NREL
NATIONAL RENEWABLE ENERGY LABORATORY

National Trends in State RPSs and Voluntary Markets

Jenny Heeter

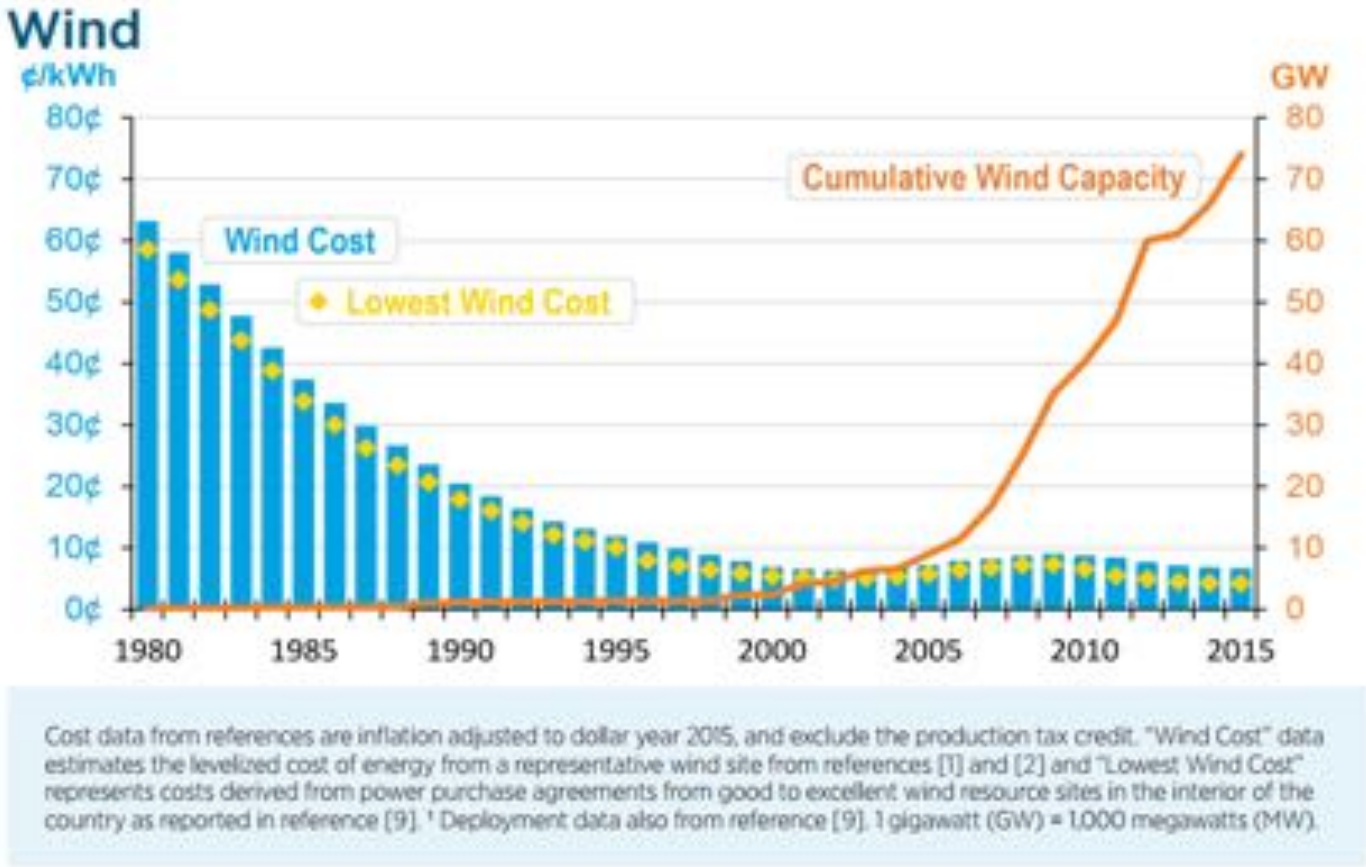
M-RETS Stakeholder Meeting

October 4-5, 2016

Key Questions

- How are renewable costs declining?
- What role to state renewable portfolio standards play in creating demand for renewables?
- How are voluntary markets responding to declining costs and increased customer demand?

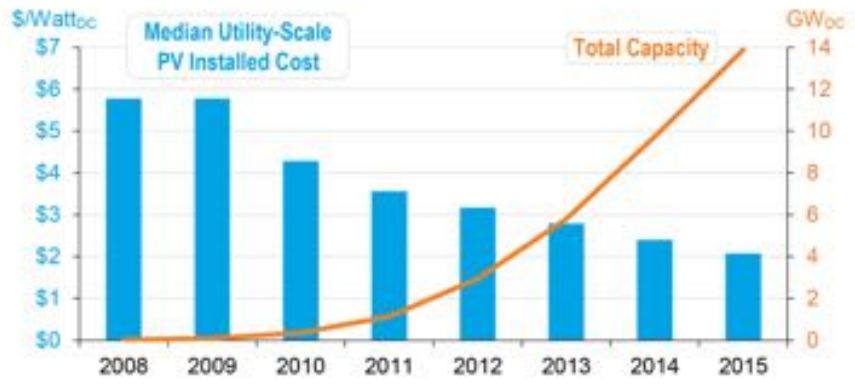
Declining Renewable Costs Continue to Drive Deployment



- Land based wind costs have declined ~41% since 2008.
- Wind provided nearly 5% of total U.S. electricity generation in 2015.
- A wind turbine installed in 2016 on average has 108% longer blades and is 48% taller than one installed in 1999.

Utility Scale PV at ~$2/W; Distributed PV at ~$4/W

Solar PV: Utility-Scale



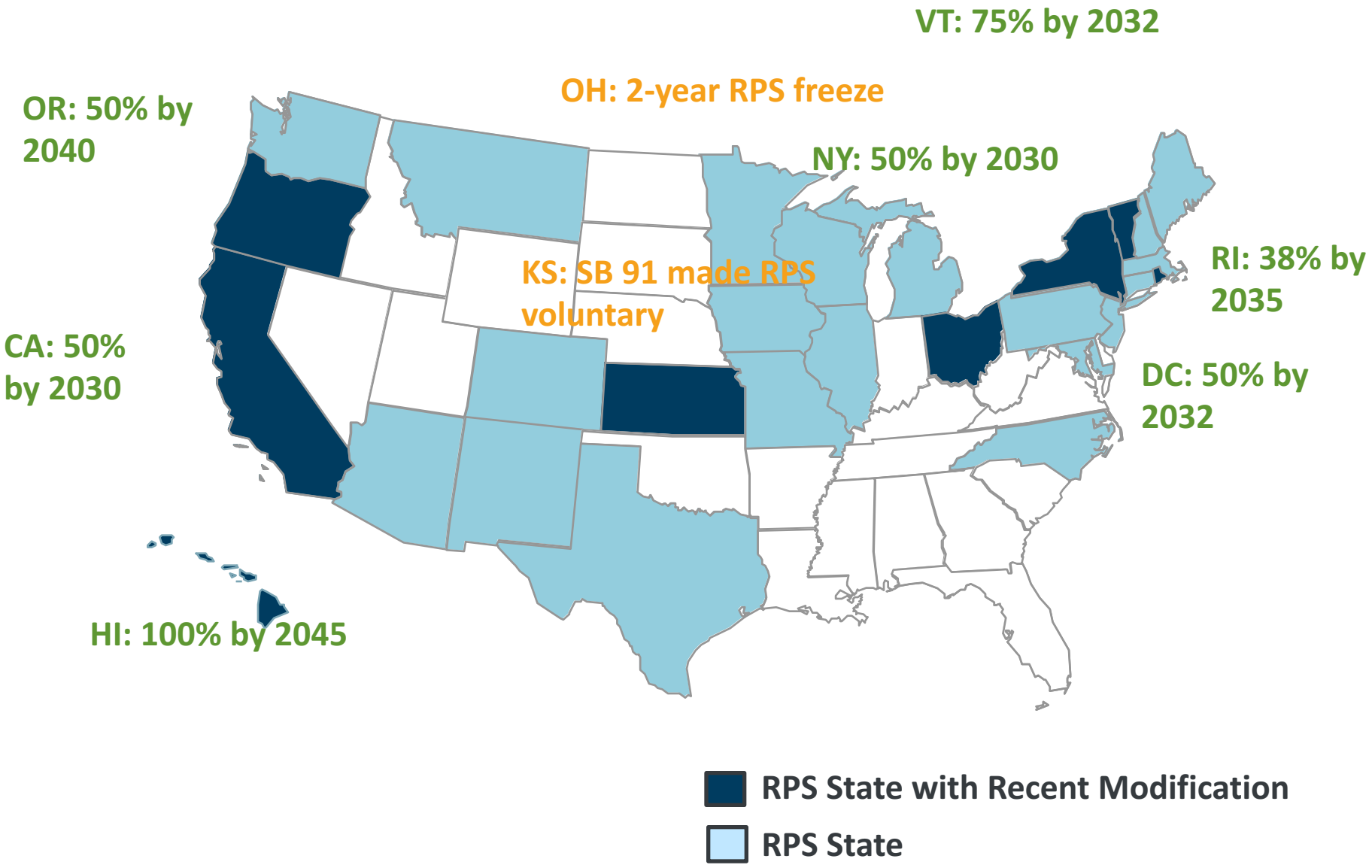
Costs from reference [4]; Deployment from reference [16]. Costs shown are the median costs and exclude the effect of the Investment Tax Credit. 1 gigawatt (GW) = 1,000 megawatts (MW). Costs and capacity are reported as DC power.

Solar PV: Distributed

Cost data from reference [3], deployment data from reference [16]. Costs are average installation costs for residential sector PV and exclude the effect of the Investment Tax Credit. 1 GW = 1,000 MW.

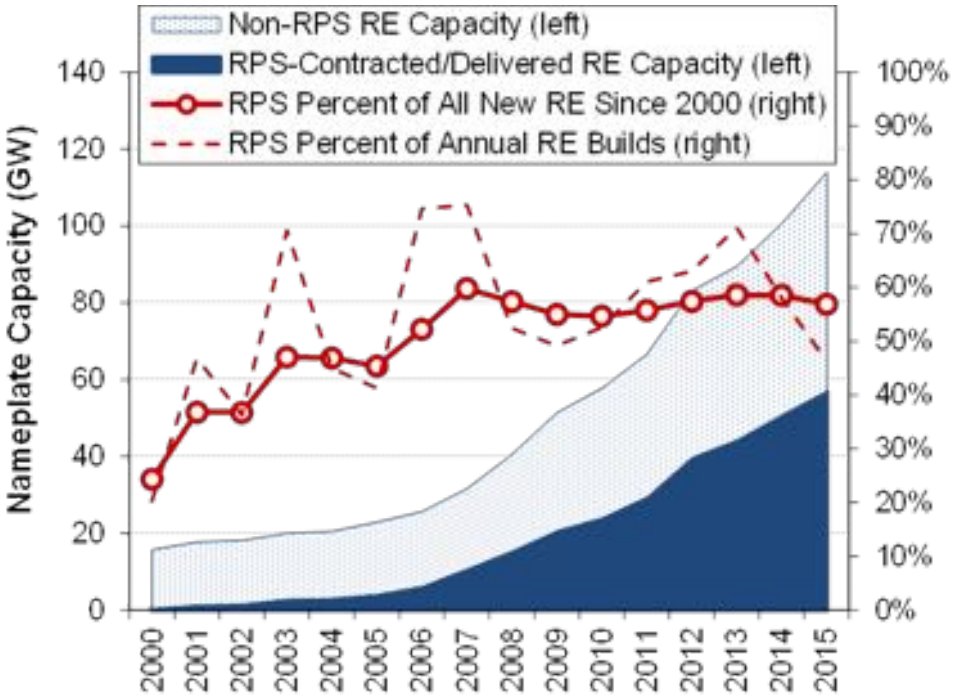
- Utility PV costs have declined by 64% since 2008.
- Distributed PV costs have declined by 54% since 2008
- In 20 states, financing a residential PV systems costs less than electricity from utility.

States are Increasing RPS Targets to >50%



RPS Policies Also Driving Growth in RE Capacity; 57% of all new RE capacity delivered to RPS-obligated load

Total U.S. Non-Hydro Renewable Generation Capacity (GW)



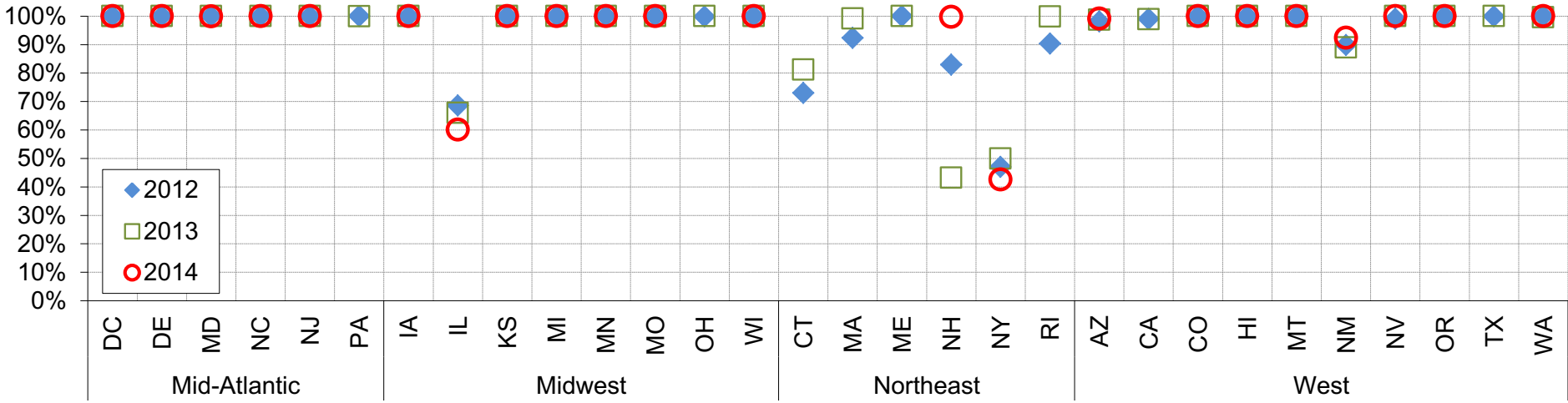
Notes: RPS-Contracted/Delivered capacity consists of RE capacity contracted to entities subject to an RPS or sold on a merchant basis into regional RPS markets, subject to additional constraints (see Supplementary Notes). Lines represent RPS-Contracted/Delivered capacity as a percent of all RE capacity additions (RPS+Non-RPS) on annual and cumulative bases.

- Total U.S. non-hydro RE capacity additions equal 100 GW since 2000
- Of that, 57 GW is contracted to load-serving entities (LSEs) with active RPS obligations or is otherwise sold into RPS markets
- Non-RPS RE capacity growth is mostly wind in Texas and the Midwest (in excess of RPS requirements, much of it selling into green power markets), as well as net-metered PV in California
- The relative contribution of RPS to RE growth has declined in recent years (from 71% of Annual RE Builds in 2013 to 46% in 2015), as other drivers have become more significant

Source: Barbose (2016). 2016 Annual RPS Summary Report. http://rps.lbl.gov

Most States Have Fully Met Recent RPS Targets; RPS drove 98 TWh of new RE in 2013

RPS Achievement: General or Primary-Tier RPS Obligations



Notes: The values represent the percentage of annual RPS targets met with RE or RECs retired for RPS compliance each year, focusing on general or primary-tier (new, Class I, or Tier I) RPS obligations—i.e., excluding technology carve-outs or secondary (existing, Class II or Tier II) resource tiers. For states with compliance years beginning in the middle of calendar years, compliance years are mapped to the chart based on their start date.

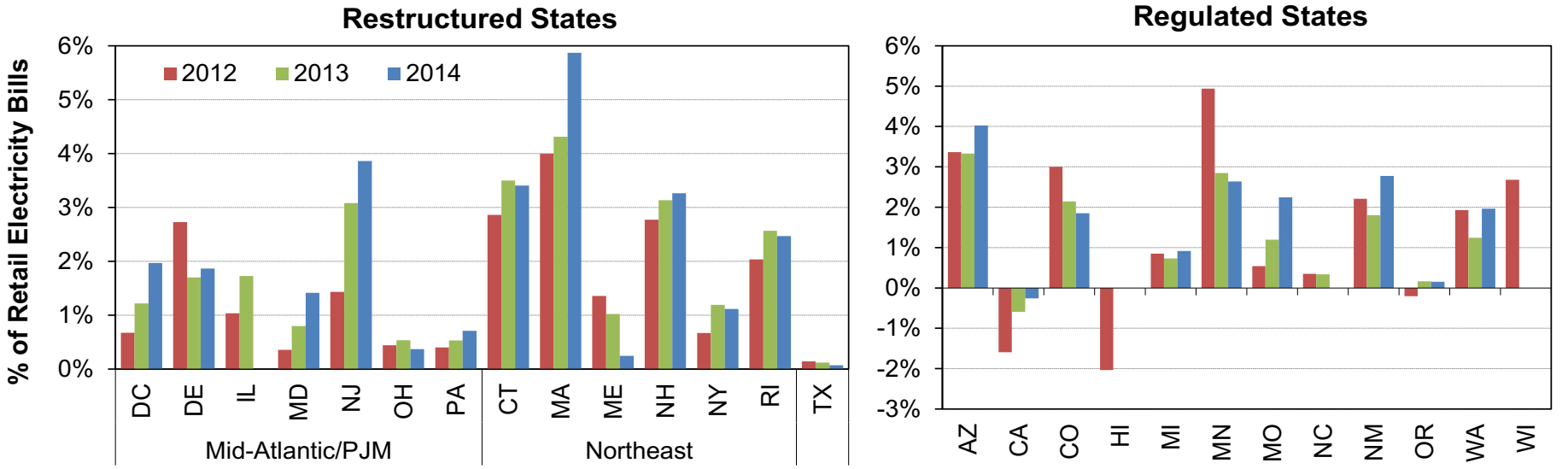
The vast majority of states fully met their interim RPS targets over the three-year period shown; exceptions include:

- **IL:** Alternative retail suppliers are required to meet 50% of RPS with ACPs
- **Northeast:** Growth in regional RE supplies lagged behind RPS demand growth
- **NM:** RPS cost caps led to reduced procurement for one utility

Source: Barbose (2016). 2016 Annual RPS Summary Report. http://rps.lbl.gov

RPS Compliance Cost Variation Across States
Ranged from -0.3% to 5.9% of retail electricity bills in 2014

Total RPS Compliance Costs (all resource tiers)



- Variation across states reflects a multitude of factors: RPS target levels, resource tiers/mix, REC prices, wholesale electricity prices, reliance on pre-existing resources, and cost calculation methods (among other differences)
- Though not shown, compliance costs can also vary among LSEs within an individual state (e.g., between IOUs and municipal utilities)

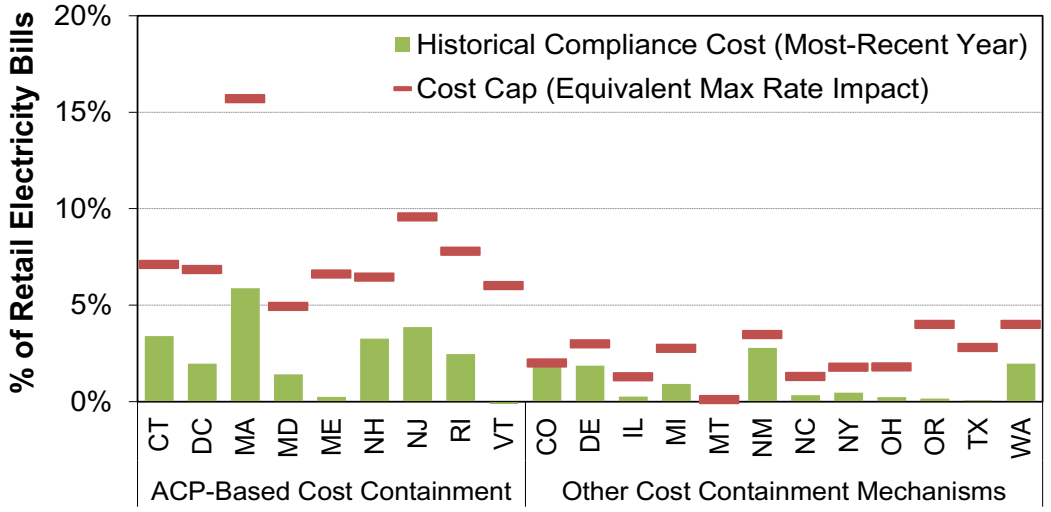
Source: Barbose (2016). 2016 Annual RPS Summary Report. http://rps.lbl.gov

Cost Containment Mechanisms Will Limit Growth in RPS Compliance Costs

RPS policies include various cost containment mechanisms

- ACPs (which cap REC prices)
- Rate impact or revenue requirement caps
- Caps on surcharges for RPS cost recovery
- RE contract price caps
- Renewable energy fund caps
- Financial penalties

Recent Costs Compared to Cost Caps

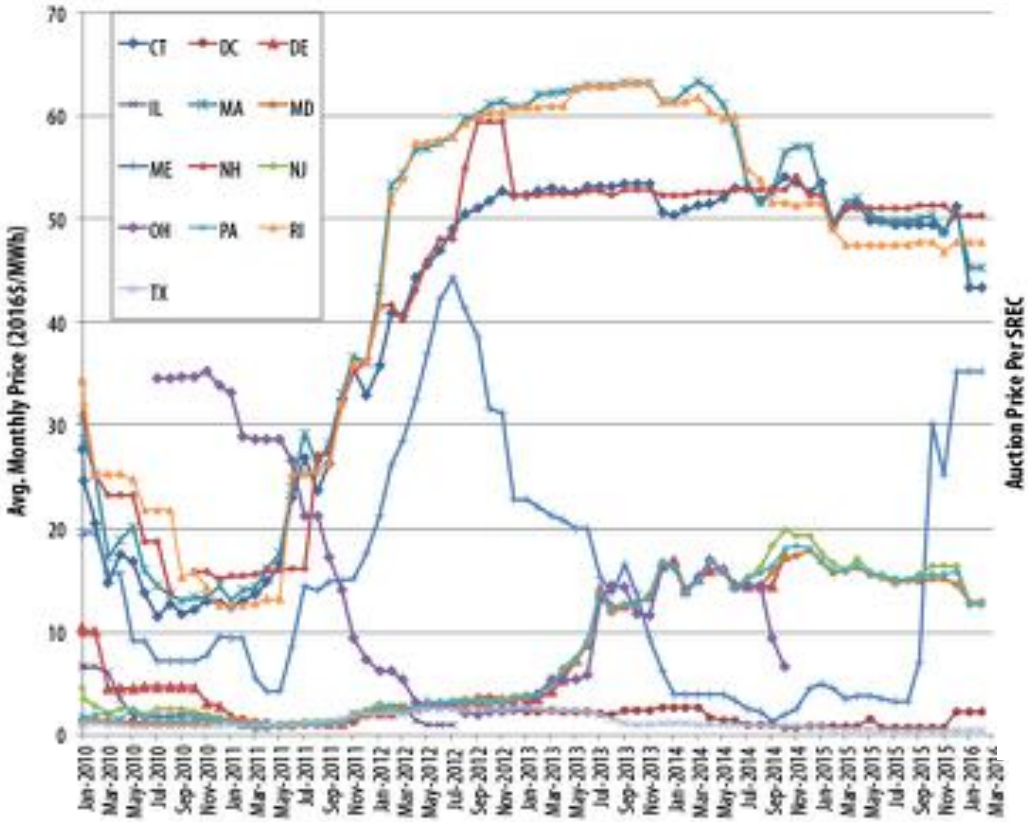


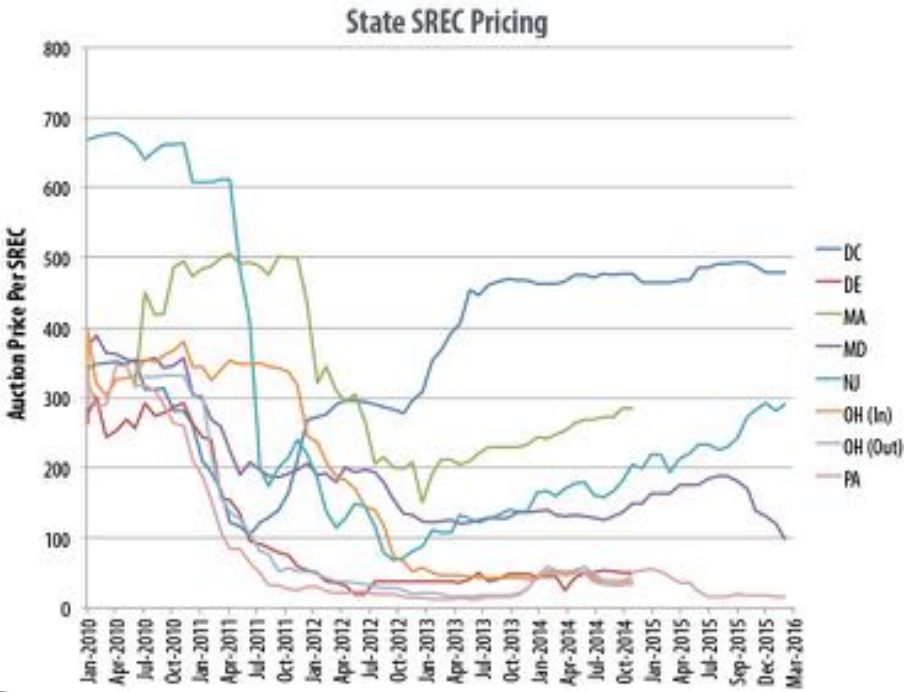
See Supplementary Notes for key methodological details.

- ACPs generally cap costs at 5-10% of retail rates (the max. rate impact if the entire RPS obligation in the final target year were met with RECs priced at the ACP)
- Cost caps in states with other cost containment mechanisms are generally more restrictive (equivalent maximum rate impact of 1-4%), and have already become binding for several states and utilities

Source: Barbose (2016). 2016 Annual RPS Summary Report. http://rps.lbl.gov

REC Pricing Varies by Market



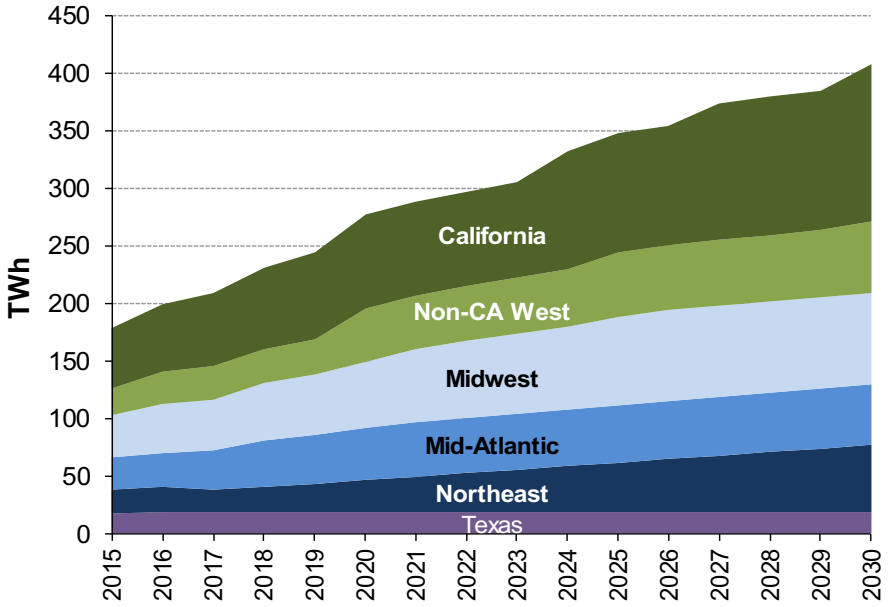


- REC pricing varies by state and by technology type (Solar RECs vs Tier 1/Main Tier RECs)
- REC pricing fluctuates depending on the supply/demand balance in the state, which is influenced by state policy

Substantial Growth in RPS Demand Remains; Total U.S. RPS Demand Roughly Doubles by 2030

Projected RPS Demand for RE

Excluding hydro, MSW, and non-RE



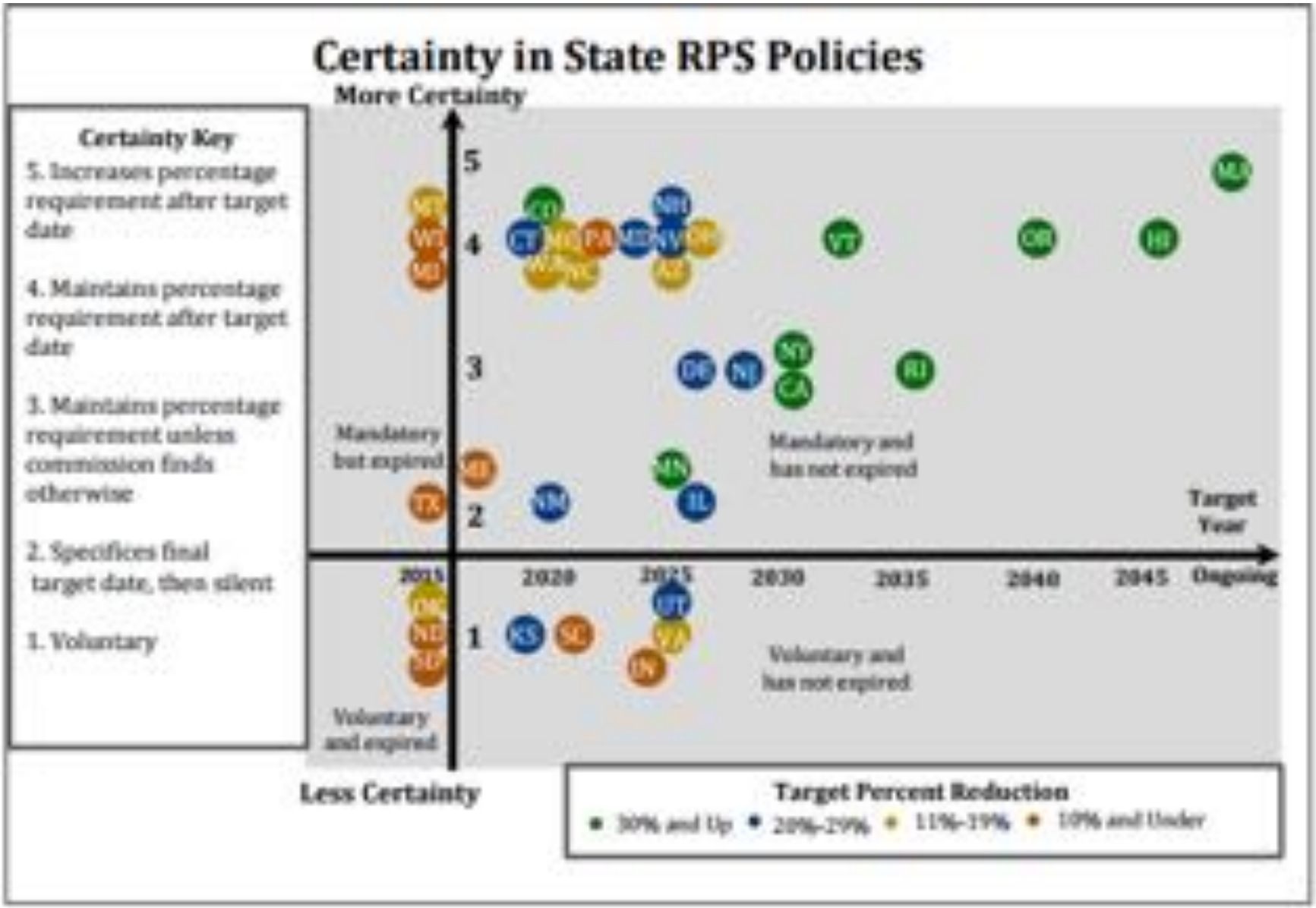
Notes: Projected RPS demand is estimated based on current targets, accounting for exempt load, likely use of credit multipliers, offsets, and other state-specific provisions. Likely contributions by hydro, municipal solid waste (MSW), and non-RE technologies are deducted from the totals for consistency across states. Underlying retail electricity sales forecasts are based on regional growth rates from the most-recent EIA Annual Energy Outlook reference case.

- Under current state targets, total U.S. RPS demand will increase from 231 TWh in 2016 to 445 TWh in 2030 (though RE-portion in figure is slightly lower: 408 TWh in 2030)
- California represents roughly 40% of that growth; most of the remainder associated with relatively large states
- Some utilities and regions are ahead of schedule, with RE purchases in excess of current requirements; increased demand does not equate to required increase in supply

State-level RPS demand projections available for download at: rps.lbl.gov

Source: Barbose (2016). 2016 Annual RPS Summary Report. http://rps.lbl.gov

Most RPSs Expire in 2020-2025 Timeframe



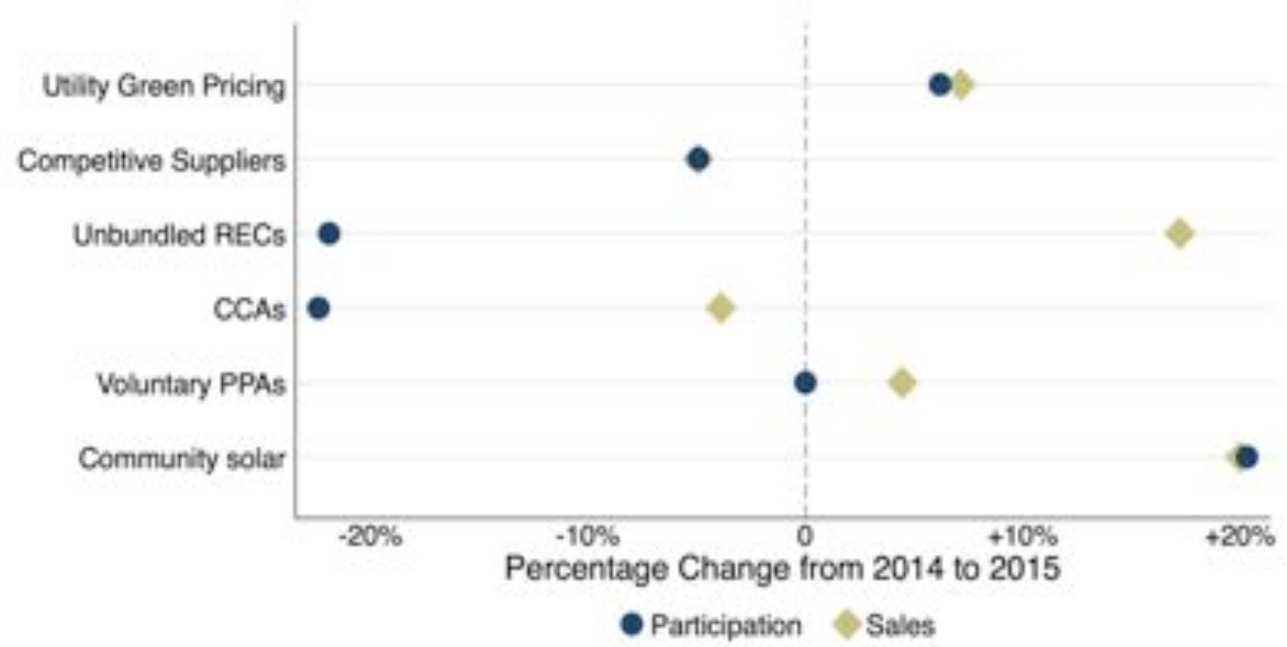
Trends in the National Voluntary Market

Purchasing Options are Expanding; Value Propositions and REC Treatment Vary

Existing and emerging purchasing methods	Value proposition	REC treatment
Utility green pricing Competitive supplier Unbundled RECs	• Match all or part of electricity consumption with renewable energy • Meet corporate sustainability goals	Purchaser keeps RECs
On-site renewables Power purchase agreements Community choice aggregation Community solar Large customer renewable energy tariff Direct project investment/crowdfunding	• Provide location for renewable development • Potentially lower electricity bill • Meet municipal GHG reduction targets • Support local solar development • Potential price hedge	Purchaser does not necessarily keep RECs

Voluntary Market Growth ~10% from 2014-2015

- More than 4.3 million customers are participating in the green power market, purchasing nearly 78 million MWh of green power in 2015.
- Unbundled RECs are still represent more than half of the market, at largest segment overall, at 42 million MWh in 2015.

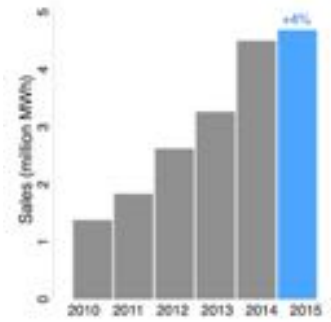


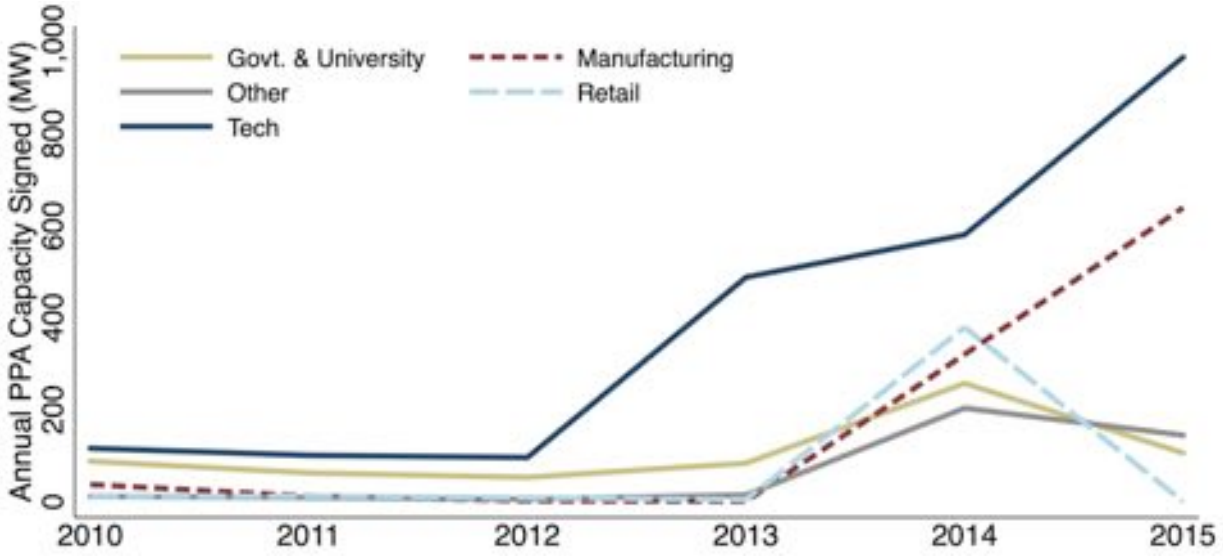
Corporate Commitments to Renewable Energy are Rapidly Increasing; Making Headlines

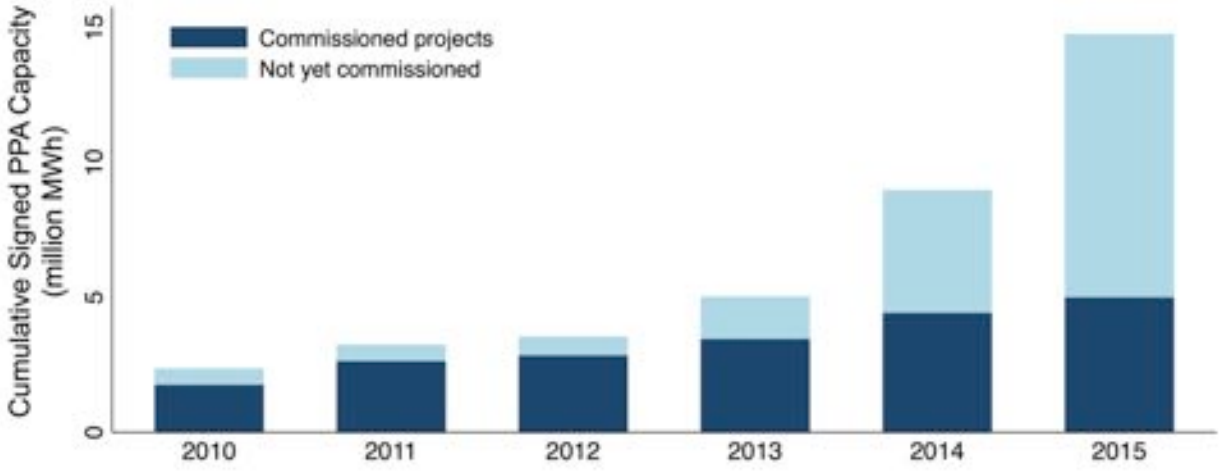
- 72% of surveyed US companies are actively pursuing renewables purchases (PWC 2016).
- US corporations signed over 2.7 GW of PPAs for large-scale, off-site renewable energy in 2015, double the signed capacity in 2014, and more than triple the signed capacity in 2013 (BNEF 2016).
- The emergence of utility green tariff programs in eight utility service territories offers an additional mechanism to meet large green power customer demand.

Voluntary PPA Sales Are Increasing, though Most Projects Signed in 2015 Have Not Become Operational

2015 Voluntary PPA Sales: 4.7 million MWh

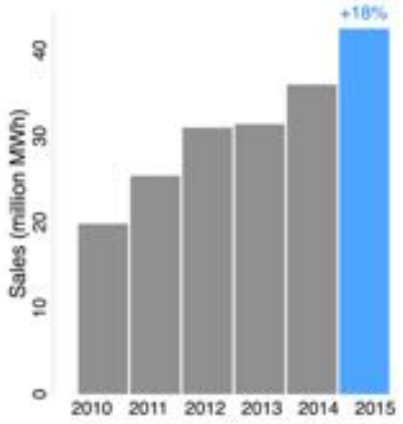




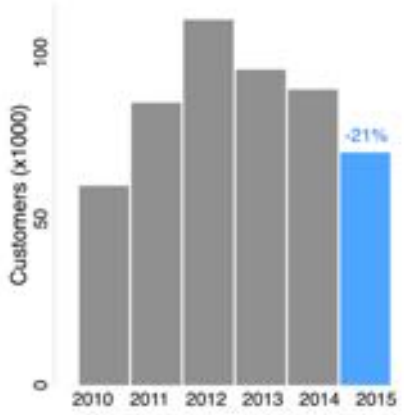


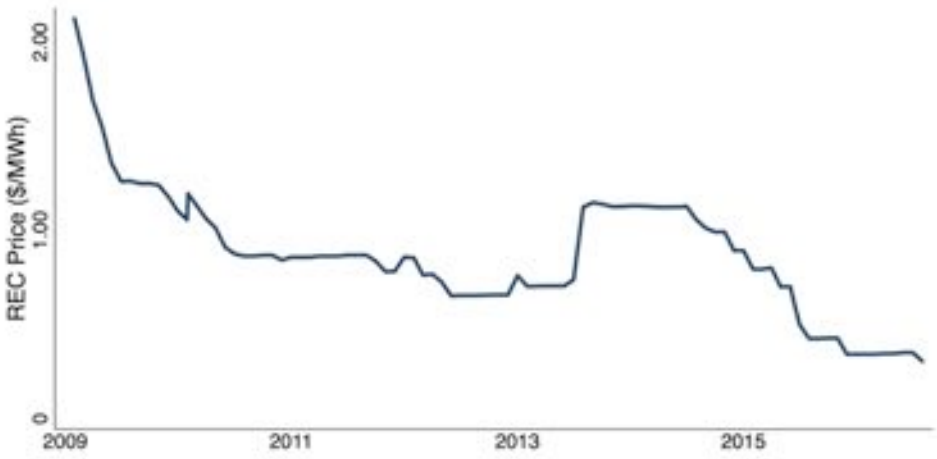
Unbundled RECs Represent More than Half of Market; 2015 Increase Likely due to Price Drop

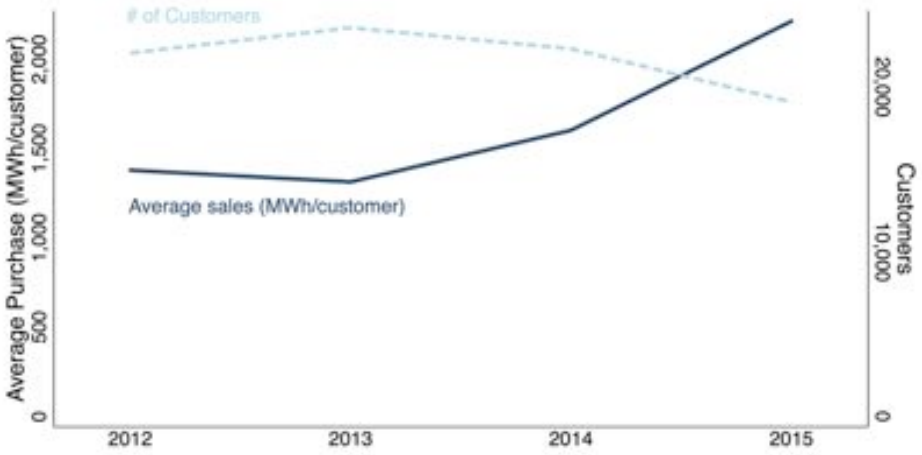
2015 Unbundled REC Sales: 42.5 million MWh



2015 Unbundled REC Participation: 69,500 customers

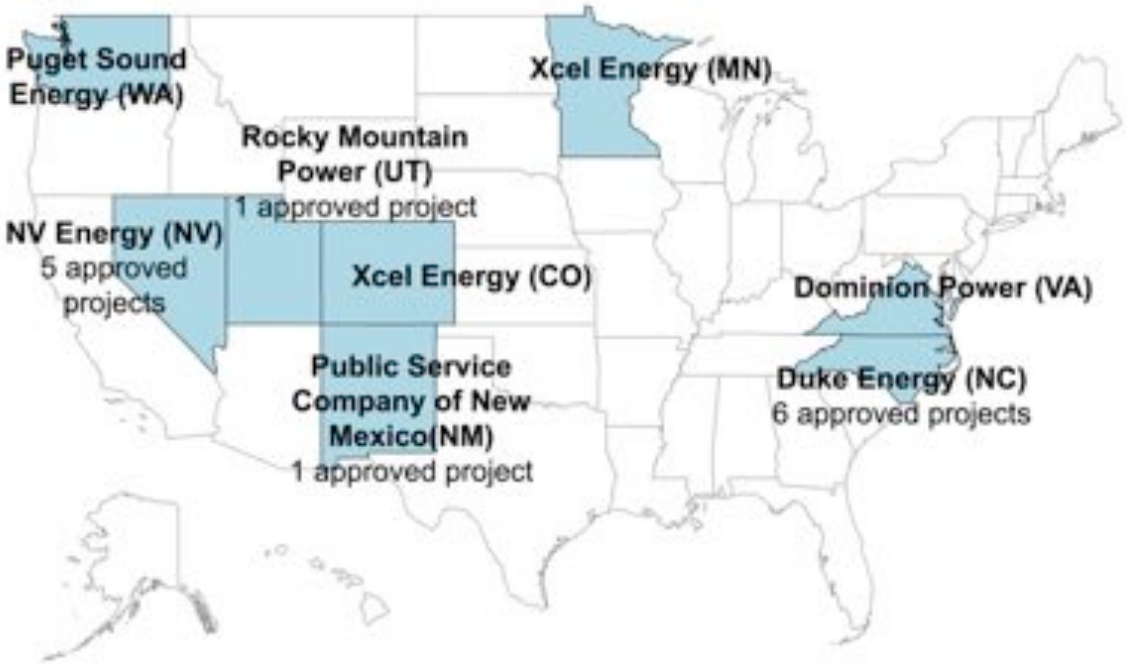






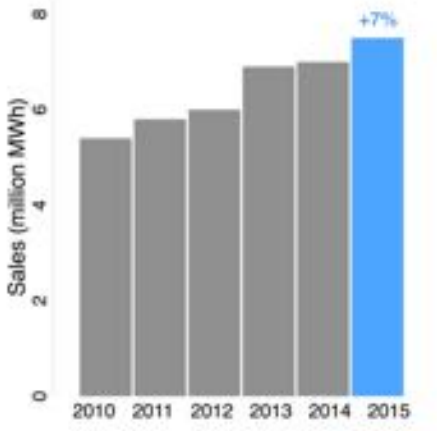
Utility Green Tariffs are an Emerging Option in Regulated States

- Utility green tariffs are currently offered in eight utility service territories
- By September 2016, at least 13 renewable energy projects had been approved, representing at least 350 MW

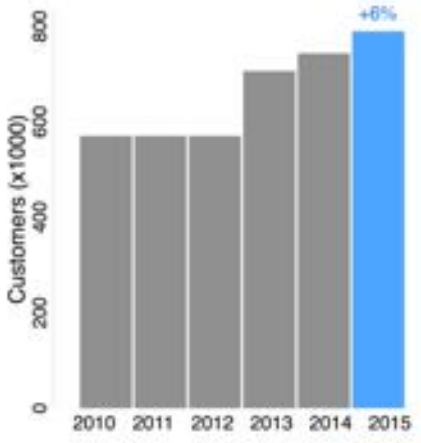


Traditional Green Pricing Sales Increased 7%; Dominated by Large Programs

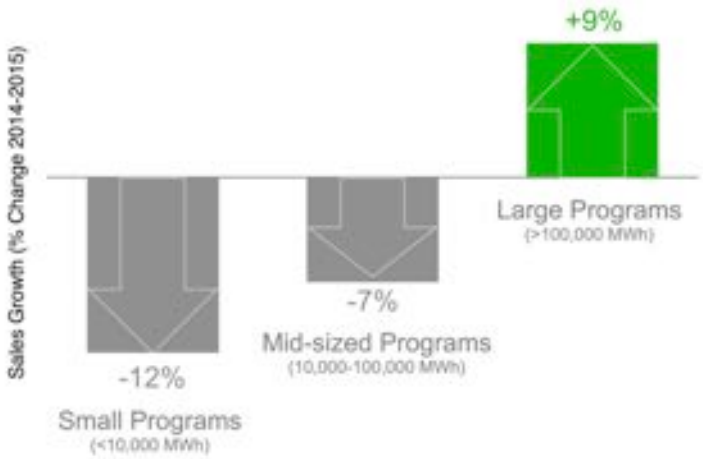
2015 Green Pricing Sales: 7.5 million MWh



2015 Green Pricing Participation: 789,000 customers

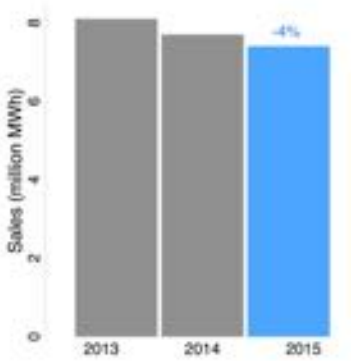


Green Pricing Sales Growth by Program Size

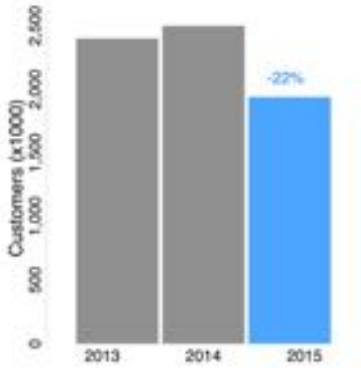


Renewables Purchased by CCAs Declined Overall, though California Market is Poised to Increase

2015 CCA Sales: 7.4 million MWh



2015 CCA Participation: 1,940,000 customers



State	Estimated green power sales (MWh) (%Δ from 2014)	Participants in CCAs with green power products (%Δ from 2014)	CCAs with green power products
Illinois[a]	4,920,000 (-5%)	1,450,000 (-31%)	54 programs
California[b]	1,650,000 (27%)	370,000 (29%)	Lancaster Choice Energy Marin Clean Energy Sonoma Clean Power
Ohio[b]	580,000 (-39%)	80,000 (-34%)	City of Cincinnati City of Cleveland
Massachusetts[a,b]	280,000 (0%)	32,000 (0%)	Cape Light Compact City of Lancaster City of Lowell

[a] Estimate extrapolated from publicly available reports of green power products in CCAs applied to historical data on electricity usage
[b] Based on NREL survey data

Community Solar is Expanding to New States; Typically Projects do not Convey RECs to Customer

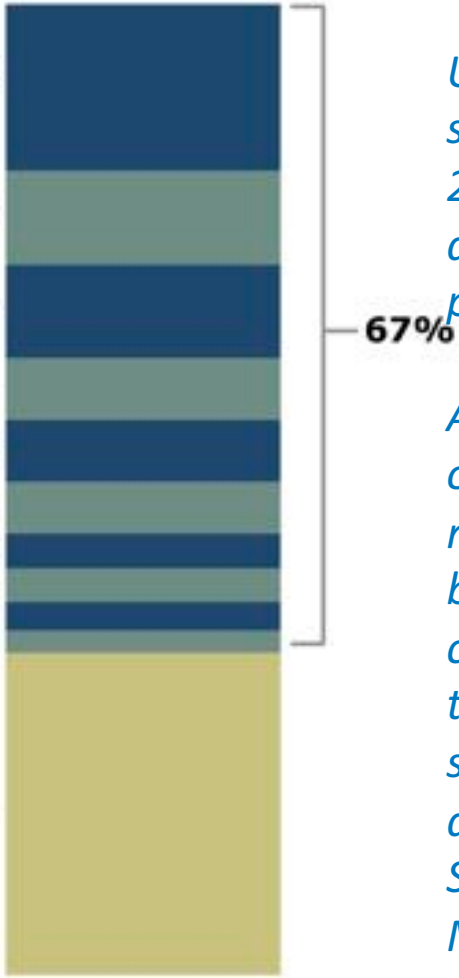
Contact information:
Jenny Heeter
303-275-4366
jenny.heeter@nrel.gov

www.nrel.gov

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

The top 10 utility green pricing programs, by sales, represented 67% of the green pricing market in 2014.

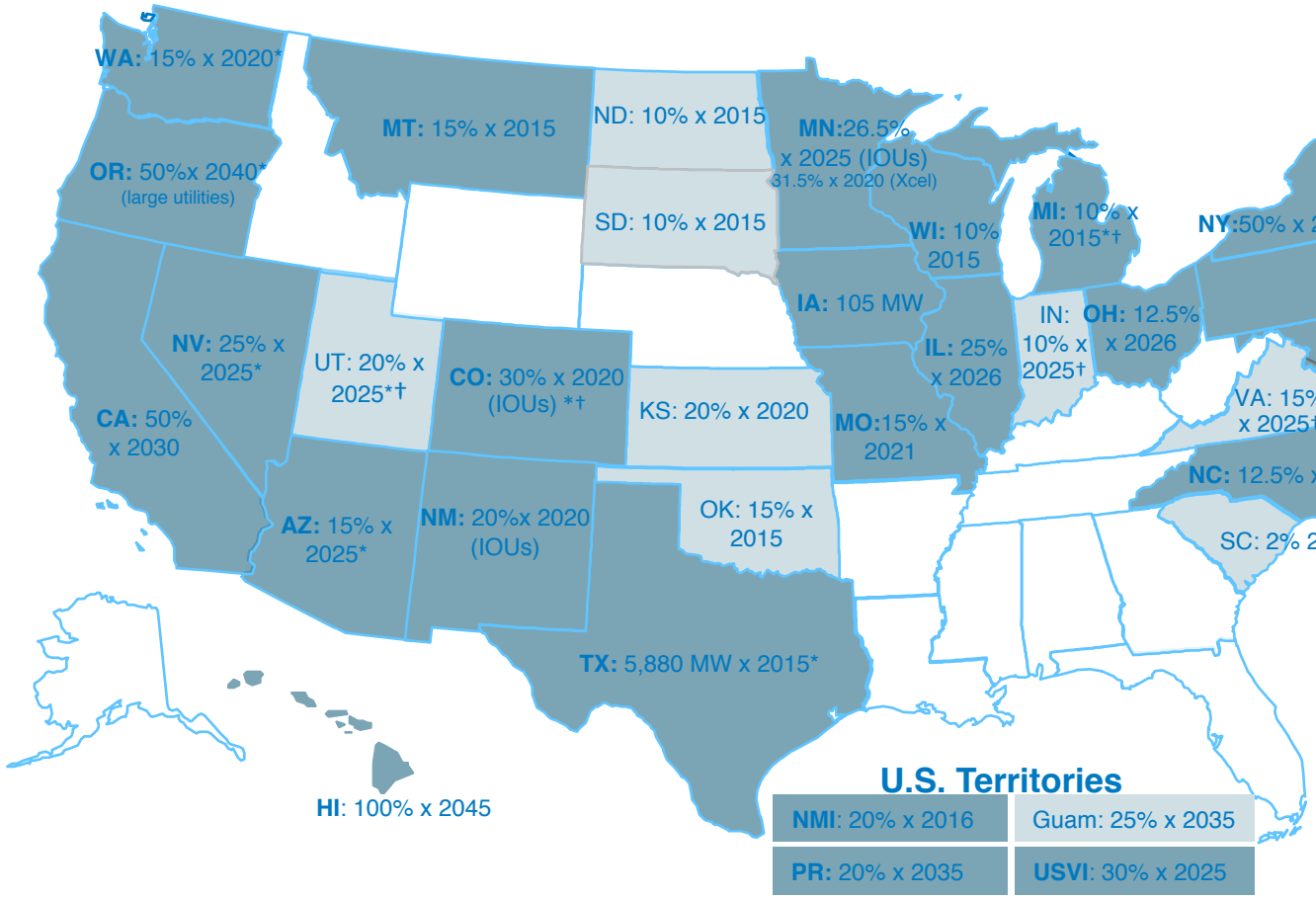
Program	Sales (MWh)
1.Portland General Electric	1,171,978
2.Austin Energy	683,986
3.PacifiCorp	673,977
4.Puget Sound Energy	450,191
5. Sacramento Municipal Utility District	446,995
6. Xcel Energy	377,480
7. Eversource/United Illuminating	250,456
8. Dominion Virginia Power	244,853
9. Tennessee Valley Authority	206,522
10. CPS Energy	170,931
All other programs	2,336,981



Utility green pricing sales grew by 5% in 2014, with the growth driven by existing large programs.

A few utilities are offering large customer renewable energy tariffs, but to date, only two companies have utilized these options; Apple signed a 20 MW agreement for solar and Switch Ltd. signed a 100 MW agreement.

August 2016 Status of Renewable Portfolio Standards



ME: 40% x 2017
NH: 24.8%x 2025
VT: 75% x 2032
MA: 15% x 2020(new resources) 6.03% x 2016 (existing resources)
RI: 38.5% x 2035
CT: 27% x 2020
NJ: 20.38% RE x 2020 + 4.1% solar by 2027
PA: 18% x 2021†
DE: 25% x 2026*
MD: 20% x 2022
DC: 20% x 2020

U.S. Territories

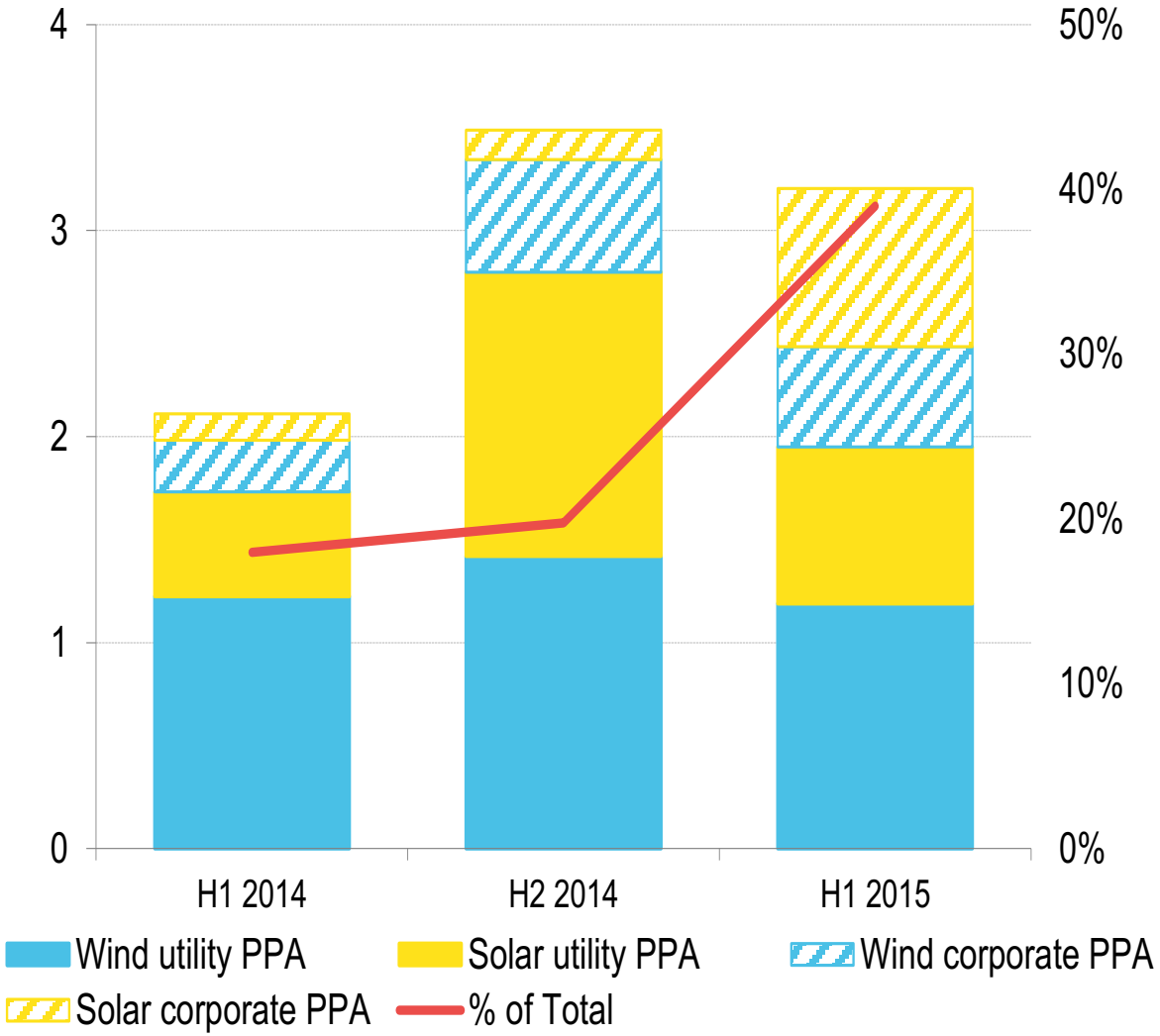
NMI: 20% x 2016	Guam: 25% x 2035
PR: 20% x 2035	USVI: 30% x 2025

29 States + Washington DC + 3 territories have a Renewable Portfolio Standard
(8 states and 1 territories have renewable portfolio goals)

Renewable portfolio standard
Renewable portfolio goal

* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources

Non-utility purchases represented 40% of PPAs in H1 2015



On a GW basis, corporate (i.e. non-utility) buyers of wind and solar accounted for 40% of the market in H1 2015; an increase from 2014 levels.

Source: Bloomberg New Energy Finance