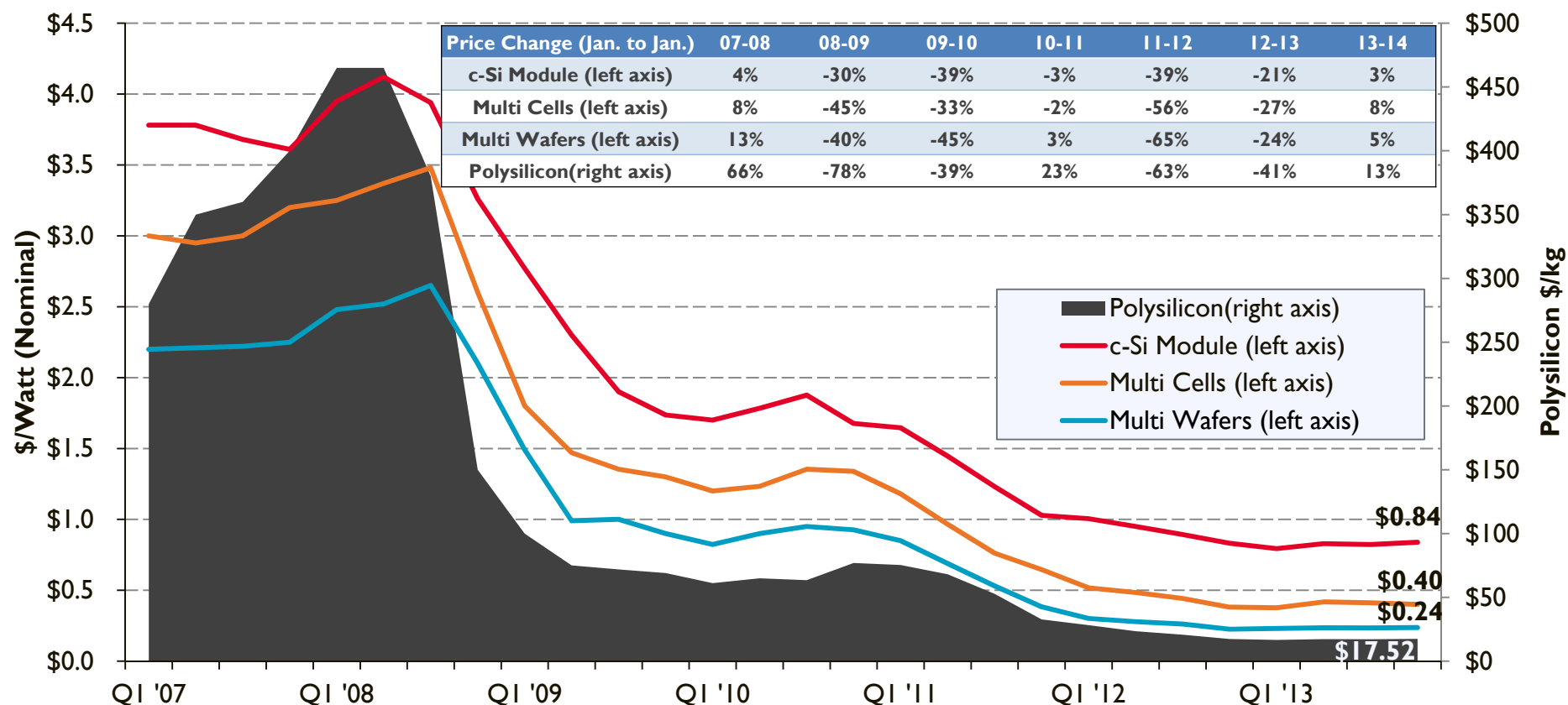
PV Manufacturers' Gross Margins



- Gross margins continue to recover due to stabilization of market pricing and continued cost reductions
 - 17% avg. gross margin of above companies in 2013 compared to 5% in 2012
- Still strong demand in Europe & U.S., as well as new countries like Japan & China
 - Solar-panel shipments in Q2 by three of the four largest producers exceeded projections by as much as 32% as demand in Asia surged (TSL, YGE, CSIQ)
- Stabilization (or increase) of price and continued reduction of costs translates into higher margins

Sources: Company figures based on Q4 '13 (and previous) SEC filings by the respective companies.

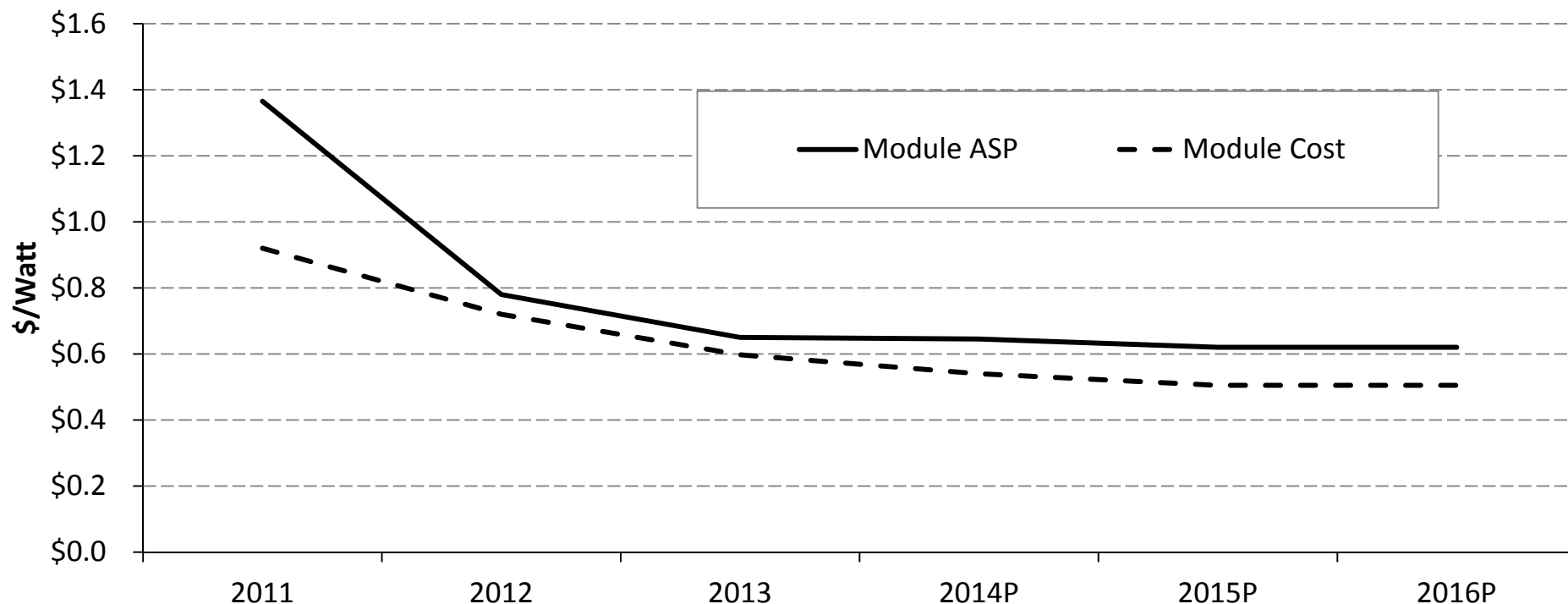
PV Module & Component Spot Pricing



- Module and component prices experiencing relatively stable pricing for past year, with modest increases as supply/demand more in balance
- Jan./Jan. '13/14 was first positive price change for c-Si modules since '07/'08
- BNEF expects poly prices to rise above \$20/kg in 2014
- Still highly competitive markets – larger buyers might have more bargaining power

Sources: Barclays (12/14/09); BNEF Solar Spot Price Index (01/15/14); Stifel Nicolaus (05/05/11); UBS ((2/12/10, 4/23/10, 7/27/10, 10/29/2010,1/24/11, 6/3/11, 6/16/11, 8/17/11, 9/16/11, 12/12/11, 1/20/12, 2/13/12, 4/19/12)). BNEF (01/09/14).

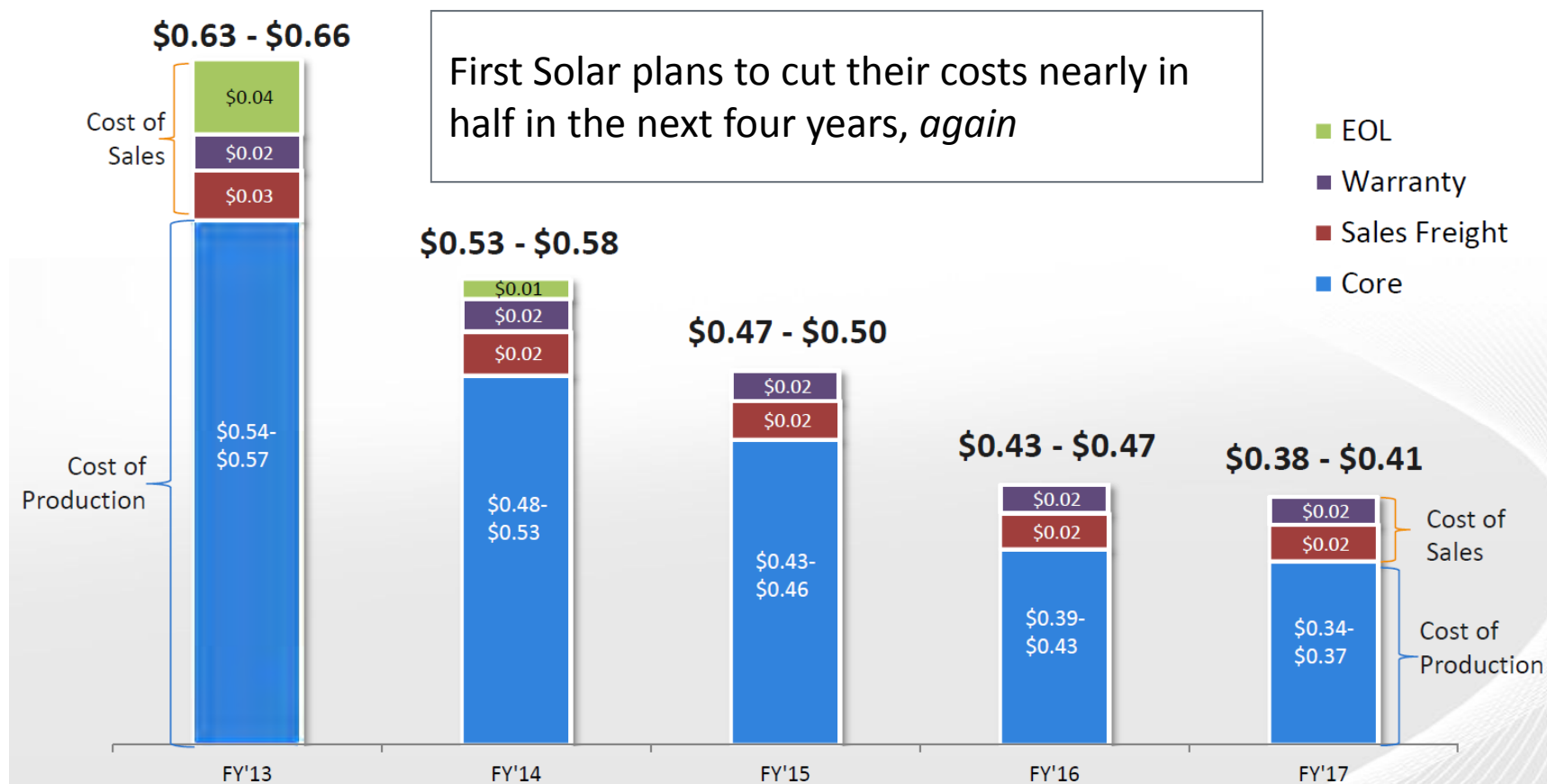
Near-term Price/Cost Projections



- Companies are expected to continue having positive gross margins as ASP's stabilize and costs continue to decline
- Mixed forecasts on future module ASP
 - However, not expected to increase or decrease dramatically in price

Sources: Lines represent the median estimates of ASP & costs for First Solar, Trina Solar, and Yingli from the following analysts, Cowen (02/26/14, 03/06/14); Deutsche Bank (11/28/12, 11/12/13, 02/26/14, 03/04/14); Stifel Nicolaus (02/26/14).

First Solar 2017 Roadmap



Module Cost per Watt Forecast*

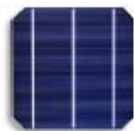
11

* Full year fleet average including underutilization & upgrade penalties

© Copyright 2013, First Solar, Inc.

Source: 2013 Corporate public filing.

SunEdison 2016 Roadmap



SunEdison targets similar cost to First Solar

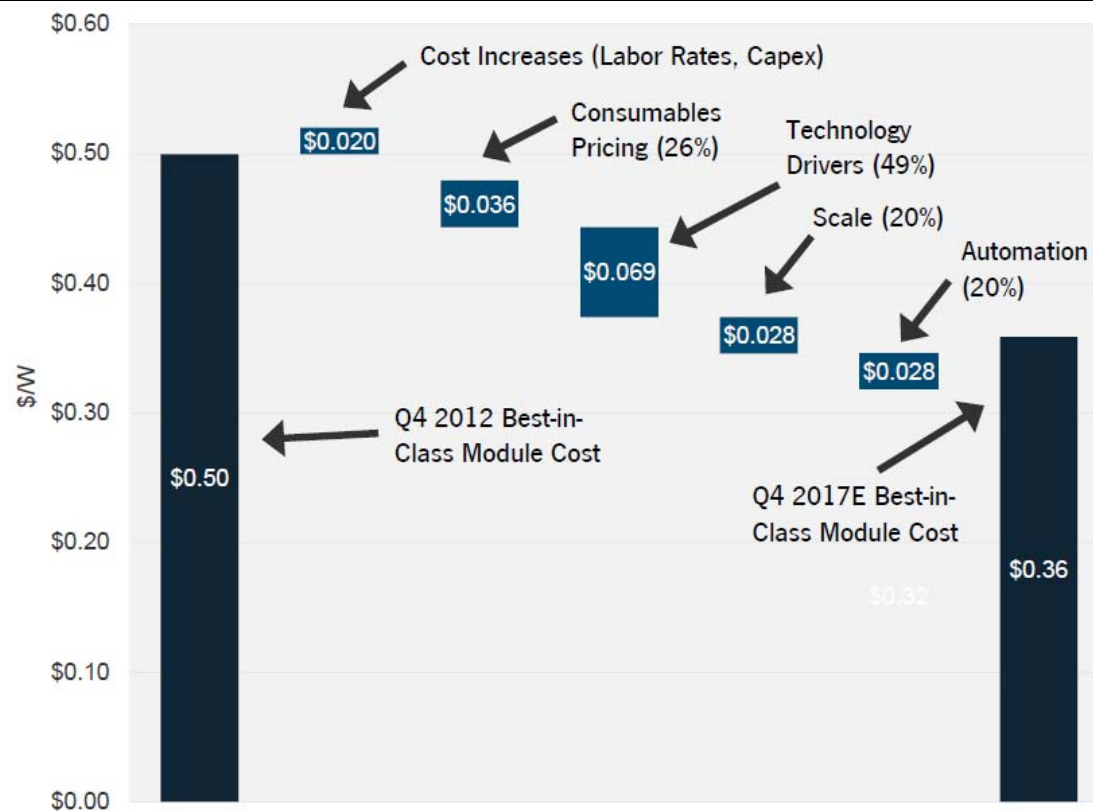
“440 Goal”

- 400Wp Module
- at \$0.40/Wp
- by 2016

Note : Cost includes opex, silicon, non-silicon, depreciation, warranty and inbound freight and excludes corporate general & admin. expenses)
Capital Markets Day | March 13, 2013



Best-In-Class Module Cost Reduction Q4 '12 – Q4 '17 (GTM Estimate)

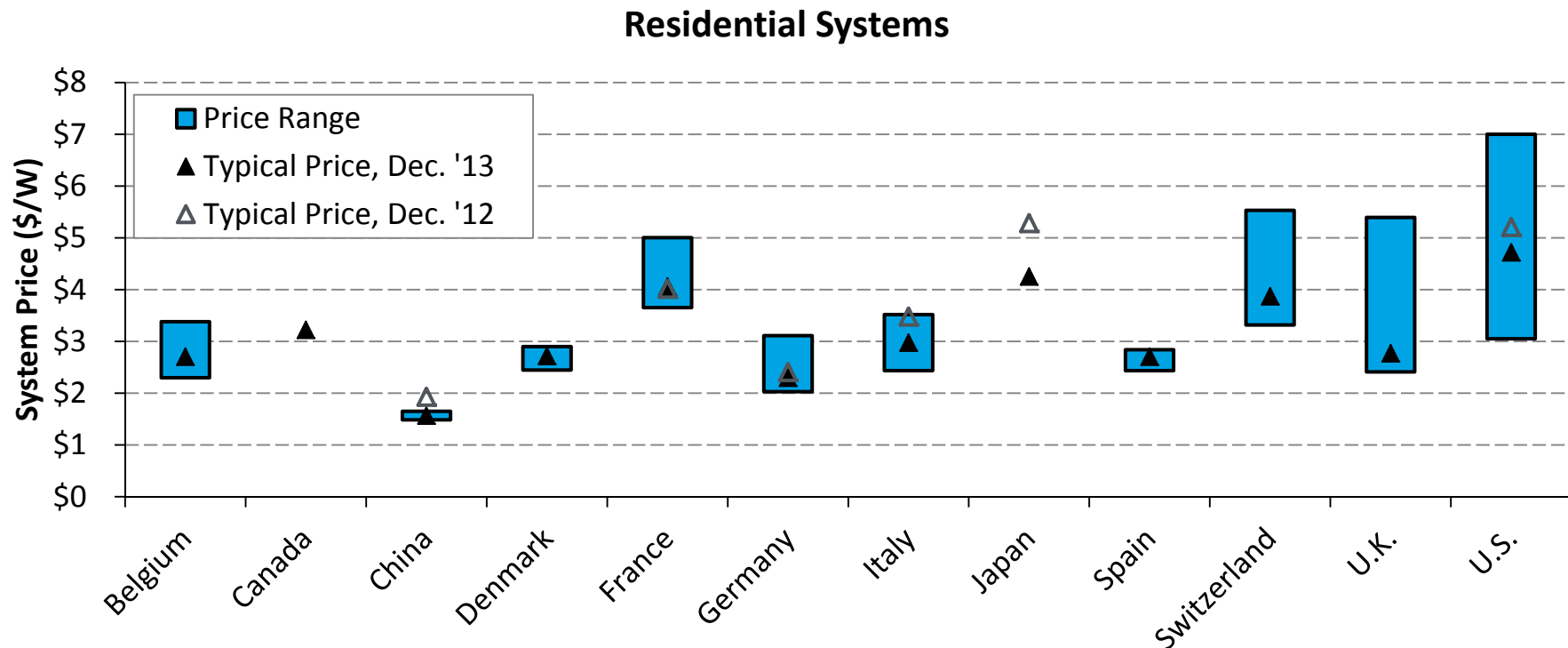


Overall conclusion from roadmaps: industry is shooting for module costs to be \$0.40/W or less in the near future – 25% margins would give a price of \$0.50/W

- Not clear what efficiency goals are at this price
- With continued mfg. overcapacity expected by analysts, uncertain whether mfg.'s will spend money on new equipment
- Major cost reductions may have to come from “soft-costs”

Sources: GTM Research: PV Technology and Cost Outlook, 2013 – 2017 (June 2013)

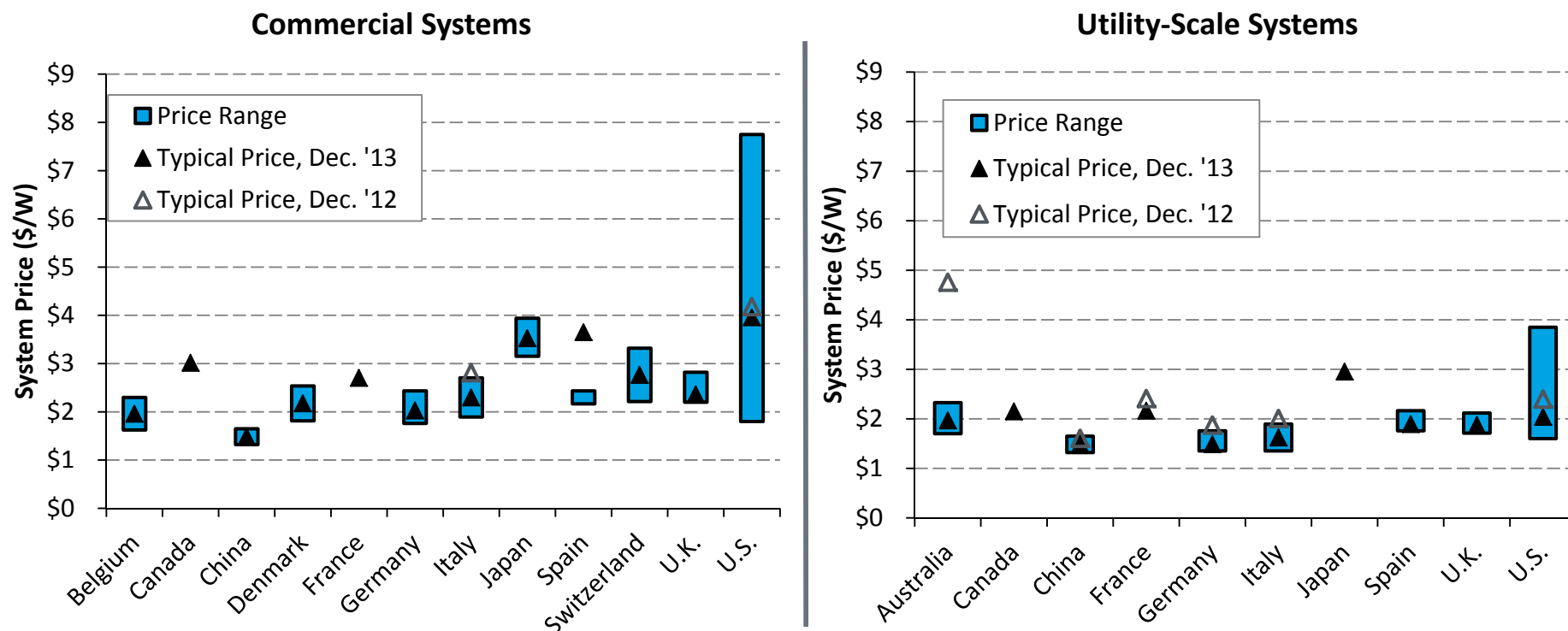
PV System Price by Country - 2012



- U.S. residential prices in 2013 still lagged behind other mature PV markets
 - In particular, the higher priced U.S. markets were 2-3x the price of other countries
- Japan was able to reduce residential system pricing by 21% versus 9% by U.S.

Sources: IEA PVPS (January, 2014).

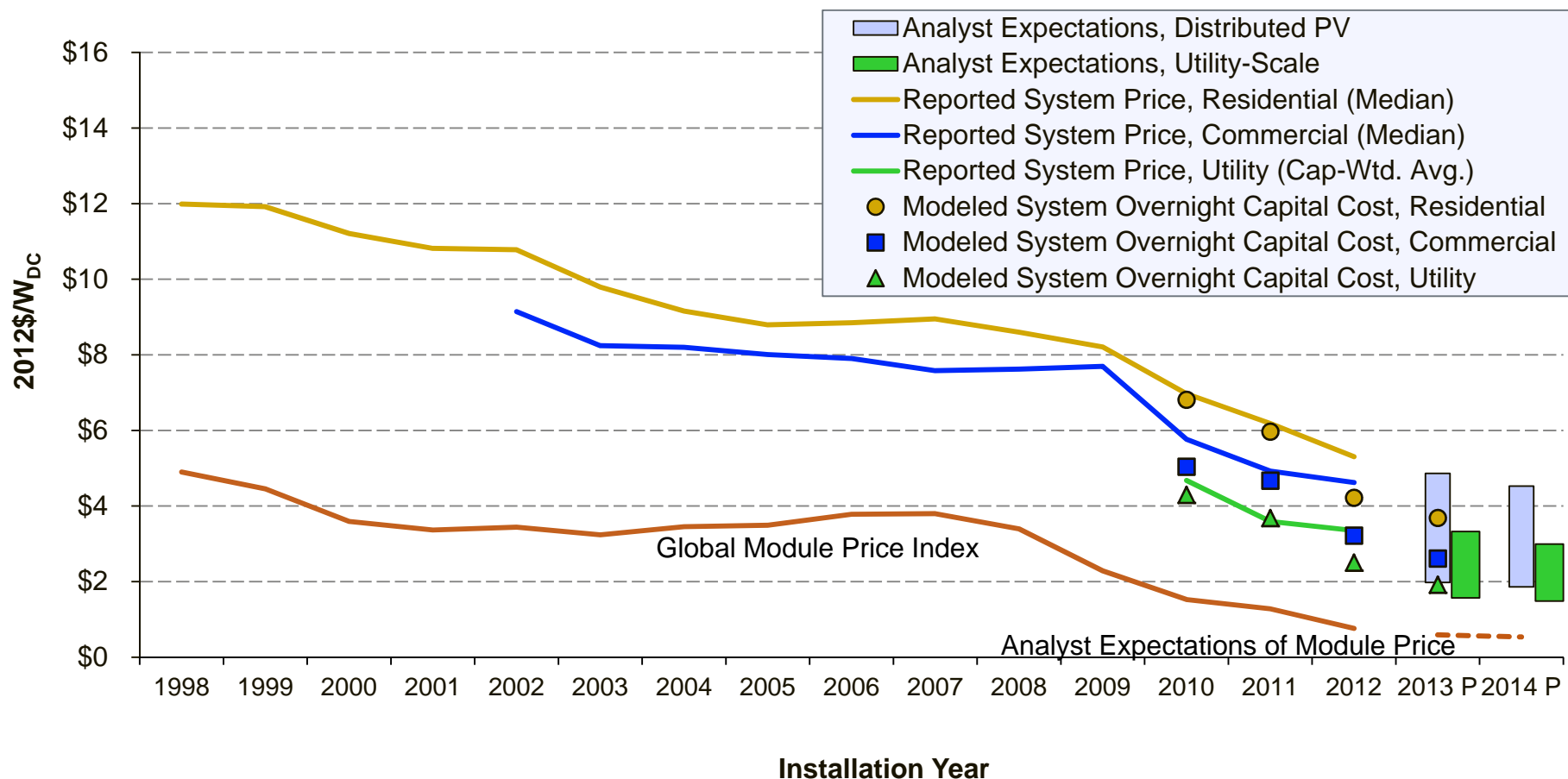
PV System Price by Country - 2013



- U.S. commercial scale system prices also lagging other countries, with higher end prices up to 4x more expensive – though there is a large range
- In utility space, U.S. is much more comparable in price to other countries, though still on higher end
 - U.S. utility-scale systems installed more efficiently than res./com. sectors, and potentially able to spread costs over more MW's

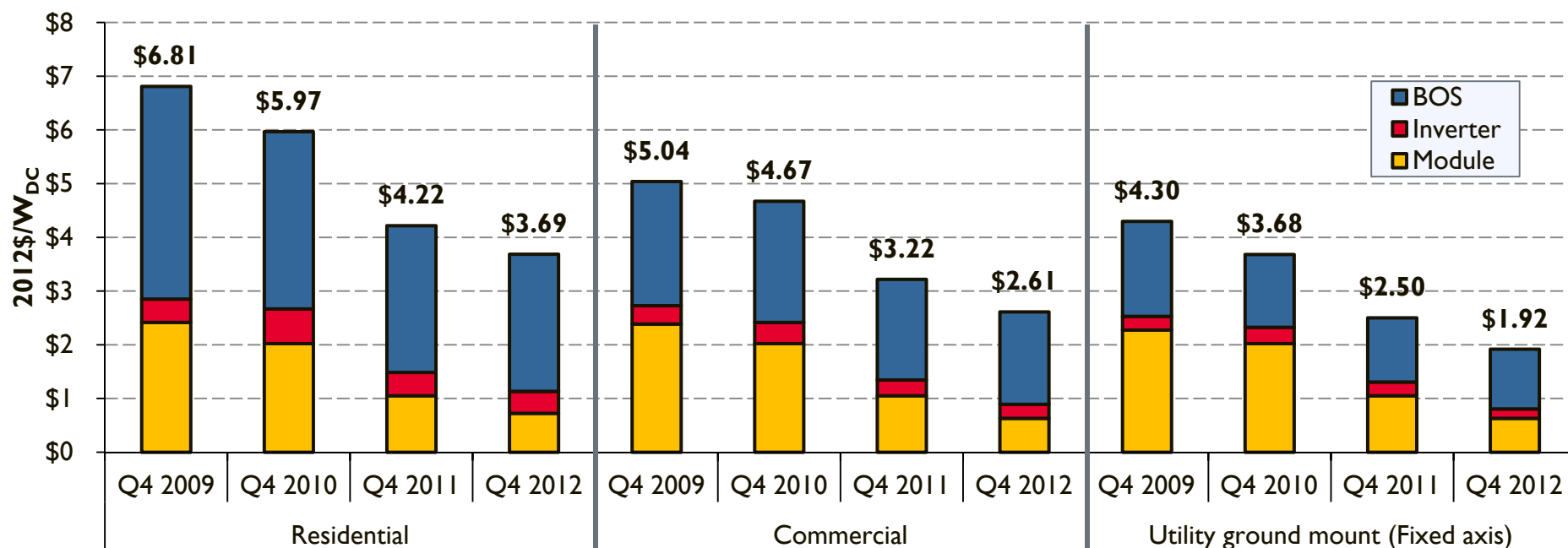
Sources: IEA PVPS (January, 2014).

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



Note: The reported system price for the residential market is representative of the median price reported for systems less than or equal to 10 kW in size. The modeled residential system price represents a ~5 kW system. The reported system price for the commercial market is representative of the median price reported for systems greater than 100 kW in size. The modeled commercial system price represents a ~220 kW rooftop system. The reported system price for the utility-scale market represents the capacity-weighted average reported price for ground-mounted systems greater than 2 MW in size, with an average project size of 16.4 MW. The modeled system price of utility-scale systems represents a ~190 MW fixed-tilt ground-mounted system. Bottom-up system prices are representative of bids by an installer in the fourth quarter of the previous year. The Global Module Price Index is the average module selling price for the first buyer (P Mints SPV Market Research).

Bottom-up Modeled Overnight Capital Cost of PV Systems by Sector, Q4 '09 - Q4 '12

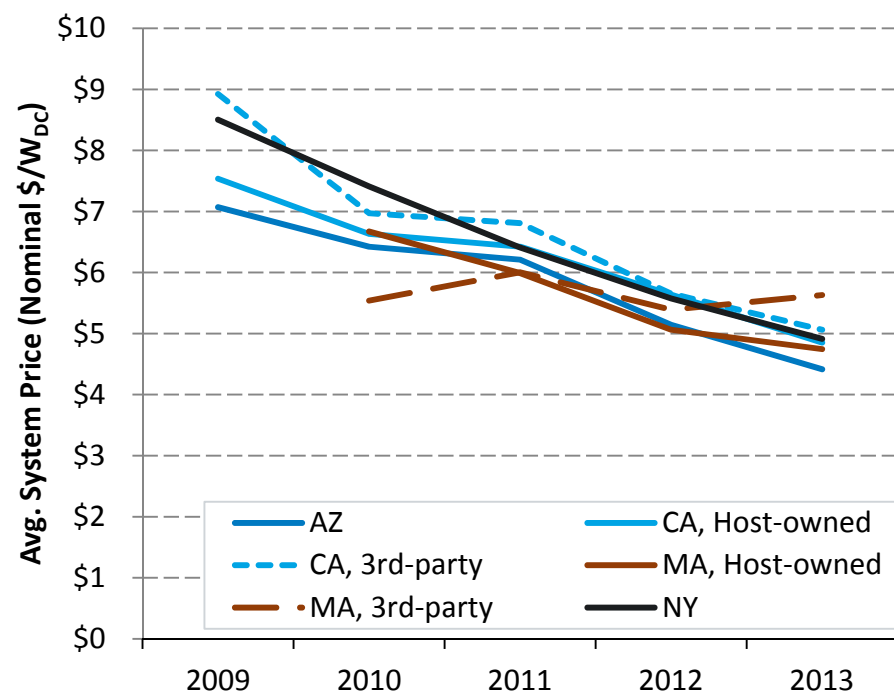
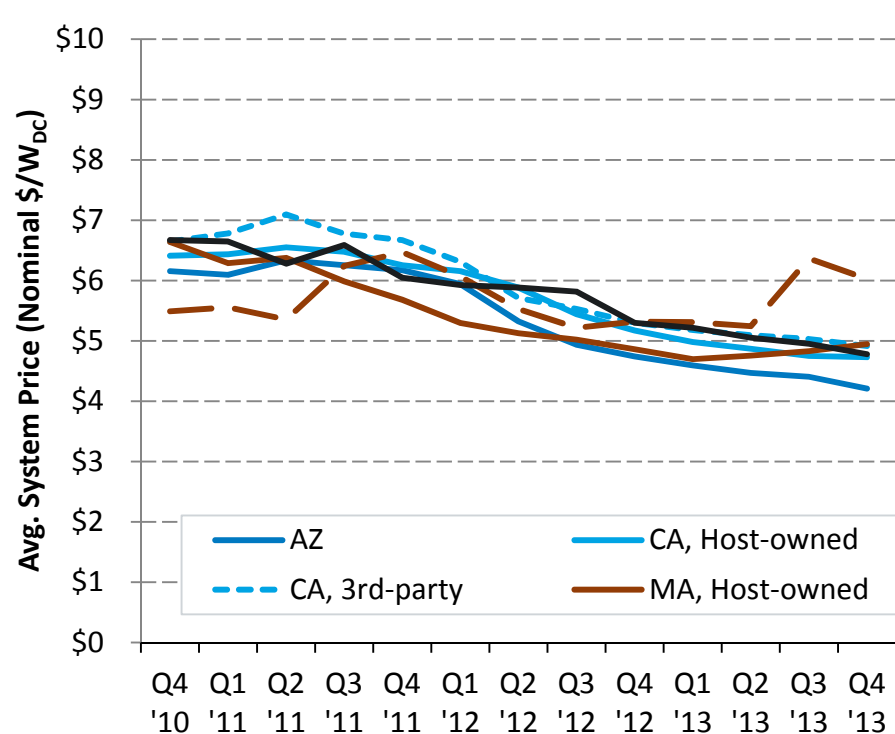


- Since Q4 2009, the overnight capital cost of systems has fallen between 14% – 18% per year
 - 50% - 75% of reduction attributed to module price reductions
- From Q4 '11 to Q4 '12, the overnight capital cost of systems fell between \$0.53/W - \$0.61/W, or 13% to 23%.

Note: Standard crystalline silicon modules (13.5% efficiency in Q4 2009 to 15.0% in Q4 2012). System size (residential: 4.6 kW in Q4 2009 to 5.1 kW in Q4 2012; commercial: 202.0 kW in Q4 2009 to 222.5 kW in Q4 2012; utility-scale: 174.6 MW in Q4 2009 to 192.8 MW to Q4 2012). The increase in module efficiency is the cause for increased system size. Modeled system sizes in the residential and commercial rooftop sectors were chosen based on typical system sizes, then adjusted for optimal inverter configuration. System sizing for utility-scale benchmarks were chosen for comparison purposes against pricing reported from DOE's Energy Information Administration (2010).

Average System Pricing by Size & Region

2.5 kW – 10 kW



- System prices in the above states, between 2.5 -10 kW, fell on average 11% between '12 & '13
 - Consistent to declines experienced in previous 4 years
- Q4 '13 pricing trended downwards as well

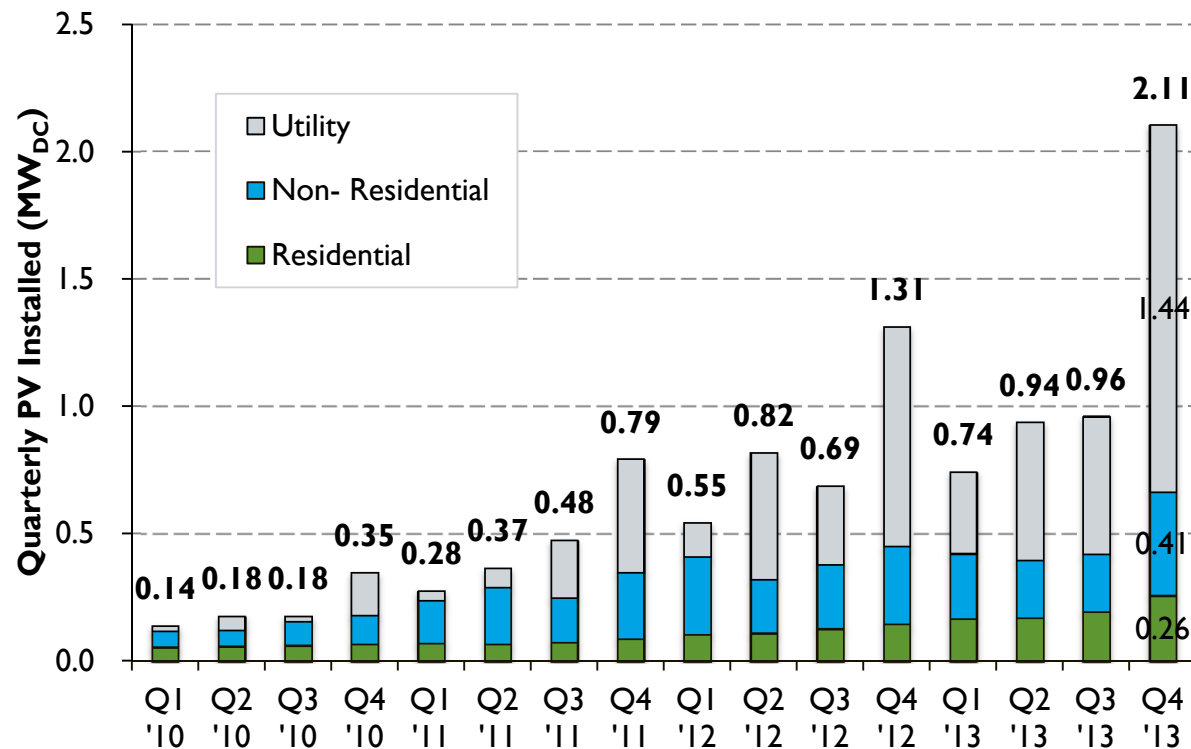
2013 MW: AZ (43); CA H.O. (47); CA 3rd-P (115); MA HO (5); MA 3-P (10); NY (14).

Sources: CSI Database, accessed 01/01/14; MA SREC Program, accessed 12/20/14; Arizona Public Services, & Salt River Project, accessed 01/02/14; NYSEDA (01/02/14).

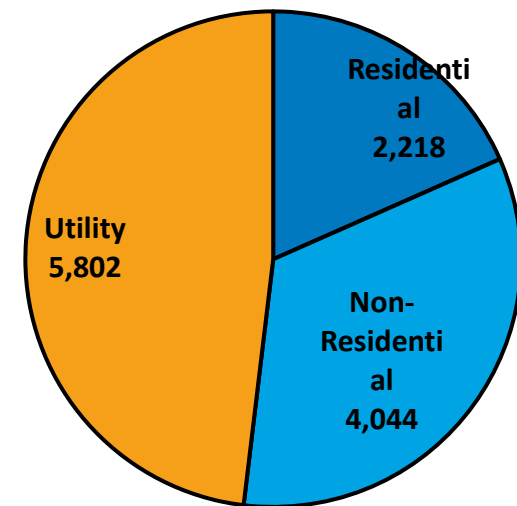
Note: NYSEDA actually represents all “residential” sector data, and is the simple average price per quarter. All other data is weighted by capacity. MA does not report whether a system is 3rd-party owned therefore it was estimated using the “applicant entity” or “installer” for the following organizations: SolarCity, CPF Capital, SunRun, Vivint, Sungevity.

U.S. Installation Breakdown

U.S. PV Installations by Market Segment



U.S. Cum. PV Installations by State (MW_{DC}), 2013

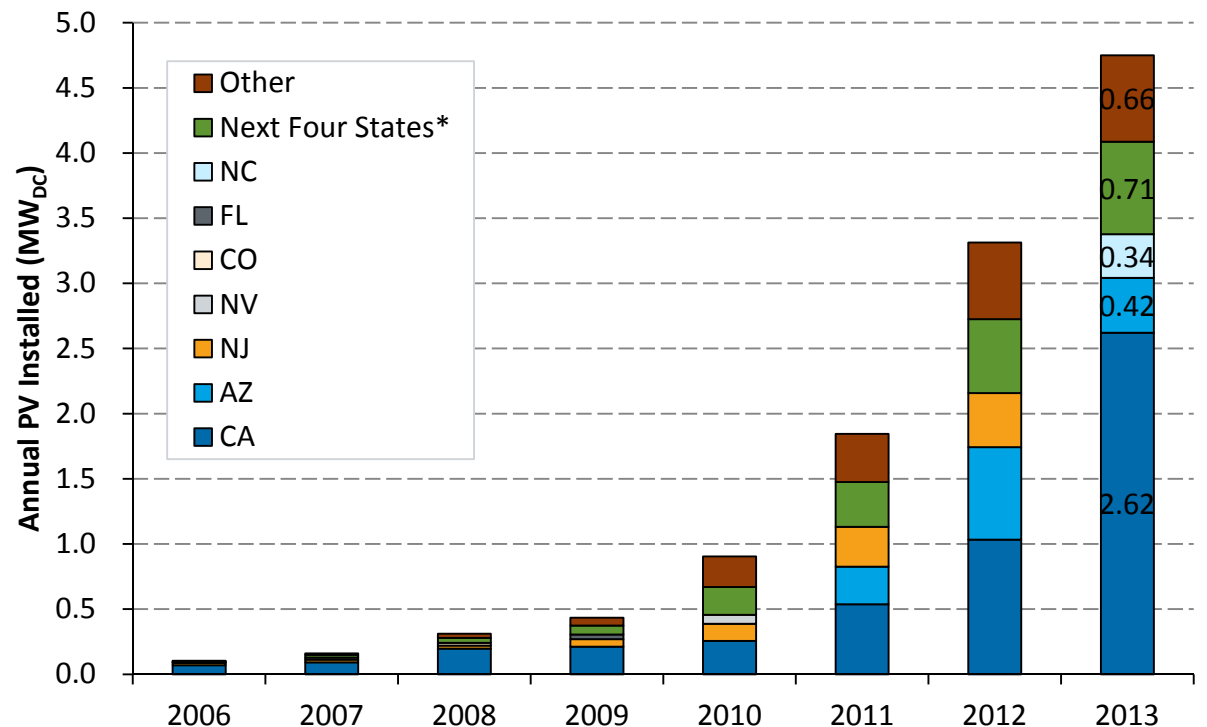


- U.S. Installed 4.8 GW of PV in 2013, 2.1 GW in Q4 '13
- Challenges maintaining growth rate in all sectors/states
 - Net metering and rate design in CA, CO, AZ, TX
 - GTM reports that developers in HI had difficulties with changing permit fees, state tax credits, and market saturation in some key geographies
- U.S. non-residential market flat
- Other markets opening up could spur demand such as MN, GA, NY (50kW-200 kW systems)
 - A PV project will be installed, on average, every 4 minutes

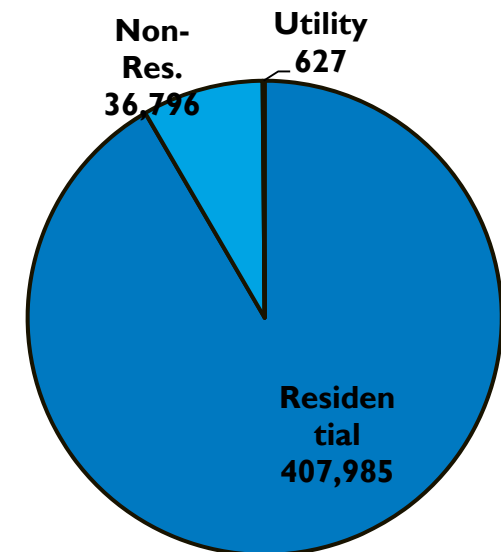
Sources: GTM/SEIA : U.S. Solar Market Insight Q4 2013.

U.S. Installation Breakdown

U.S PV Installations by State



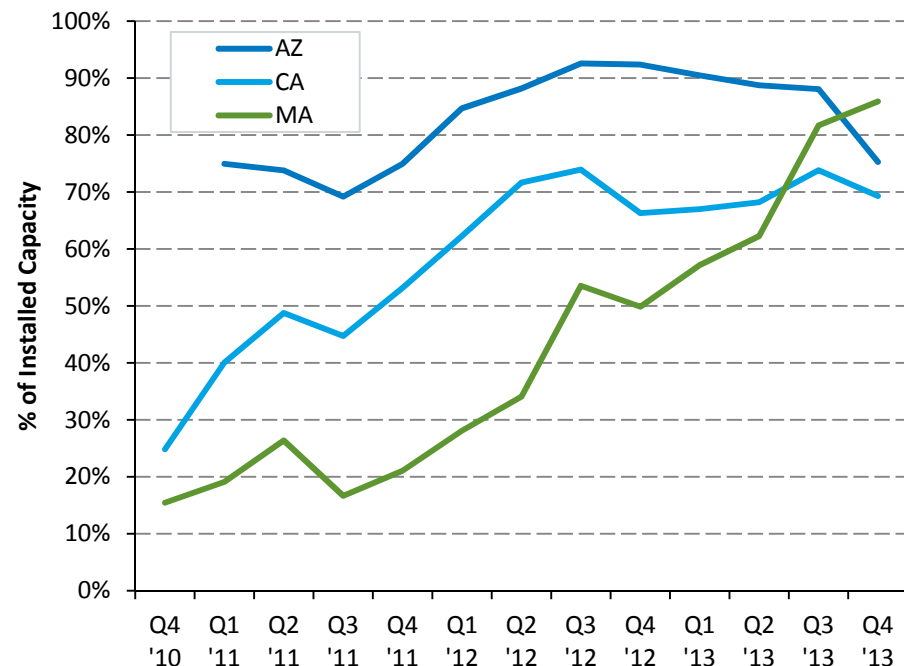
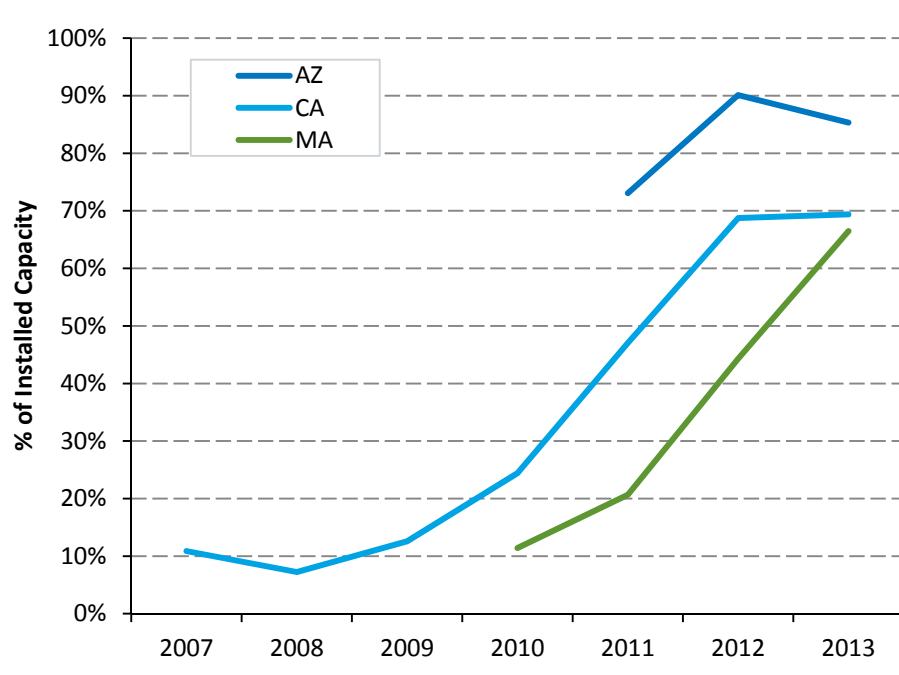
U.S. PV Cumulative Installations (#), 2013



- Several states largely spurring PV market in U.S.
 - CA, AZ, and NJ each have more than 1 GW of cumulatively installed PV
- However, this trend is changing slowly as 16 states currently have 100 MW or more of PV capacity and 11 states each installed more than 50 MW in 2013 alone
- 92% of the # of all systems are residential
 - 131k res. installed in '13

Sources: GTM/SEIA : U.S. Solar Market Insight Q4 2013.

Residential 3rd-Party System Ownership by Region



- 3rd-party ownership continues to dominate residential sector in several markets
- AZ & CA % have leveled off in past year – with continued sales of host-owned systems
 - New availability of residential loans
 - Rebounding of housing market allow systems to be financed through mortgages or home equity loans

Sources: CSI Database, accessed 01/01/14; MA SREC Program, accessed 12/20/14; Arizona Public Services, & Salt River Project, accessed 01/02/14.

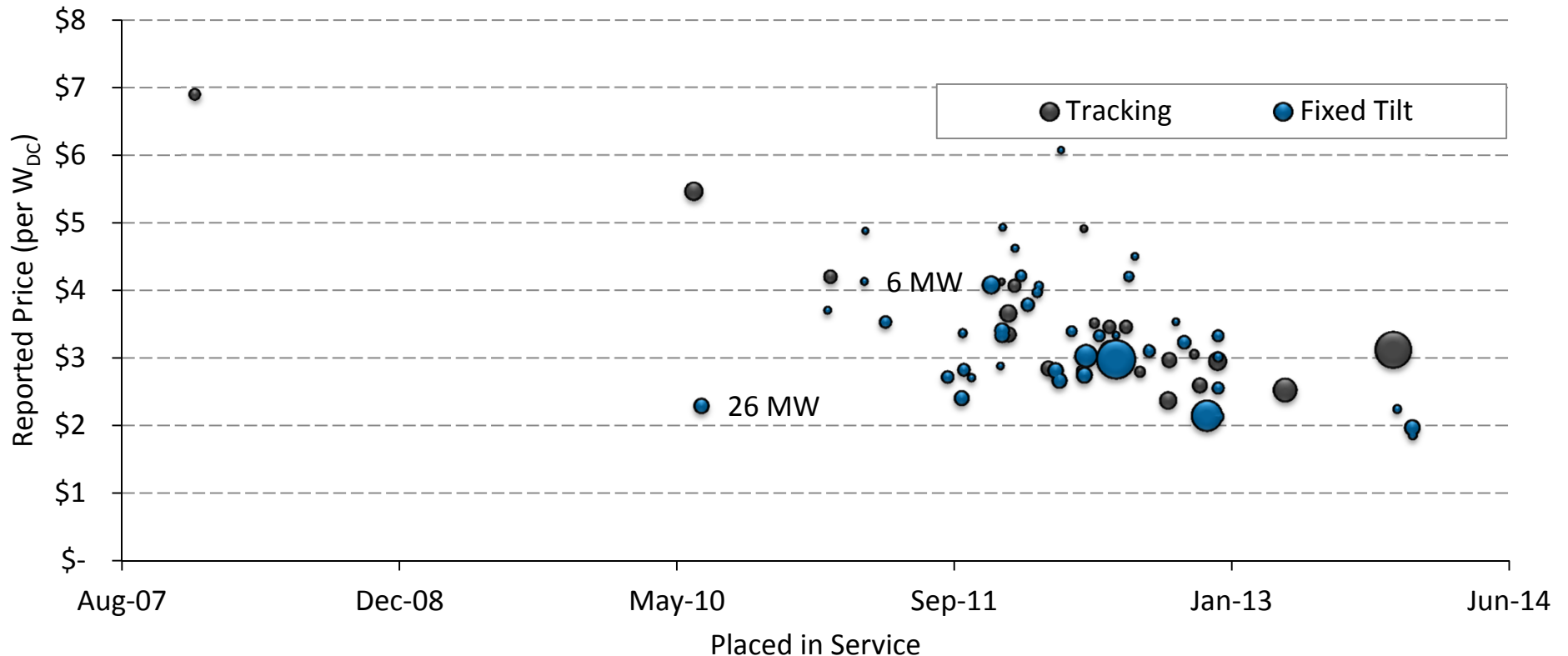
Note: MA does not report whether a system is 3rd-party owned therefore it was estimated using the “applicant entity” or “installer” for the following organizations: SolarCity, CPF Capital, SunRun, Vivint, Sungevity.

Utility Involvement in 3rd party ownership/distributed systems

- **Utilities making strategic investment in distributed solar to diversify risk**
- “On its face you would look at it and say distributed generation is a threat,” said Nick Akins, chief executive of American Electric Power, in an interview.” But on the other hand we see it as an opportunity because our business is changing. There's no getting around it.”
- SolarCity has formed partnerships with Direct Energy and Crius Energy Trust (both energy retailers) to finance projects for utilities’ customers
 - Direct Energy and SolarCity sign \$124MM deal to provide solar to Direct Energy’s business customers
 - Crius has 230,000 customers in 9 U.S. states. SolarCity will now offer residential products to them
 - Partnerships are designed to reduce SolarCity’s customer acquisition costs
 - SolarCity also purchased Paramount Solar, a lead generation firm it had been working with, to improve customer acquisition as well
- Edison International, which owns SCE, announced in Aug. ‘13 it had bought SoCore Energy, a distributed solar developer focused on commercial rooftop installations
- In H1 ‘13, Edison International, Duke Energy and two other undisclosed utilities were part of a \$42MM corporate investment in Clean Power Finance
- In May ‘13, the IPP Nextera, which owns mostly wind, natural gas and nuclear assets, acquired Smart Energy Capital, a commercial solar project developer
 - Smart Energy Capital has been involved in 75 MW of PV deployment; Nextera operates 18 GW of energy assets
- Other utilities are investing in portfolios of projects (PG&E) or installing solar panels themselves (Dominion, PSE&G)

Sources: BNEF (09/11/13); Cleantech Finance (07/03/13), 09/23/13); Forbes (08/13/13); Greentech Media (05/16/13); Wall Street Journal (05/28/13).

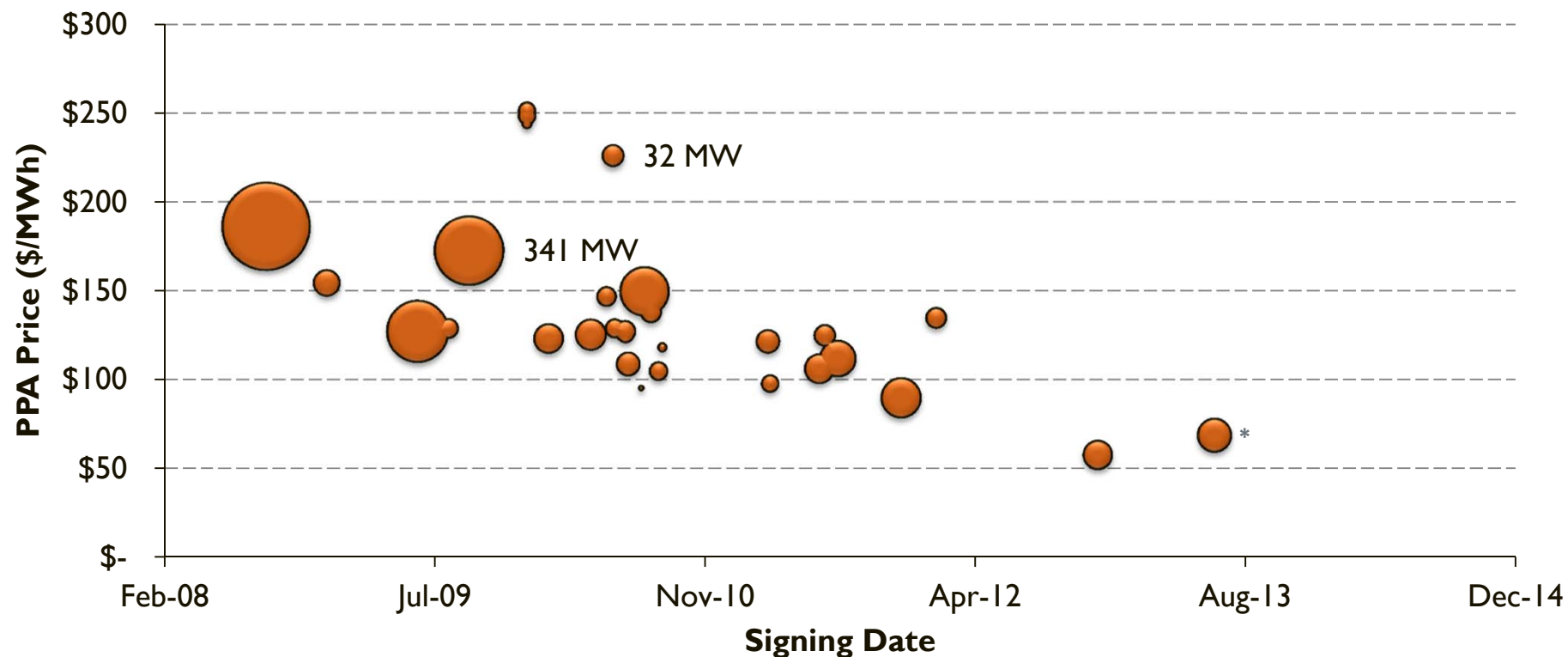
Utility-Scale Pricing



- Still great volatility in utility-scale system price, however in general prices are decreasing over time – most installs now being reported between \$2-3/W
- There are a number of factors besides tracking that are driving differences in pricing

Sources: Individual system pricing from corporate press releases & public filings. Additional information gathered from publicly available grant data from Treasury Department. <http://www.treasury.gov/initiatives/recovery/Pages/1603.aspx>. Specific project location and system size based on various press releases and corporate filings. Grant basis is assumed to be 1.00/0.30 of grant award.

US Solar PPA Price (Utility Projects)

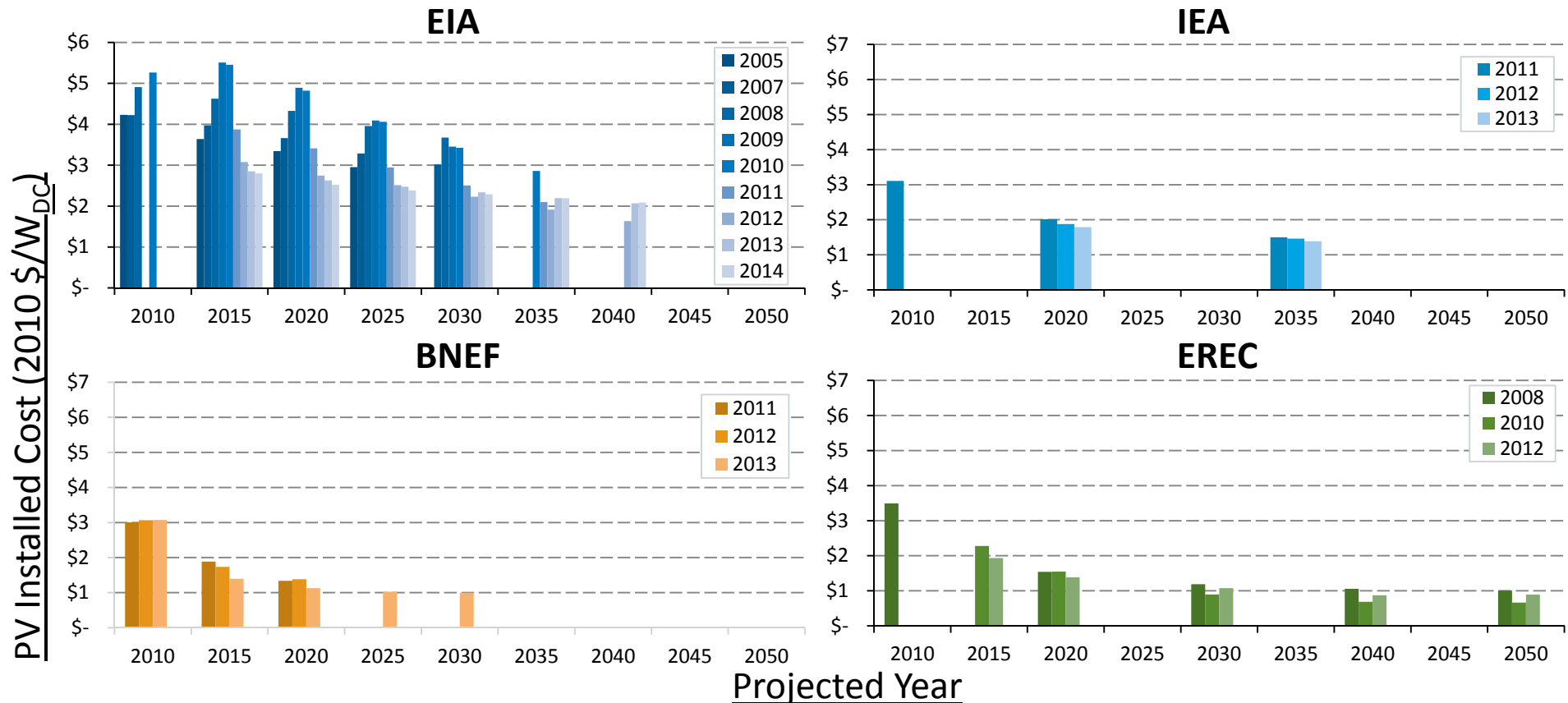


- PPA prices have continued to decline due to intense competition among solar developers
 - Macho Spring was signed for \$58/MWh however benefits from a \$27/MWh state tax credit
 - As states near RPS targets and RFP's taper out, PPA's are becoming harder to find

* Represents aggregation of three projects in California.

Source: BNEF H2 2013 NA PV Outlook.

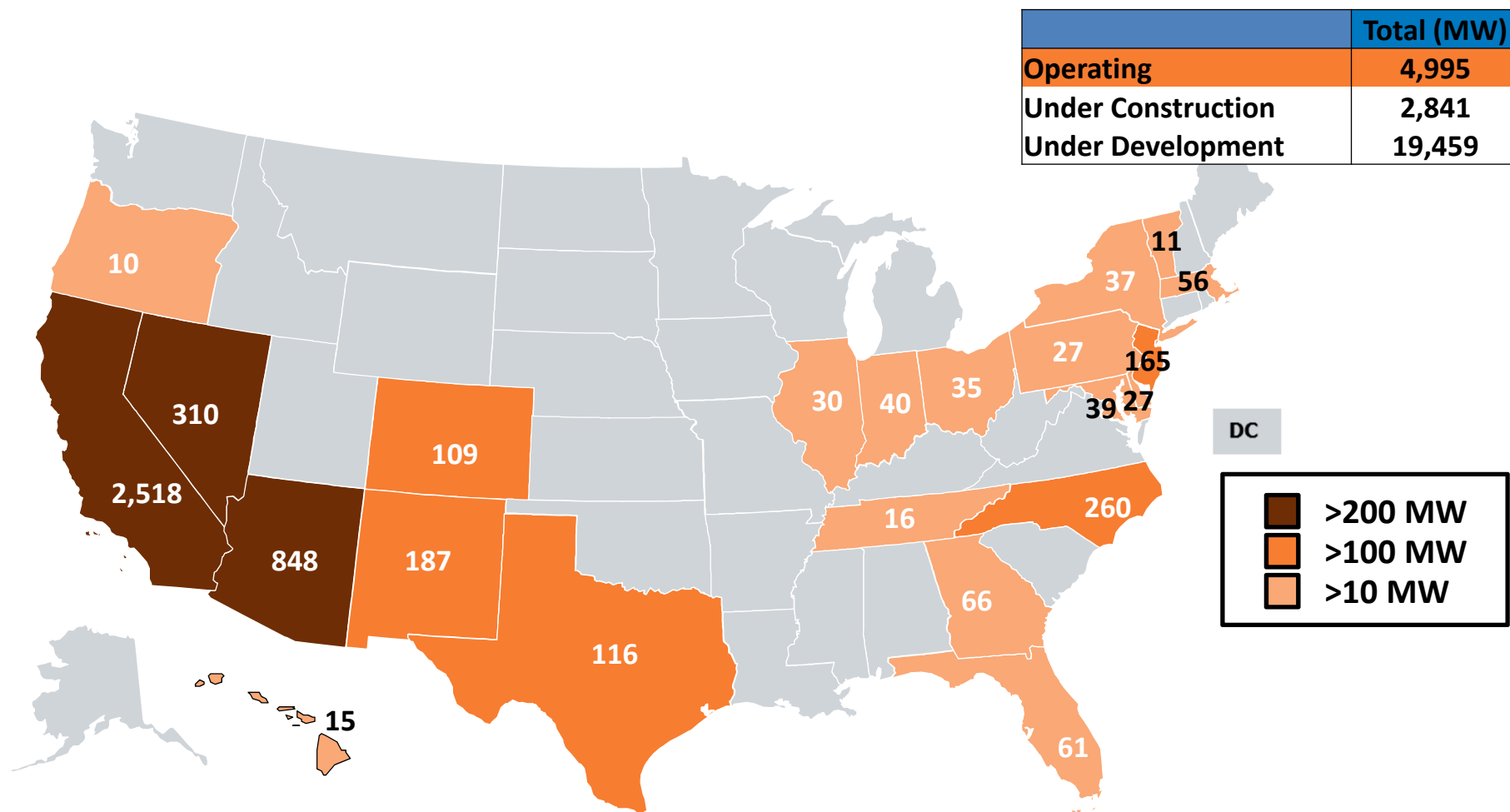
Change in Utility PV Projections over Time



- BNEF, IEA and EREC all get very close to SunShot target by 2020-2030
- EIA projections continue to be the highest. They were actually increasing through 2010, but have fallen significantly during past couple of years

Sources: Greenpeace/EREC, “Energy Revolution” (July 2008, 2010, 2012); International Energy Agency, “World Energy Outlook 2011/2/3” (November 2011, 2012, 2013), New Policy Scenario; Bloomberg New Energy Finance, Q2 2011, Q1 2012, Q4 2013, “PV Market Outlook” (07/18/11, 02/06/12, 12/02/13); U.S. Energy Information Administration, Annual Energy Outlook 2005-2013 & 2014 ER (December 2013).

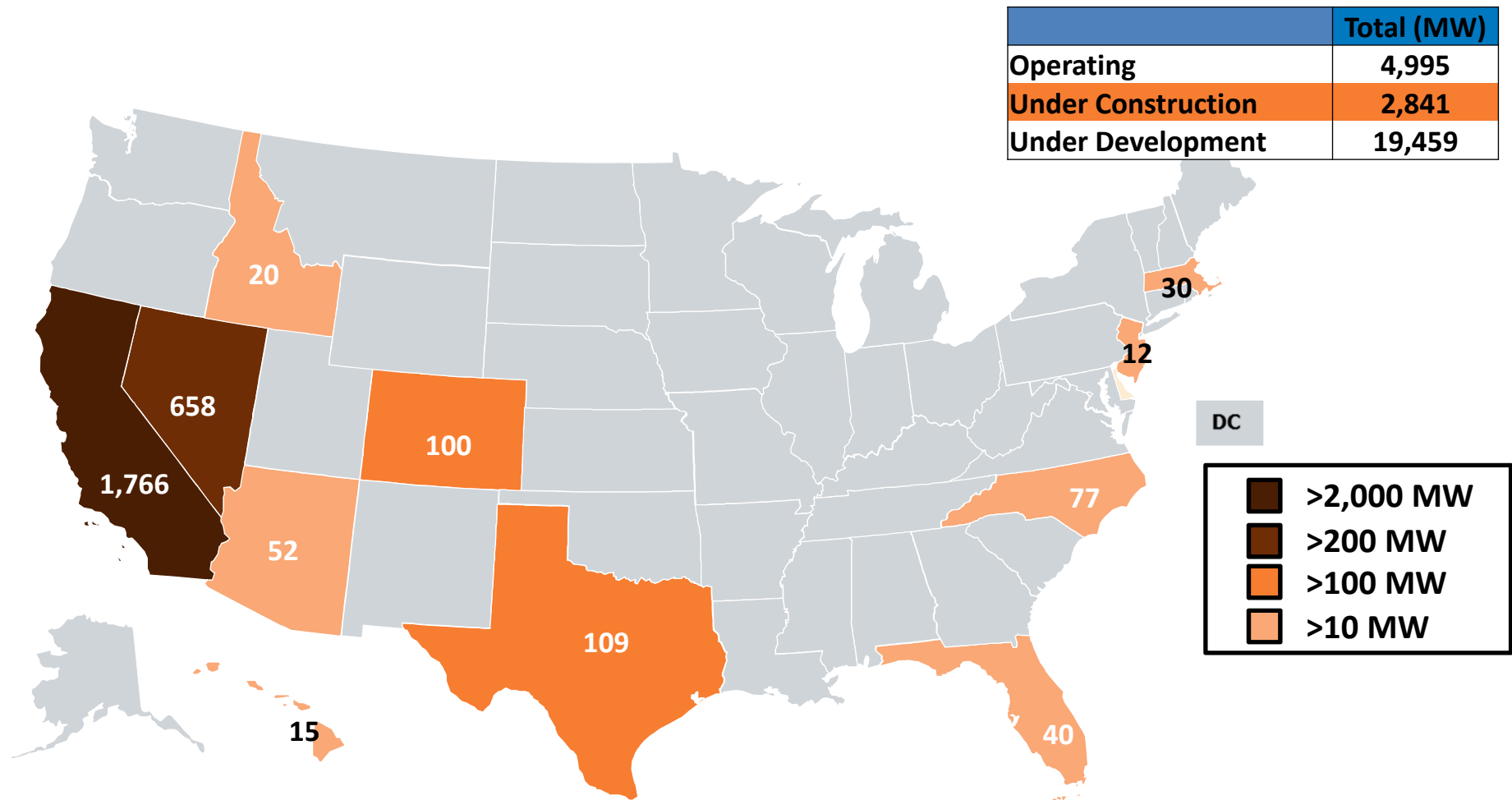
Large PV, In Operation (> 1 MW)



Note: PV Capacity is quoted in Watts AC.

Sources: SEIA Major Solar Projects, 03/06/14

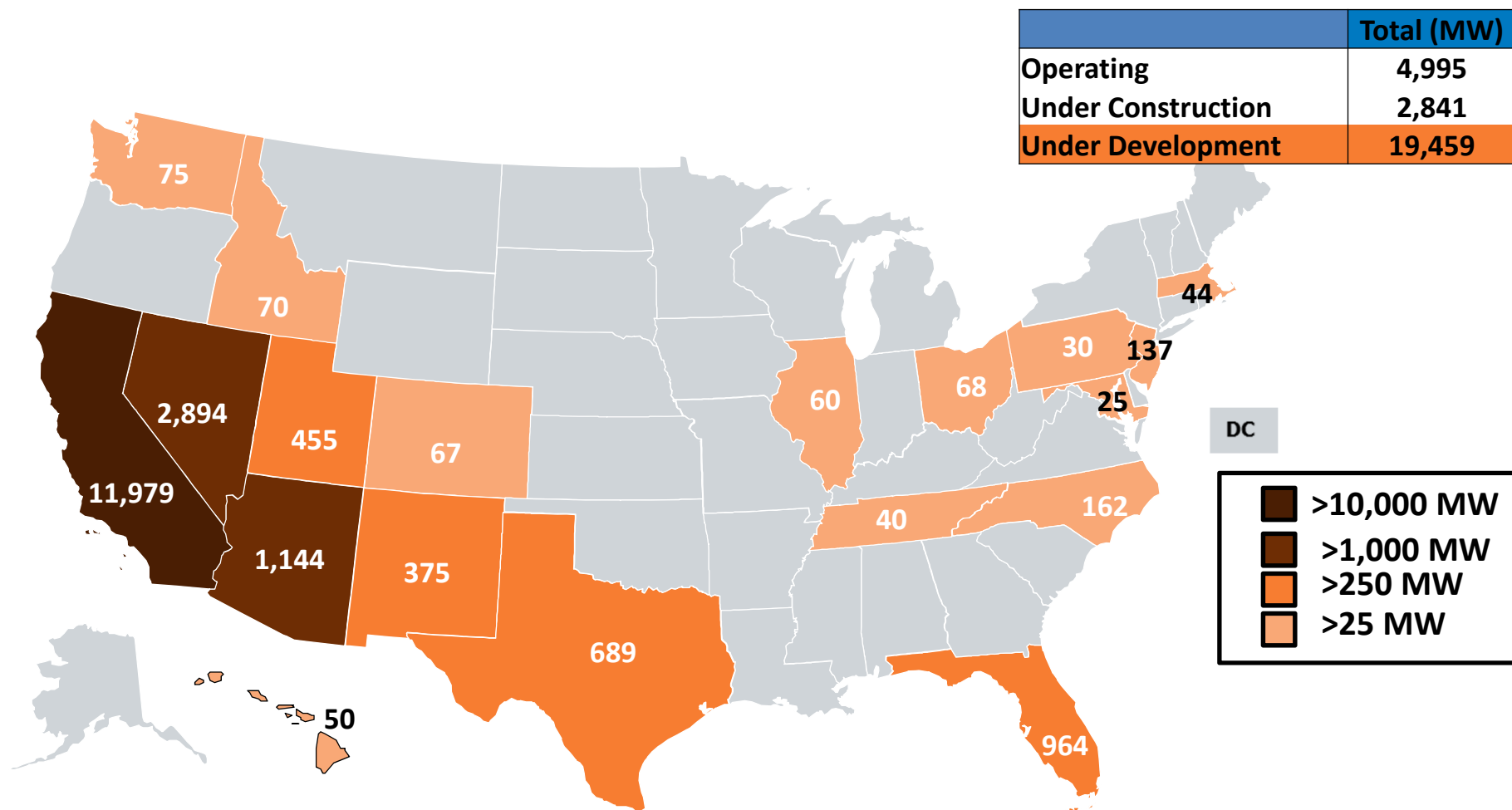
Large PV, In Construction (> 1 MW)



Note: PV Capacity is quoted in Watts AC.

Sources: SEIA Major Solar Projects, 03/06/14

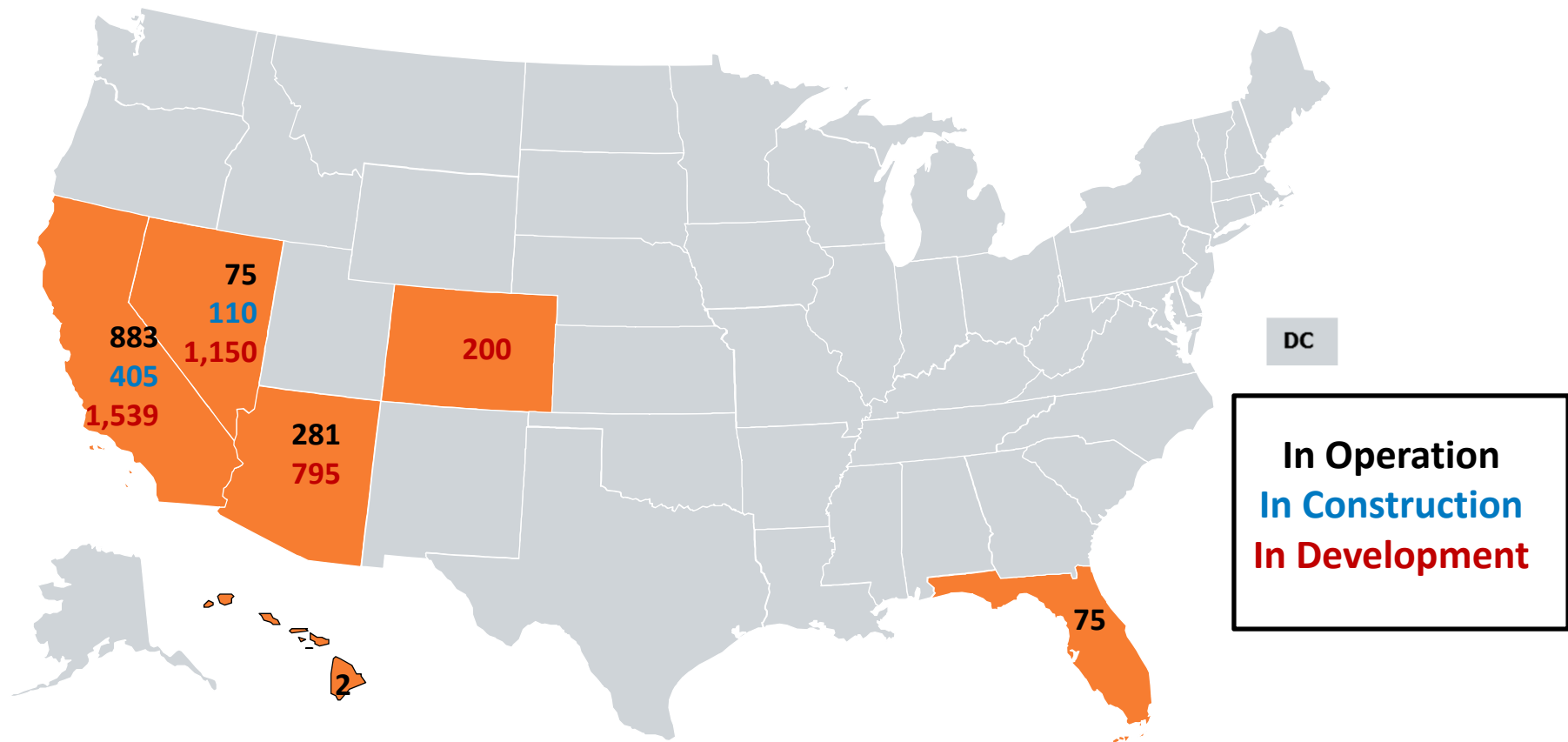
Large PV, In Development (> 1 MW)



Note: PV capacity is quoted in watts AC.

Sources: SEIA Major Solar Projects, 03/06/14

U.S. Large CSP Pipeline (> 1 MW)

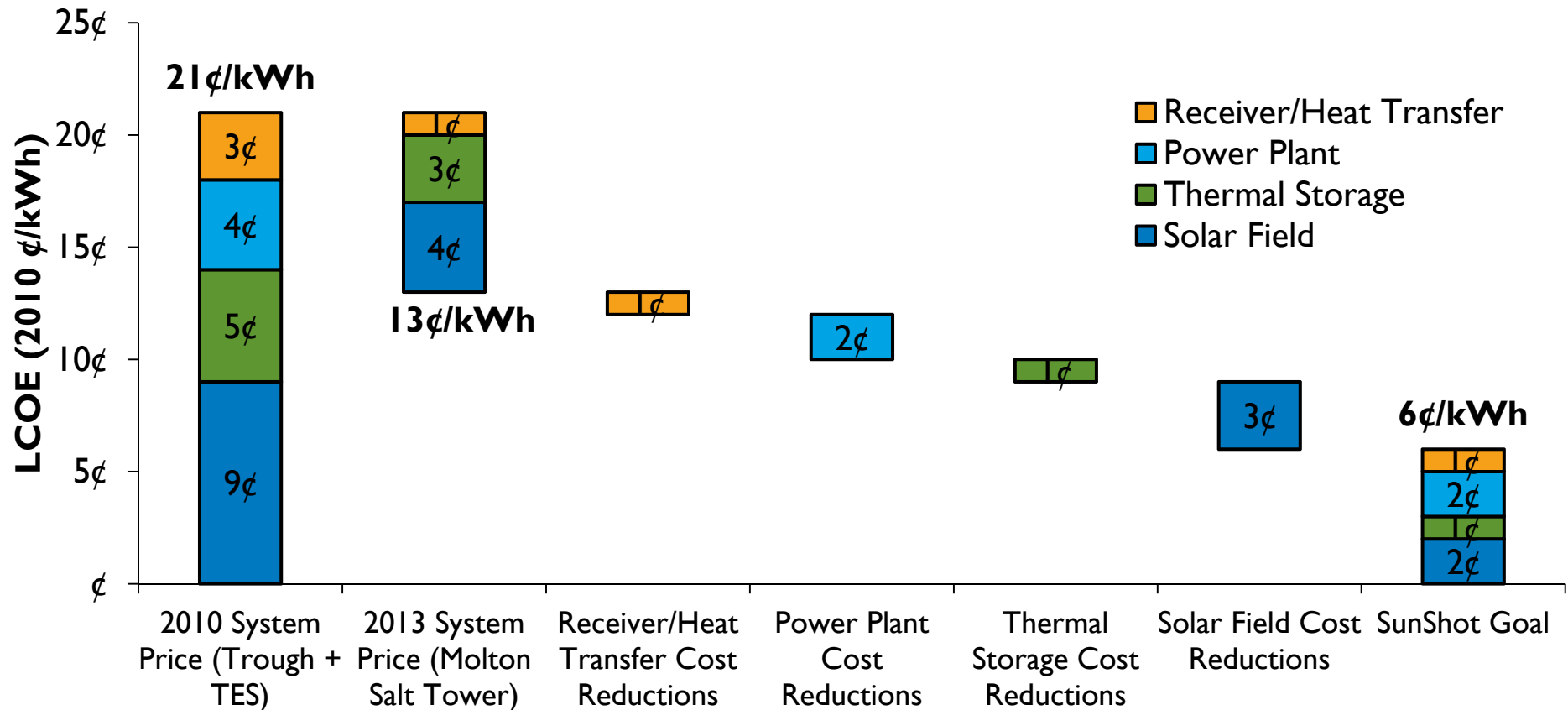


- Largest solar project, 392 MW Ivanpah project, and largest solar project with storage, 280 MW Solana project (w/ 6 hrs of storage) placed in service late last year

Note: CSP capacity is quoted in watts AC.

Sources: SEIA Major Solar Projects, 03/06/14

2010 & 2013 CSP Baselines and SunShot Goal

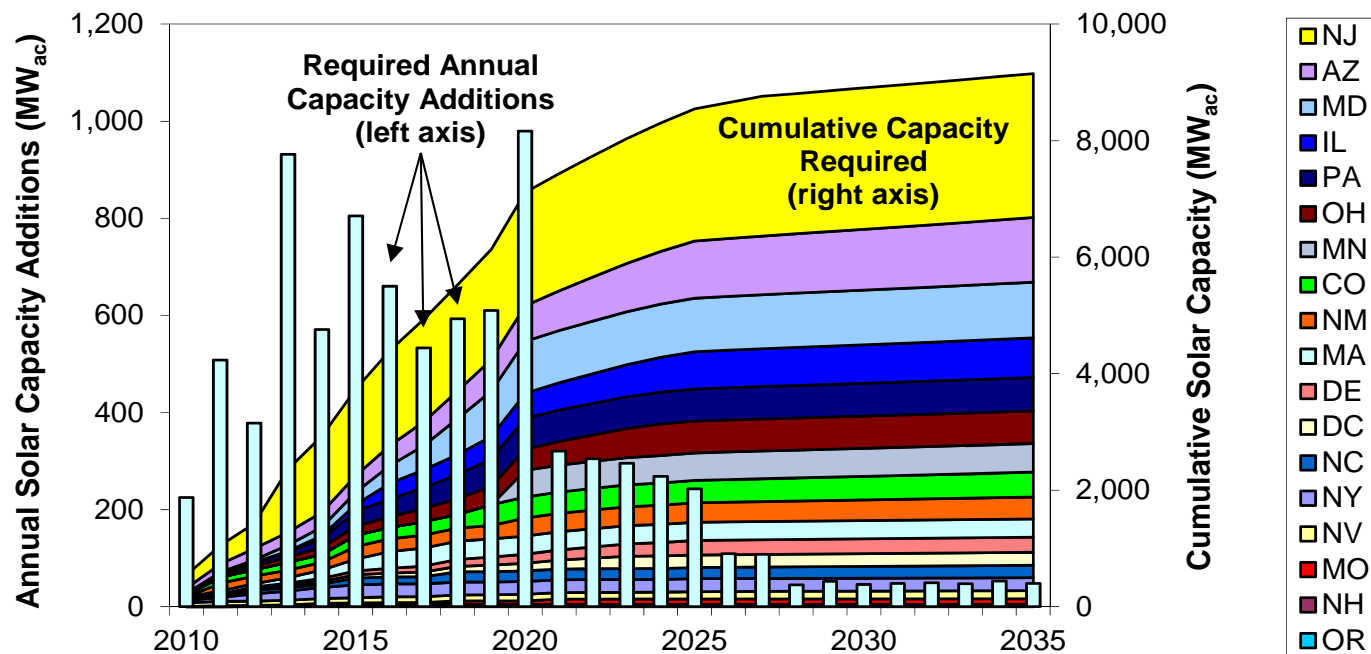


- 8 ¢/kWh reduction in LCOE (38%) from 2010 to 2013
- An additional 7 ¢/kWh (54%) LCOE reduction still necessary to achieve SunShot goals

Note: assumes no ITC. \$2013 converted to \$2010 using the “Chemical Engineering Plant Cost Index.”

Solar Market Growth is on Pace to Meet Future Solar/DG Set-Aside Requirements

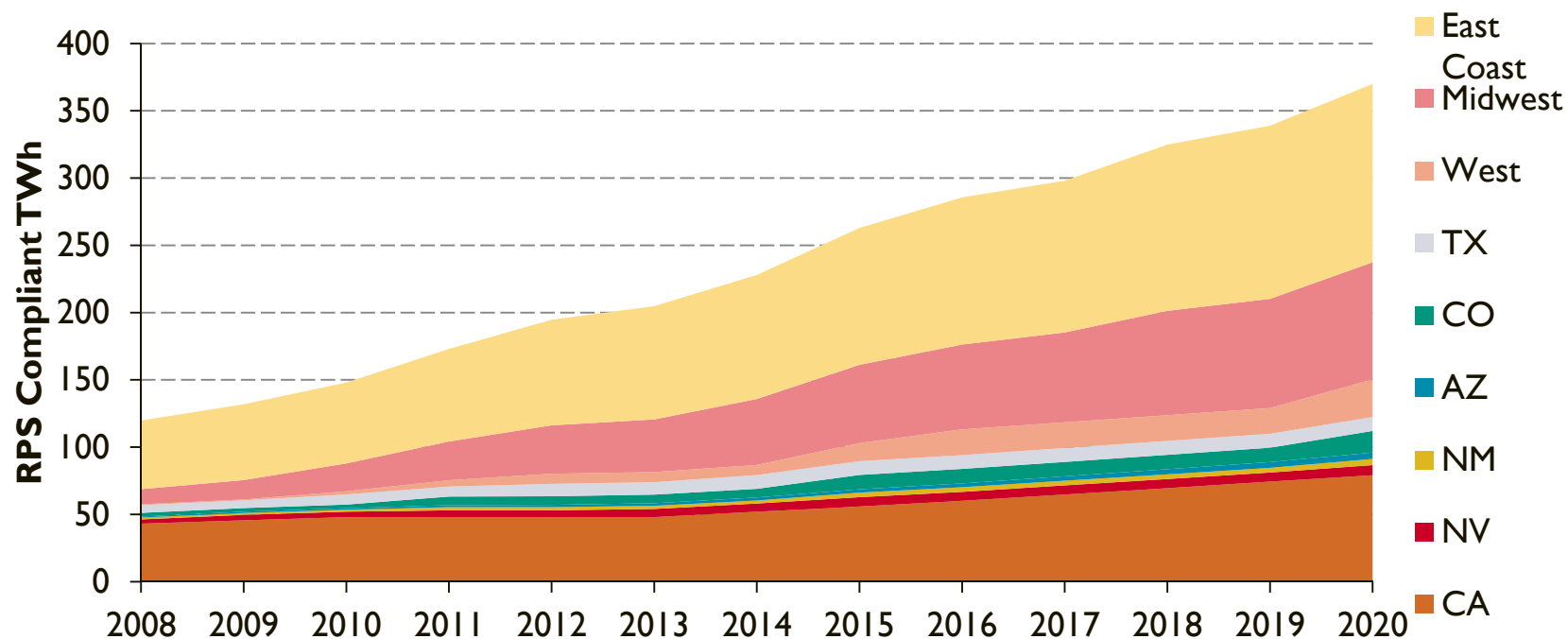
- Cumulative capacity requirement grows to **9,200 MW by 2035**
- Required average annual solar capacity additions of **700 MW/yr through 2020**, tapering off thereafter
- By comparison, set-aside PV additions reached 1,200 MW in 2012



RPS has traditionally driven a lot of solar deployment, but unless they are raised in future, they will play less of a

Source: Galen Barbose,
LBNL

Total RPS Targets of all 29 States with Laws



- Solar is incentivized beyond carve-out through total RPS targets
- Solar carve-out is a small portion of the total RPS goals
 - 16 TWh solar carve-out vs. 370 TWh's by 2020 (10% of U.S. electricity sales)
- If California, which has no solar carve-out, satisfied additional RPS requirements from 2012-2020 through solar installations, it would represent ~22 GW
 - CO ~7GW (solar carve-out 1.1 GW)
 - NV, NM, AZ ~2 GW
 - Other regions more likely to use larger % of Wind (and some RPS's have % req. for other technologies)
- Other factors may push solar installations beyond RPS targets

Sources: RPS: DSIRE RPS Spreadsheet120612, Retail Sales: 2011 EIA. Assumed capacity factor 1,400 kWh/kW

Thank You

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