

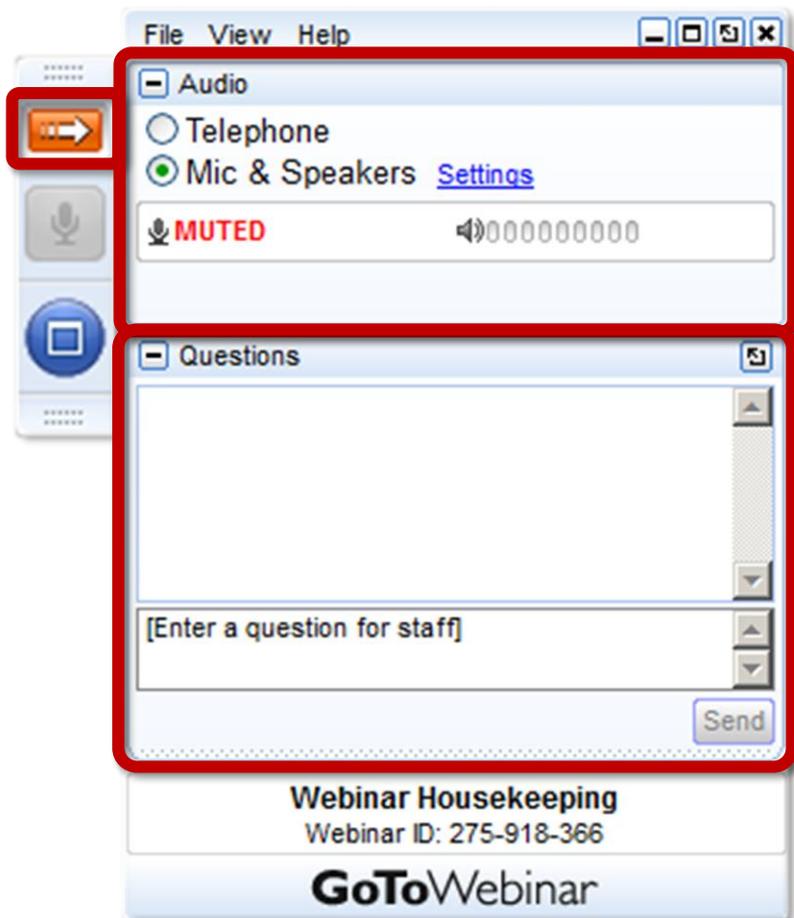
**RPS Collaborative Webinar**

# U.S. Renewables Portfolio Standards: 2017 Annual Status Report

Hosted by  
Warren Leon, Executive Director, CESA

September 6, 2017

# Housekeeping



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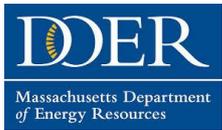
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# Clean Energy States Alliance



[www.cesa.org](http://www.cesa.org)

# RPS Collaborative

- With funding from the Energy Foundation and the US Department of Energy, CESA facilitates the **Collaborative**.
- Includes **state RPS administrators, federal agency representatives**, and other stakeholders.
- Advances dialogue and learning about RPS programs by **examining the challenges and potential solutions** for successful implementation of state RPS programs, including **identification of best practices**.
- To sign up for the Collaborative listserv to get the **monthly newsletter** and announcements of **upcoming events**, see: [www.cesa.org/projects/renewable-portfolio-standards](http://www.cesa.org/projects/renewable-portfolio-standards)



U.S. DEPARTMENT OF  
**ENERGY**



# Guest Speaker

- **Galen Barbose**, Research Scientist, Electricity Markets and Policy Group, Lawrence Berkeley National Laboratory





Energy Technologies Area

Lawrence Berkeley National Laboratory

# U.S. Renewables Portfolio Standards 2017 Annual Status Report

**Galen Barbose**

*Lawrence Berkeley National Laboratory*

**CESA RPS Collaborative Webinar**

*September 6, 2017*

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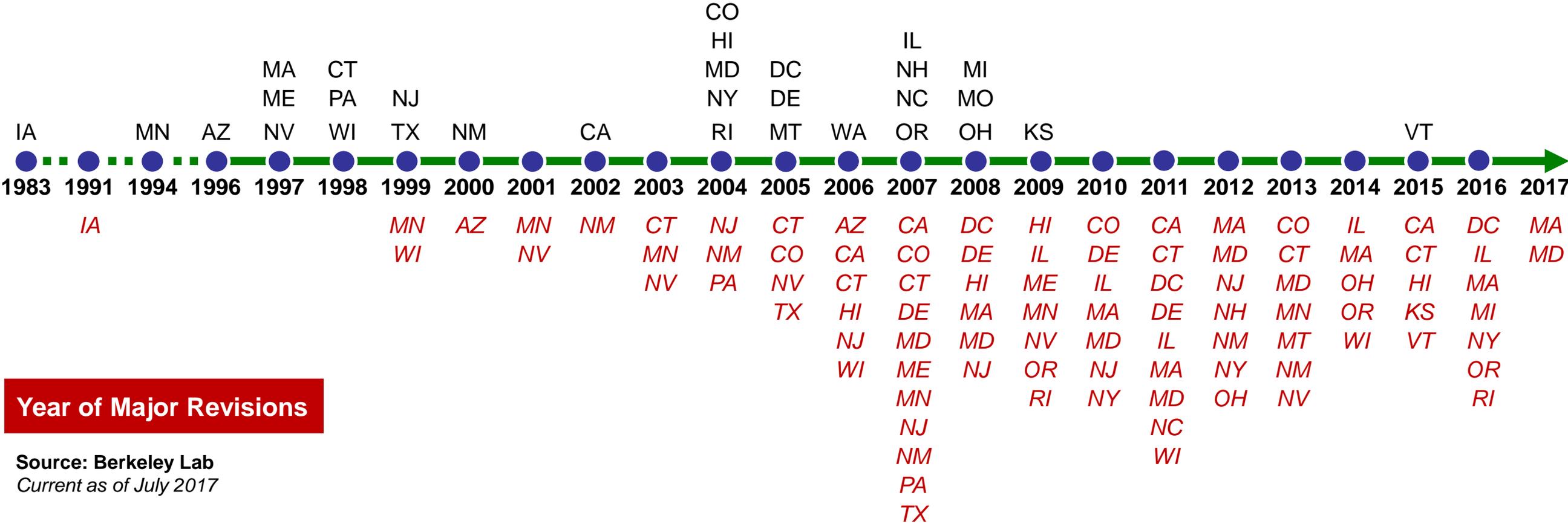
- **Evolution of state RPS programs**
- Historical impacts on renewables development
- Future RPS demand and incremental needs
- RPS target achievement to-date
- REC pricing trends
- RPS compliance costs and cost caps
- Outlook



# Most RPS Policies Have Been in Place for at Least 10 Years

States continue to make regular and significant revisions

## Year of RPS Enactment



## Year of Major Revisions

Source: Berkeley Lab  
Current as of July 2017

# General Trends in RPS Revisions

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**Increase and extension of RPS targets:** More than half of all RPS states have raised their overall RPS targets or carve-outs since initial RPS adoption; many in recent years

**Creation of resource-specific carve-outs:** Solar and DG carve-outs are most common (18 states + D.C.), often added onto an existing RPS

**Long-term contracting programs:** Often aimed at regulated distribution utilities in competitive retail markets; sometimes target solar/DG specifically

**Refining resource eligibility rules:** Particularly for hydro and biomass, e.g., related to project size, eligible feedstock, repowered facilities

**Loosening geographic preferences or restrictions:** Sometimes motivated by concerns about Commerce Clause challenges or to facilitate lower-cost compliance

In addition, although many states have introduced bills to repeal, reduce, or freeze their RPS programs, only two (OH, KS) have thus far been enacted

# RPS Legislation and Other Revisions in 2016 and 2017-to-date

Most proposals sought to strengthen or make small technical changes

## RPS-Related Bills Introduced and Enacted in 2016 & 2017

|                   | Strengthen | Weaken | Neutral | Total |
|-------------------|------------|--------|---------|-------|
| <b>Introduced</b> | 96         | 51     | 81      | 228   |
| <b>Enacted</b>    | 13         | 3      | 17      | 33    |

Contrasts to previous years with more prevalent efforts to repeal or weaken RPS requirements

*Data Source: EQ Research (August 31, 2017)*

*Notes: Includes legislation from 2016 sessions and from 2015-2016 sessions active in 2016, as well as legislation active in 2017 sessions. Companion bills are counted as a single bill.*

## Major RPS revisions (legislative and administrative) made in 2016 and 2017-to-date:

- **DC:** Increased and extended RPS to 50% by 2032
- **IL:** Created requirements for “new” solar and wind, with additional carve-outs; IPA takes over procurement for retail suppliers
- **MA:** Created requirements for off-shore wind (1,600 MW by 2027) and new solar procurement program (1,600 MW)
- **MD:** Increased and accelerated RPS to 25% by 2020
- **MI:** Increased and extended RPS to 15% by 2021
- **NY:** Increased and extended RPS to 50% by 2030, and expanded coverage statewide
- **OR:** Increased and extended RPS to 50% by 2040 for large IOUs
- **RI:** Increased and extended RPS to 38.5% by 2035

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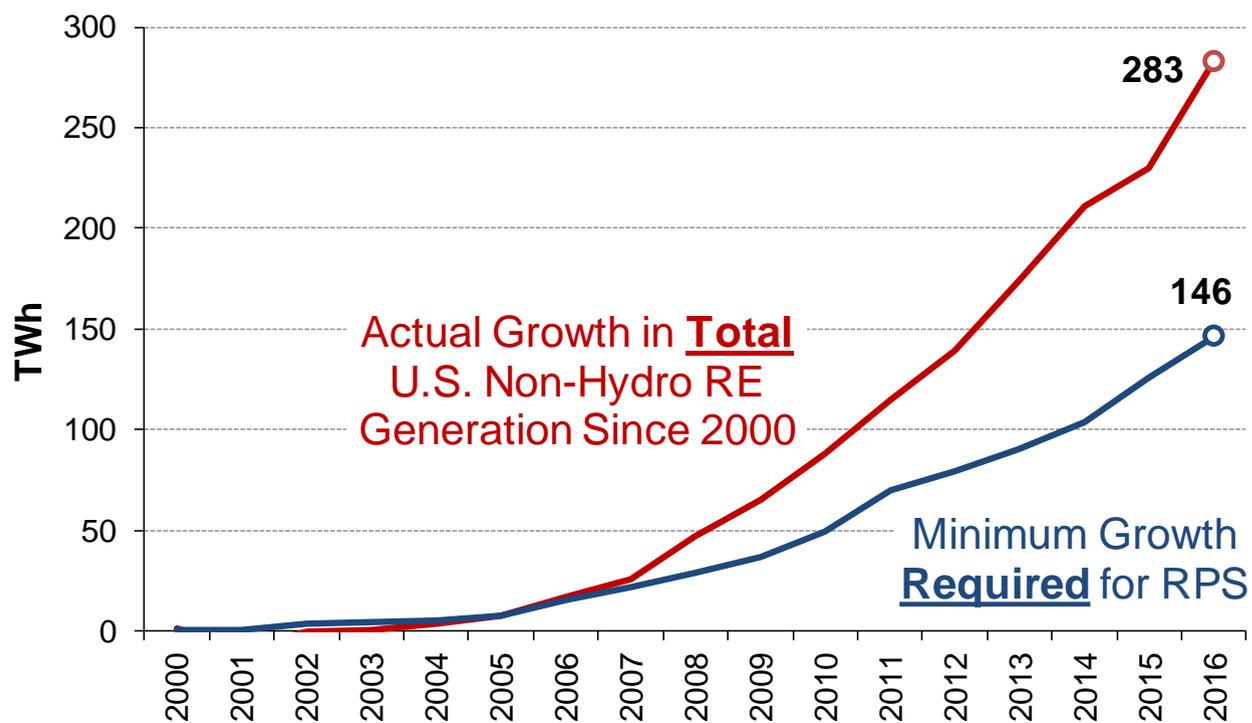
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# RPS Policies Have Been One Key Driver for RE Generation Growth

RPS requirements constitute ~50% of total U.S. RE growth since 2000

## Growth in Non-Hydro Renewable Generation: 2000-2016



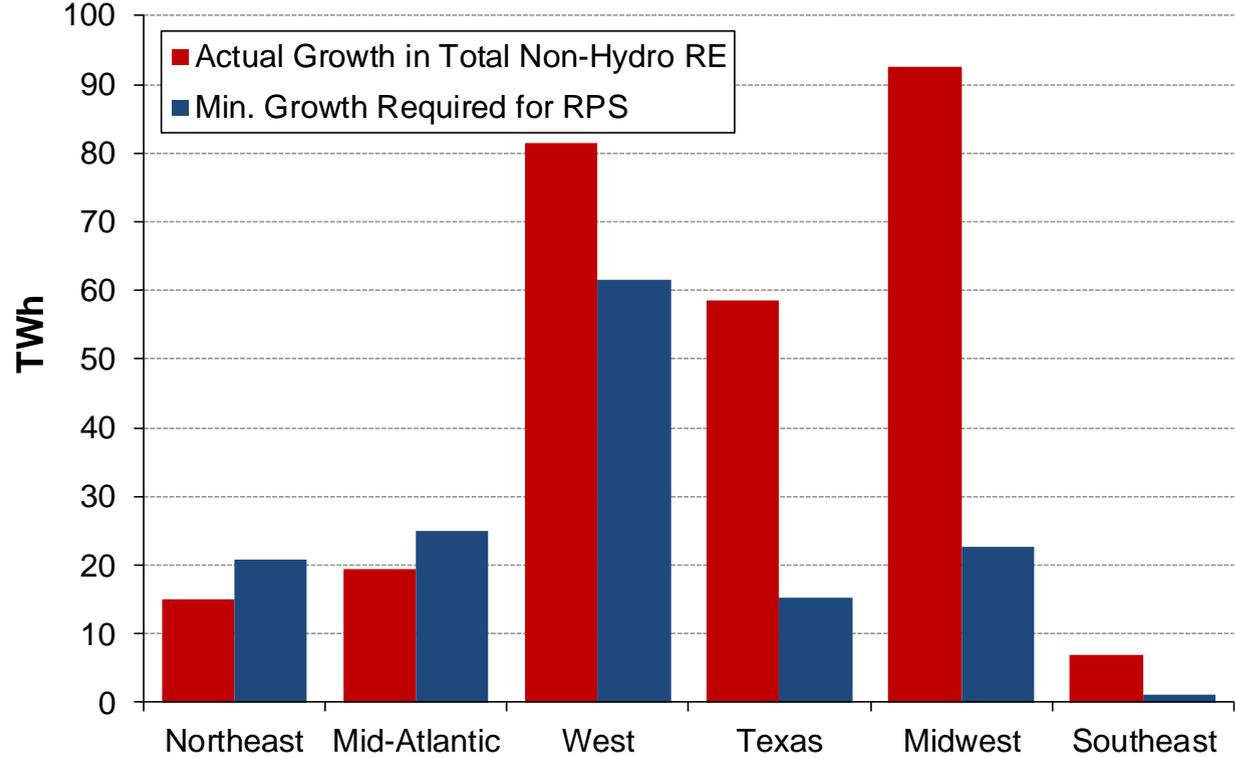
Notes: Minimum Growth Required for RPS excludes contributions to RPS compliance from pre-2000 vintage facilities, and from hydro, municipal solid waste, and non-RE technologies. This comparison focuses on non-hydro RE, because RPS rules typically allow only limited forms hydro for compliance.

- Total non-hydro RE generation in the U.S. grew by 283 TWh from 2000-2016
  - Many factors contributed to that growth (tax credits, other incentives, cost declines, etc.)
- RPS policies required 146 TWh increase over that period
  - Not strict attribution: some of that would have occurred without RPS
- Additional RE growth associated with:
  - Economic utility purchases
  - Corporate procurement and other voluntary green power markets
  - Accelerated RPS procurement

# RPS Role in Driving RE Growth Varies by Region

Seemingly most critical in the Northeast, Mid-Atlantic, West

## Growth in Non-Hydro Renewable Generation: 2000-2016



Notes: Northeast consists of New England states plus New York. Actual growth shown for that region is estimated based on new RE capacity that meets the vintage requirements for RPS eligibility. Mid-Atlantic consists of states that are primarily within PJM (in terms of load served).

### Northeast, Mid-Atlantic, West

- Actual RE growth closely matches RPS needs
- Northeast and Mid-Atlantic rely, to some degree, on REC from neighboring regions to meet compliance obligations

### Texas and the Midwest

- Actual RE growth far outpaced RPS needs, given favorable wind energy capacity factors/economics in those regions

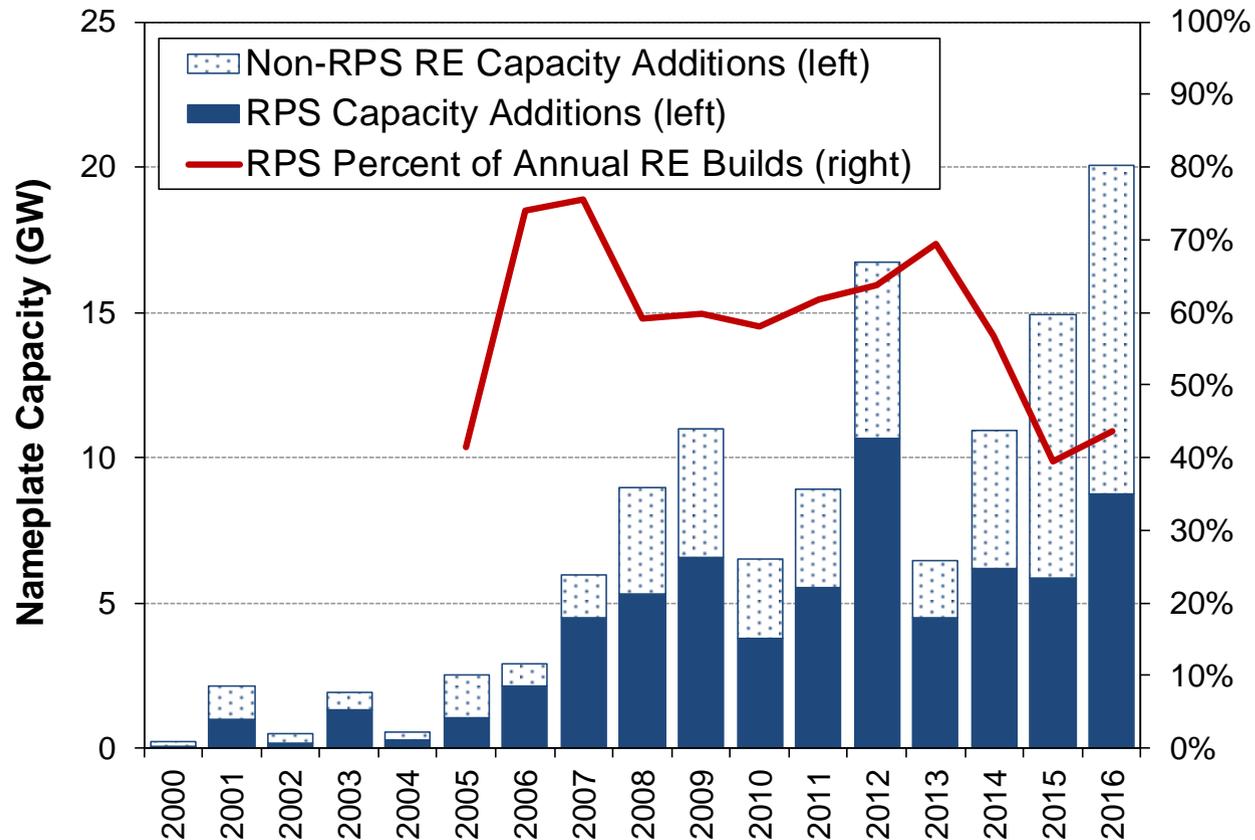
### Southeast

- Minimal RE growth or RPS demand, with just a single RPS state (North Carolina)

# RPS's Have Provided a Stable Source of Demand for RE Growth

Though RPS *portion* of total RE growth has declined over the past couple years

## Annual Renewable Capacity Additions



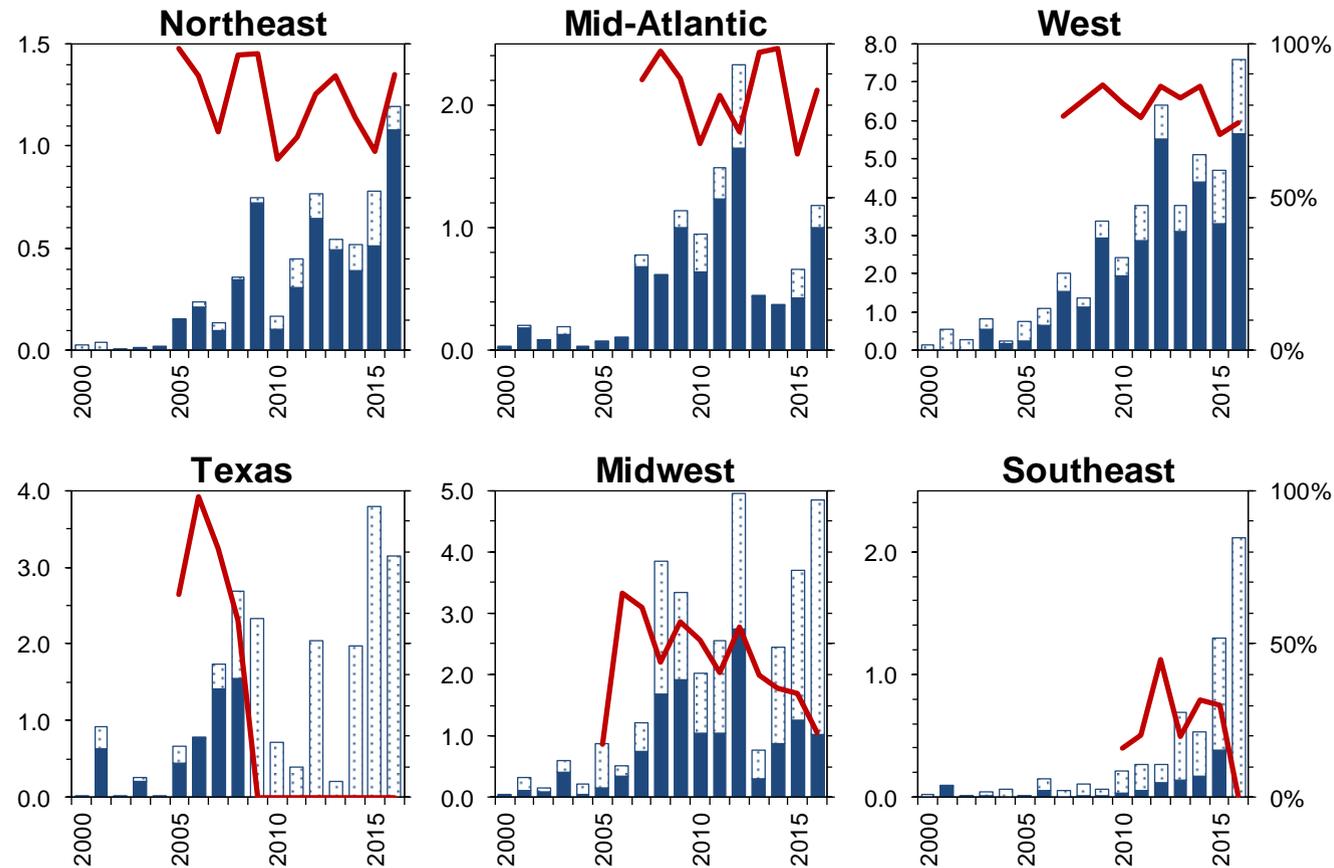
Notes: RPS Capacity Additions consists of RE capacity contracted to entities with active RPS obligations or sold on a merchant basis into regional RPS markets.

- Cumulatively, 120 GW of RE capacity added in the U.S. since 2000
  - Just over half of that capacity (56%) consist of projects (at least partially) driven by RPS obligations
- Over the past decade, an average of 6 GW/year of RE capacity added for RPS demand
  - Has provided a floor in down years (e.g., 2013)
- In the past couple years, the RPS-portion of new RE builds has been lower than previously (44% in 2016 vs. 60-70% in 2008-2014)
  - Partly due to rebounding wind growth in TX and Midwest, some serving growing demand from corporate procurement
  - Also the result of net-metered PV in California and some utility-scale PV in non-RPS markets

# RPS Policies Remain Central to RE Growth in Particular Regions

70-90% of 2016 RE additions in Northeast, Mid-Atlantic, West serve RPS demand

■ Non-RPS RE Capacity Additions (left, GW) 
 ■ RPS Capacity Additions (left, GW) 
 — RPS Percent of Annual RE Builds (right)



Notes: Northeast consists of New England states plus New York. Actual growth shown for that region is estimated based on new RE capacity that meets the vintage requirements for RPS eligibility. Mid-Atlantic consists of states that are primarily within PJM (in terms of load served).

## RPS policies have been a larger driver in...

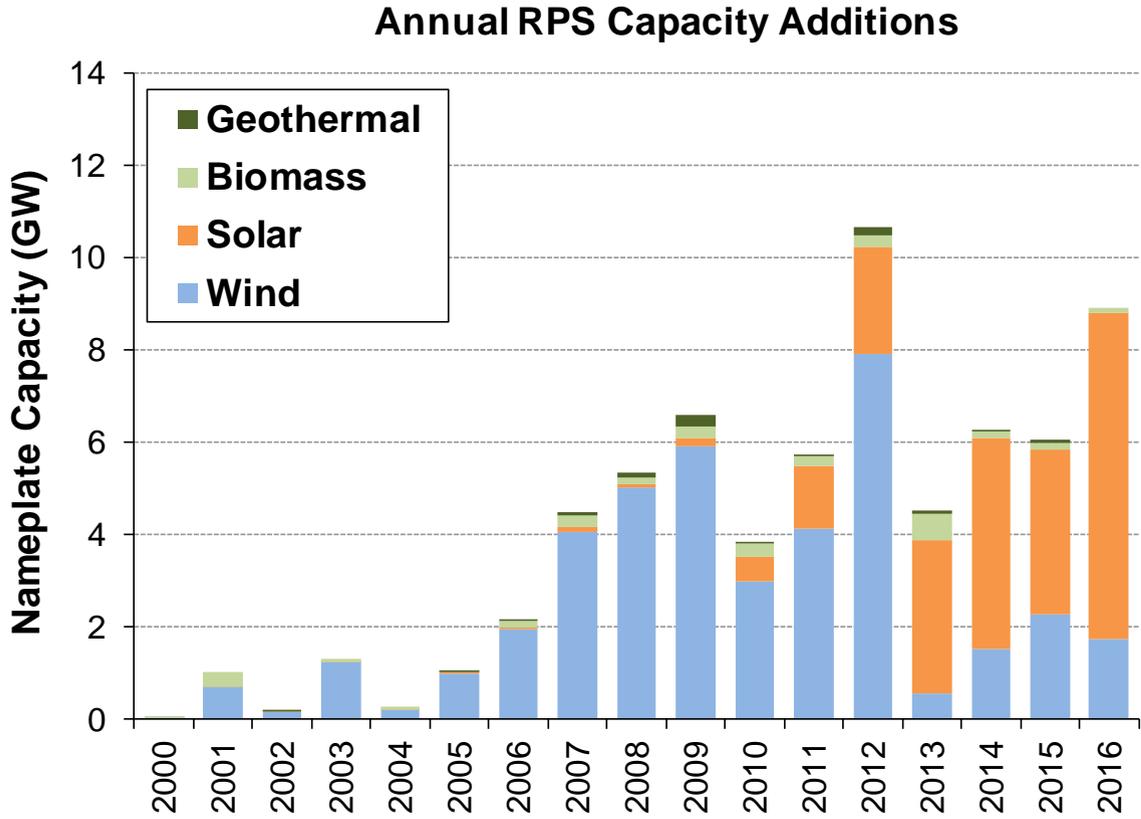
- **Northeast:** Relatively small market, but almost all capacity additions serving RPS demand
- **Mid-Atlantic:** Combo of solar carve-out capacity and wind projects (merchant or corporate procurement, but RPS-certified and likely selling RECs for RPS needs)
- **West:** The bulk of U.S. RPS capacity additions in recent years; split evenly between CA and other states

## But have been a smaller driver in...

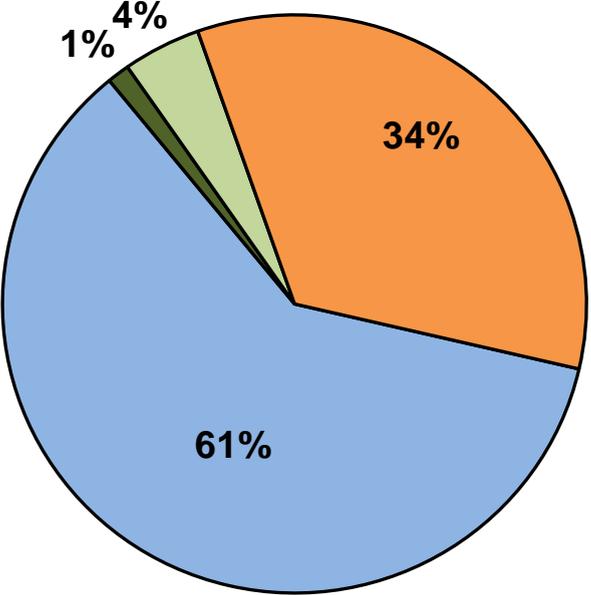
- **Texas:** Achieved its final RPS target in 2008 (7 years ahead of schedule); all growth since is Non-RPS
- **Midwest:** Lots of wind development throughout the region, some contracted to utilities with RPS needs
- **Southeast:** RE growth almost all utility-scale PV; primarily driven by PURPA and utility procurement, but some serving RPS demand in NC and PJM

# Wind Was Historically the Dominant Source of New-Build for RPS, But Solar Has Recently Taken the Mantle

## RPS Capacity Additions by Technology Type



Cumulative RPS Capacity Additions



Wind is 61% of all RPS builds to-date, but solar was 79% of 2016 RPS builds

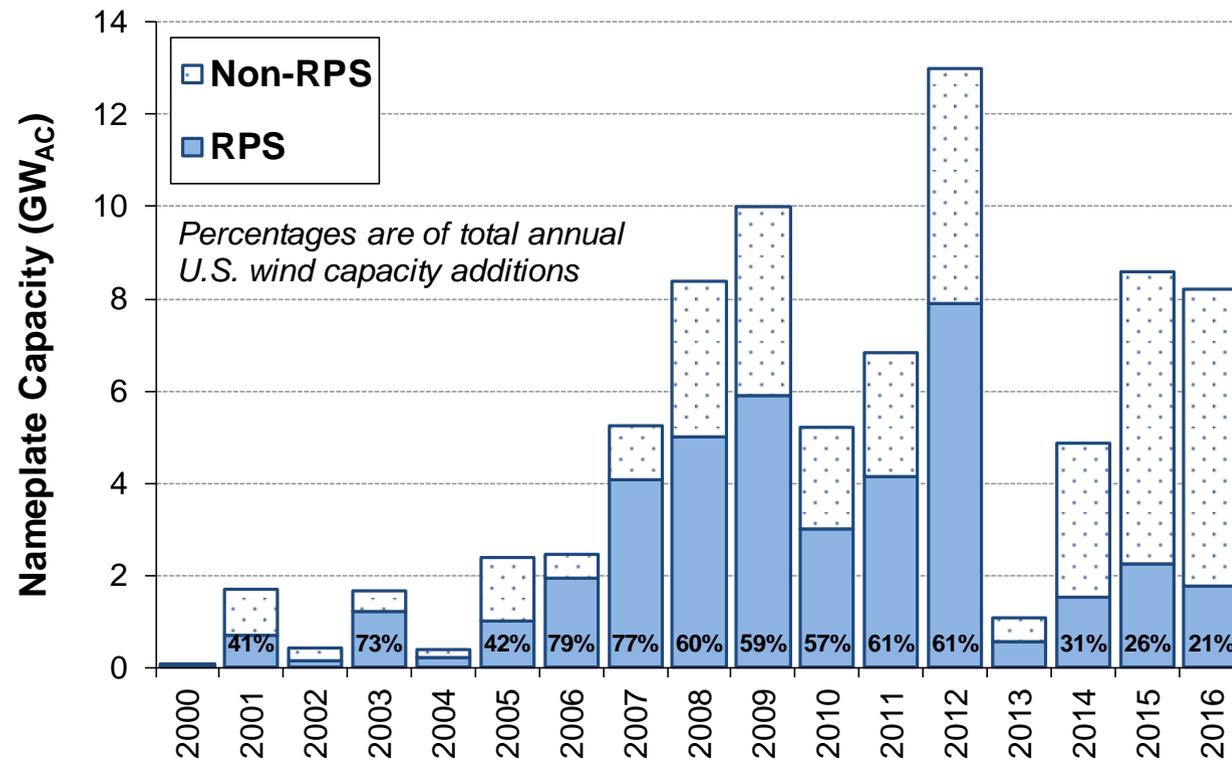
- Growing role of solar for RPS reflects:
  - Ramping up of solar carve-out requirements
  - Increasing cost-competitiveness of utility-scale solar vis-à-vis wind
- Wind capacity growth still strong, but recent additions primarily not for RPS

Notes: "RPS Capacity Additions" represent RE capacity contracted to entities subject to an RPS or sold on a merchant basis into regional RPS markets. On an energy (as opposed to capacity) basis, wind represents approximately 75%, solar 16%, biomass 5%, and geothermal 4% of RPS-related renewable energy growth.

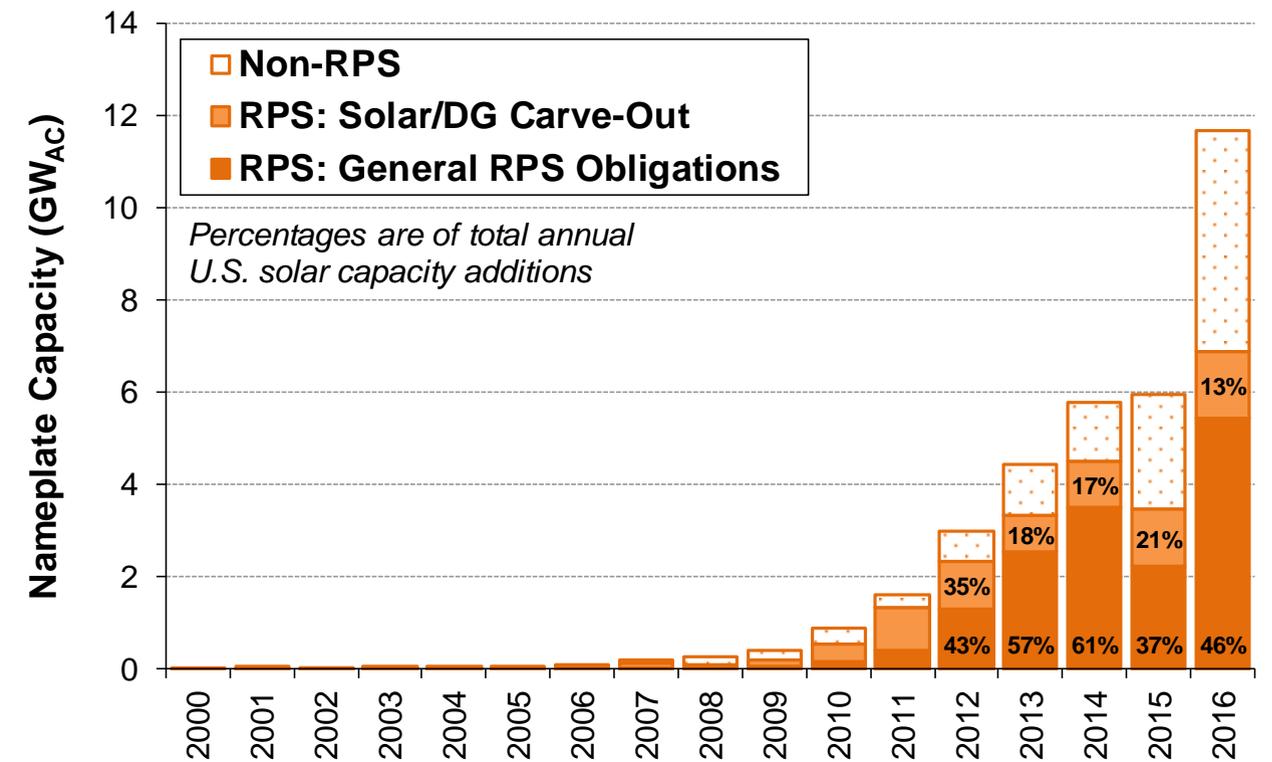
# Recent Wind Additions Built Primarily Outside of RPS Requirements, While Solar is More-Concentrated in RPS States

In 2016, **21%** of all wind additions were dedicated to RPS demand, compared to **59%** for solar (46% for general RPS obligations + 13% for carve-outs)

## Wind Capacity Additions



## Solar Capacity Additions



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# States Are Starting to Approach Final Target Years

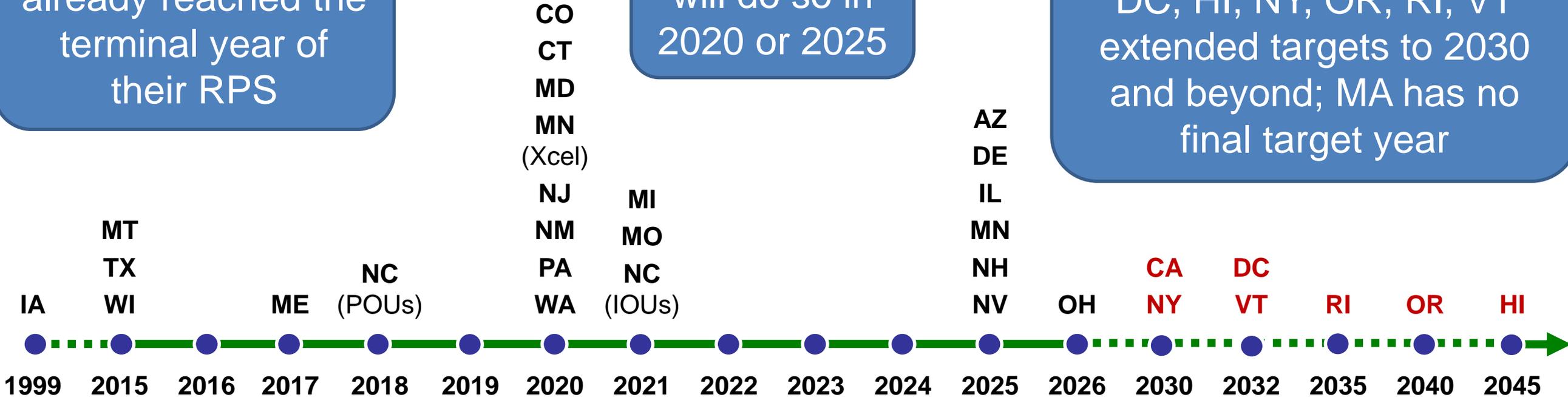
Half of all RPS states reach their final target year by 2021

## Year of Final RPS Target

Several states have already reached the terminal year of their RPS

Most others will do so in 2020 or 2025

Recent revisions in CA, DC, HI, NY, OR, RI, VT extended targets to 2030 and beyond; MA has no final target year

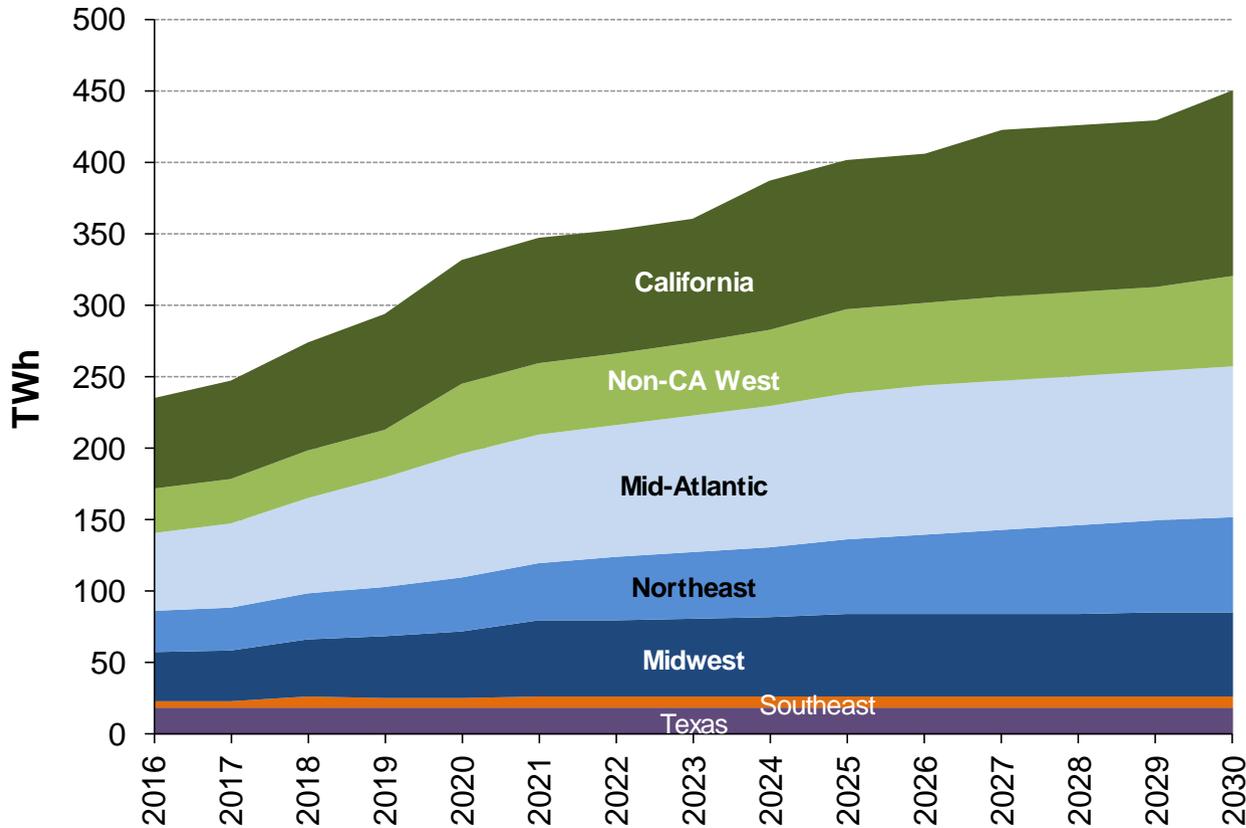


RPS needs will continue to slowly grow after final targets, due to load growth and RE retirements

# Projected RPS Demand

Total U.S. RPS demand roughly doubles by 2030

## Projected RPS Demand (TWh)



- Under current policies, total RPS demand grows from roughly 235 TWh in 2016 to 450 TWh in 2030
- To be sure, increased demand does not equate to required increase in supply
  - Some utilities/regions ahead of schedule, others are behind
  - Some growth in demand will likely be met with banked RECs

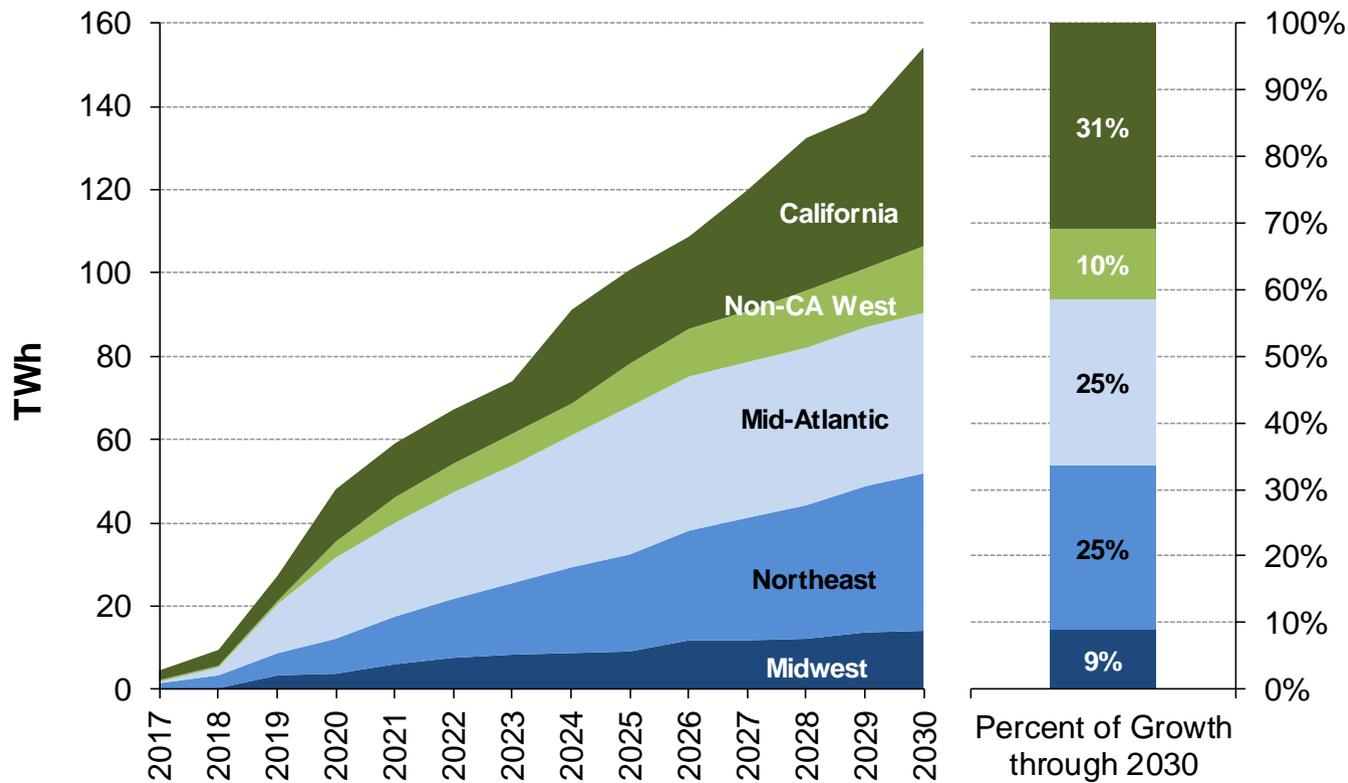
State-level RPS demand projections available for download at: [rps.lbl.gov](https://rps.lbl.gov)

*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. Underlying retail electricity sales forecasts are based on regional growth rates from the most-recent EIA Annual Energy Outlook reference case.*

# Required Increase in RPS Generation Supply

Equates to roughly 50% increase in U.S. renewable energy generation

## Required Increase in RPS Generation (TWh)



Notes: For regulated states, incremental RPS needs are estimated on a utility-specific basis, based on each utility's RPS procurement and REC bank as of year-end 2016. For restructured states, incremental RPS needs are estimated regionally, based on the pool of RPS-certified resources registered in the regional REC tracking system, allocated among states based on eligibility, demand, and other considerations.

## Required increase in RPS supply estimated:

- Relative to *available* RPS resources as of year-end 2016 (see notes for further details)
- Accounting for REC banking over the forecast period, per each state's rules

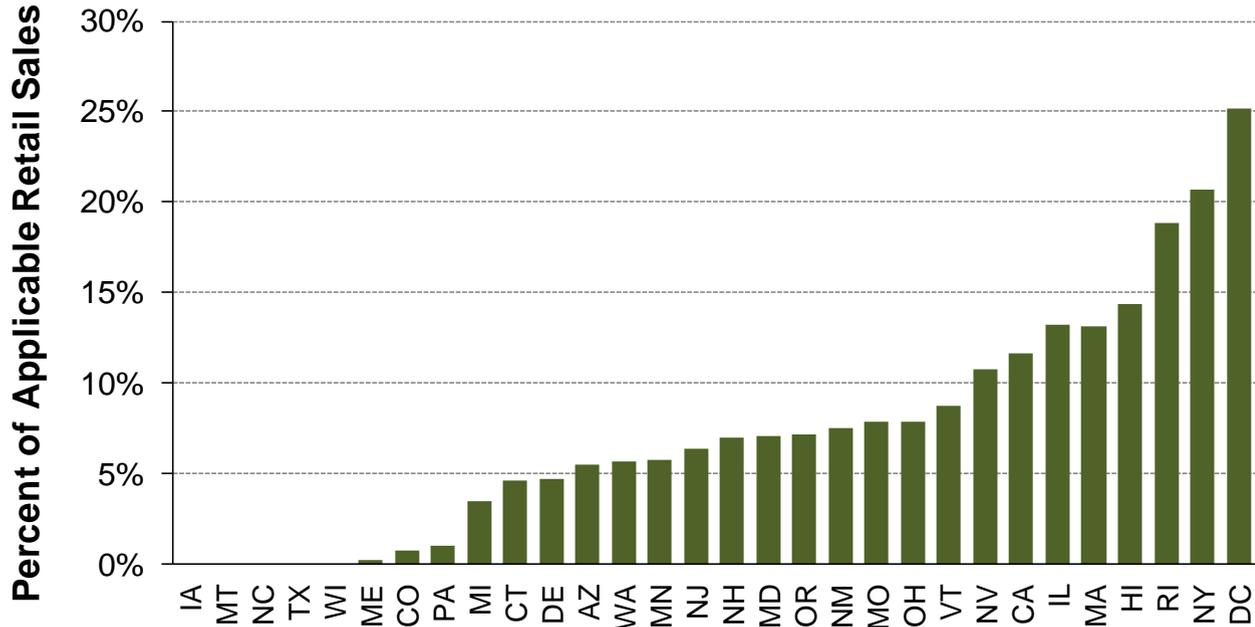
- 150 TWh increase in RPS resources needed to meet RPS demand growth through 2030
  - By comparison, current U.S. RE = ~300 TWh
- Relatively steady rate of growth at aggregate national level; some regions are lumpy
- Greatest incremental needs in:
  - California (50% statewide RPS by 2030)
  - Mid-Atlantic (well distributed among states)
  - Northeast (mostly NY's 50%-by-2030 CES)

# Residual RPS Procurement Needs by 2030

8 states with (effectively) no remaining need; 8 others with needs >10% retail sales

- Residual RPS procurement needs a function of target rise, current surplus, and REC banking rules
  - DC, NY, RI targets rise by 20-30% of retail sales by 2030
  - CA, HI, OR have similar target rise, but much smaller residual procurement needs due to current surplus and (in CA/OR) relatively permissive REC banking rules
- For regional REC markets (New England and PJM), residual needs may be more meaningfully expressed in aggregate regional terms
  - NEPOOL residual needs = 10% of retail sales by 2030
  - PJM residual needs = 7% of retail sales by 2030
- For some states, residual needs continue to rise beyond 2030 with increasing RPS targets and/or depletion of REC banks

**Residual RPS Procurement Needs by 2030**  
(Percent of Applicable Retail Sales)



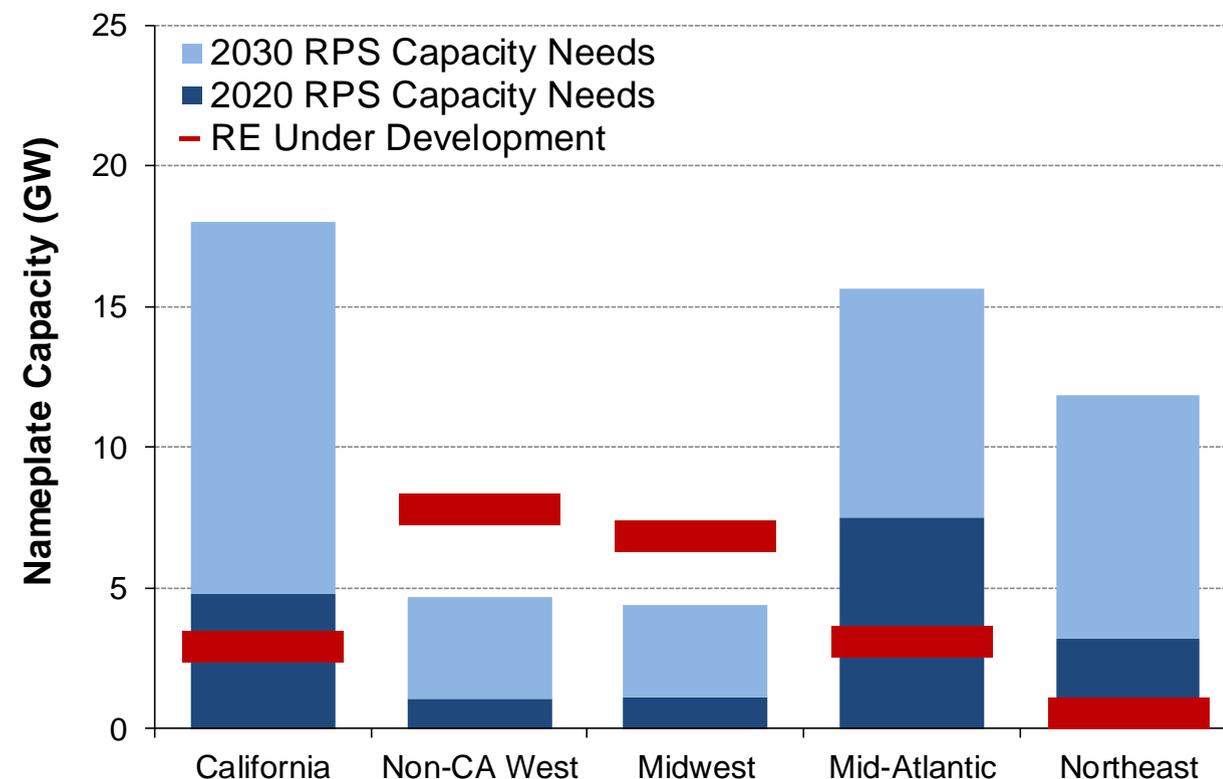
Notes: For regulated states, residual procurement needs are estimated on a utility-specific basis, based on each utility’s RPS procurement and REC bank as of year-end 2016, assuming no future sales of surplus RECs and accounting for the accumulation of banked RECs over time, per each state’s rules. For New England and PJM states, aggregate regional procurement needs are allocated among states in proportion to each state’s growth in RPS demand through 2030. For PJM, aggregate procurement needs are calculated separately for the “premium” states with more restrictive eligibility rules (DE, MD, NJ, PA) and for others (DC, IL, OH).

# Required RE Capacity Builds for RPS

Roughly 18 GW needed by 2020, 55 GW by 2030

- Equates to a 40% increase in U.S. RE capacity by 2030
- Requires an average build-rate of 4 GW per year
  - A slowing, but not elimination, of RPS-driven growth (historically ~6 GW/yr associated with RPS needs)
- RE already under development will likely meet some portion of remaining RPS needs
  - Could easily meet all residual needs in Non-CA West and Midwest regions
  - Some of that capacity may also serve RPS demand in neighboring regions (e.g., California and Mid-Atlantic)

## Required Increase in RPS Capacity (GW)



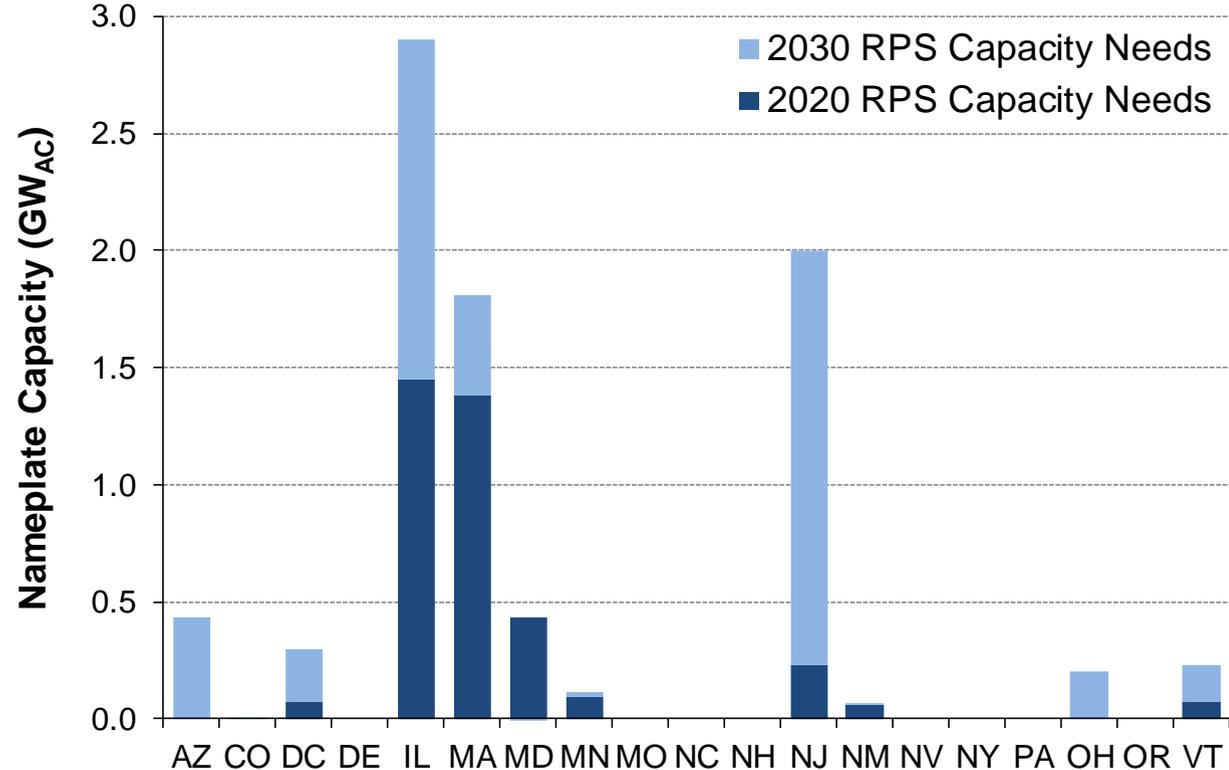
Notes: Calculated from estimated incremental generation needed to meet RPS demand, based on state-specific assumptions about the mix and capacity factor of new RPS supply. RE Under Development consists of units permitted or under construction, site preparation, or testing as of June 2017, plus units that entered commercial operation in 2017, based on data from ABB-Ventyx Velocity Suite.

# Required Capacity Builds for Solar/DG Carve-Outs

Concentrated primarily in IL, MA, NJ

- About half of all states have already met their final carve-out targets, have no further needs
- Among those with some remaining need, an additional 4 GW required by 2020, 8 GW by 2030
  - **IL:** recently enacted requirement for long-term contracts with “new” solar (25% of which must be DG)
  - **MA:** recently developed SMART program; exact trajectory is undetermined
  - **NJ:** aggressive targets and 15-year limit on solar project eligibility; need for “replacement capacity” in later years
  - Various others (AZ, DC, MD, MN, NM, OH, VT) each with 100-400 MW remaining need

## Required Increase in Solar/DG Carve-Out Capacity (GW)

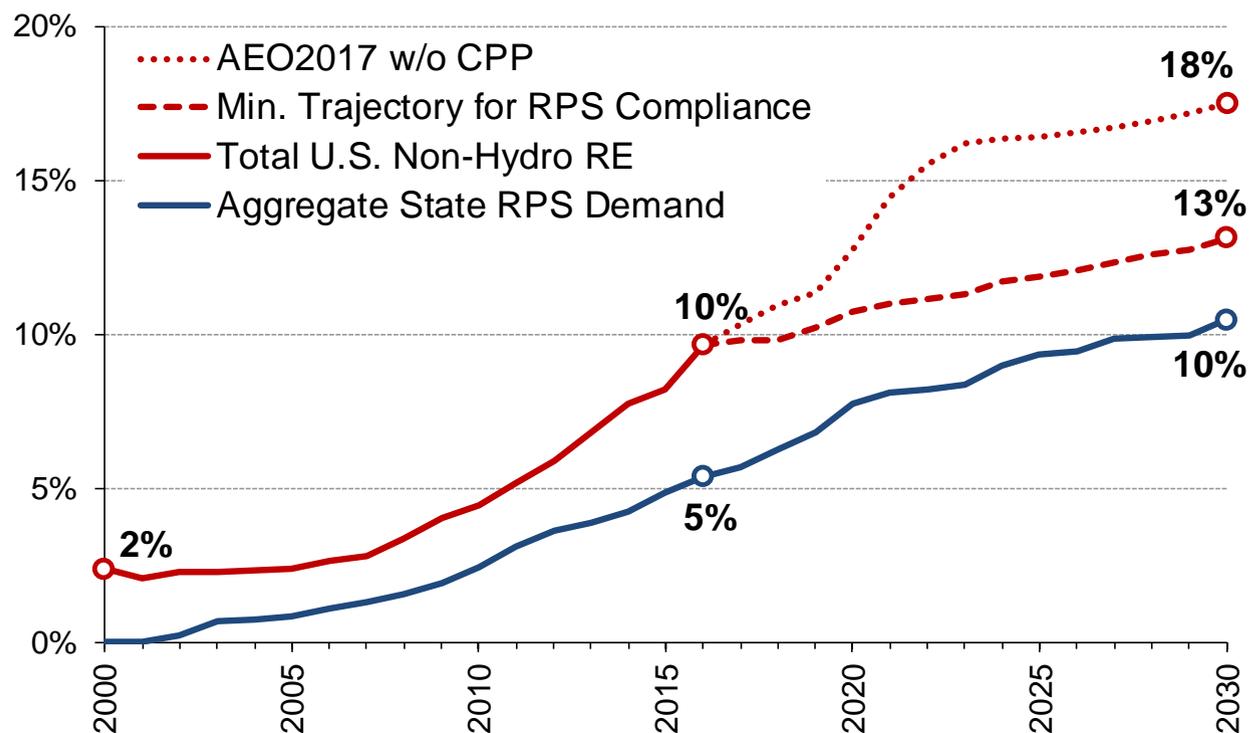


Notes: Calculated from estimated incremental generation needed to meet solar/DG carve-out demand, based on state-specific assumptions about the capacity factor of new solar/DG carve-out supply. For MA, we assume that the aggregate 1600 MW target under the SMART program is met by 2021, consistent with current build rates.

# Comparison of U.S. RPS Demand and RE Supply

EIA-forecasted RE growth projected to well-exceed minimum RPS needs

## U.S. RPS Demand vs. RE Supply (% of Retail Electricity Sales)



Notes: The figure focuses on non-hydro RE, given the limited eligibility of hydro for state RPS obligations. Accordingly, the Aggregate State RPS Demand excludes historical and projected contributions by hydro as well as by municipal solid waste, demand-side management, and other non-RE technologies.

- In aggregate, state RPS targets equate to 10% of U.S. retail electricity sales by 2030
- However, to meet those targets, total U.S. RE supply will need to reach 13% of retail sales
  - Accounts for the fact that not all existing RE supplies are available for future RPS demand
- EIA projects much greater RE growth, reaching 18% of retail sales by 2030
  - Rapid growth prior to expiration of ITC/PTC
- RPS policies clearly just one driver for continued RE growth
  - Other drivers: tax credits, RE cost declines, corporate procurement

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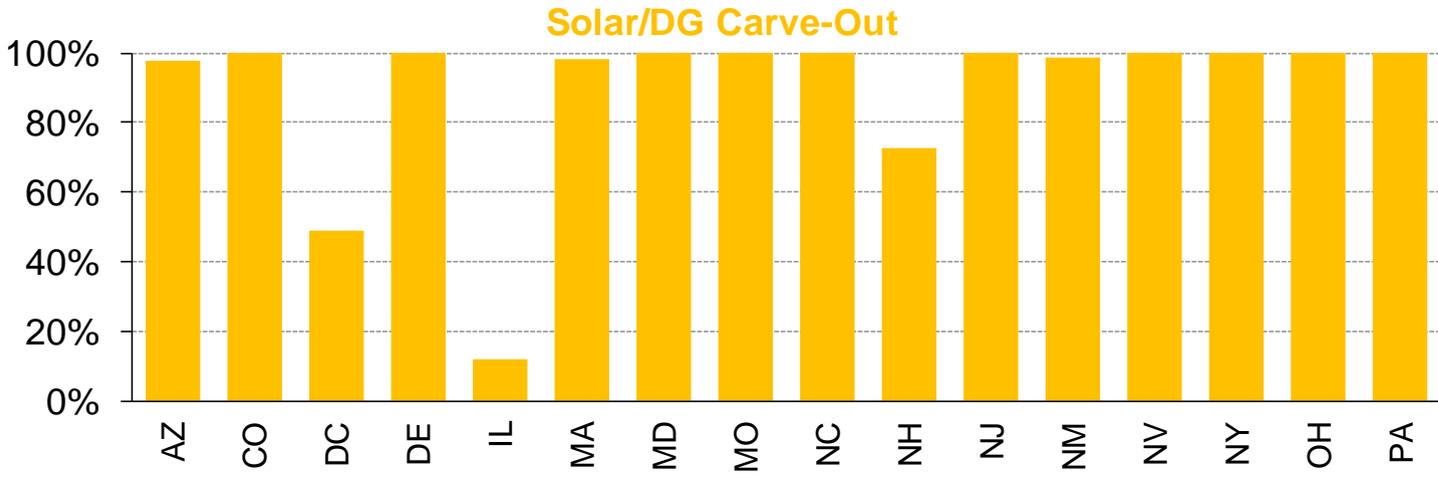
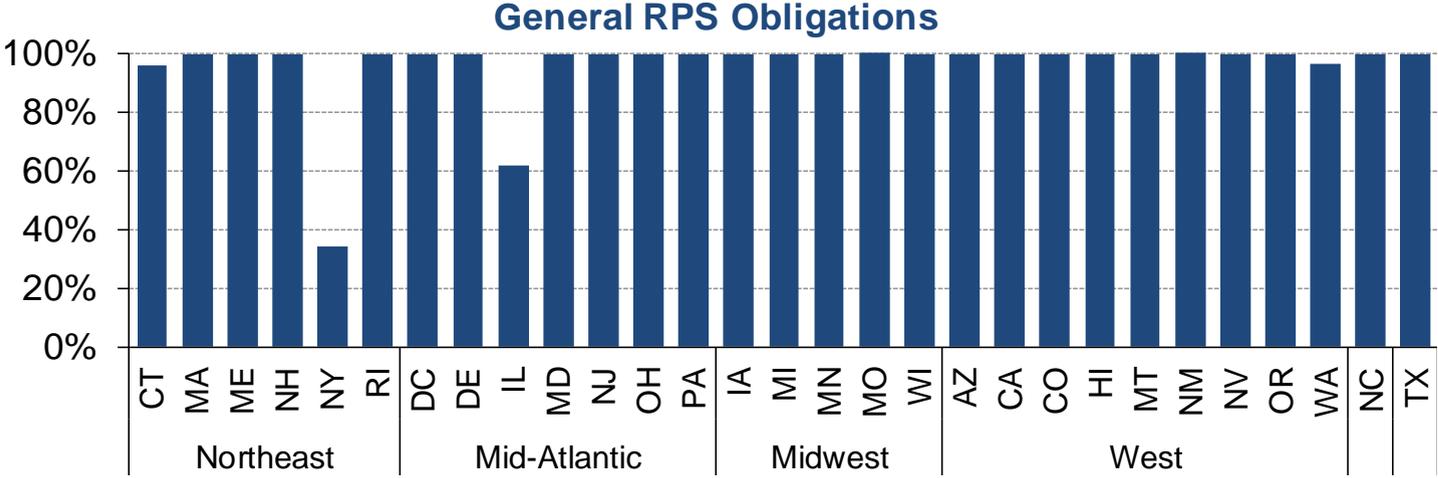
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# States Have Generally Met Their Interim RPS Targets

Exceptions typically reflect unique state-specific issues

**Percentage of RPS Obligations Met with RECs or RE**  
*For most-recent compliance year available in each state*



- Many states/utilities well ahead of schedule, easily meeting interim targets
- Others met interim targets only by relying on stockpile of banked RECs from prior years
- Relatively few instances where interim targets significantly missed
  - **DC (Solar):** In-district eligibility requirements limit pool of supply
  - **IL (General RPS & Solar):** Alternative retail suppliers required to meet 50% of RPS with ACPs
  - **NH (Solar):** Unusually low solar ACPs have led to SRECs flowing into neighboring Class I markets
  - **NY (General RPS):** Procurement has lagged targets, partly due to budget constraints

Notes: “General RPS Obligations” refers to the non-carve-out portion of RPS requirements in each state. For New England states, it refers to Class I obligations, and for PJM states it refers to Tier I obligations.

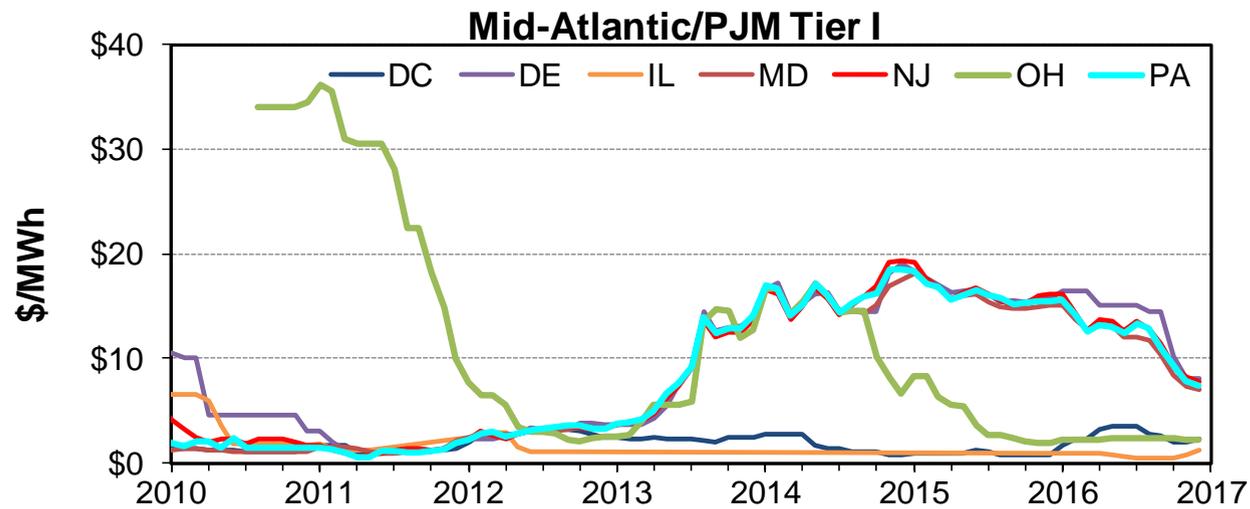
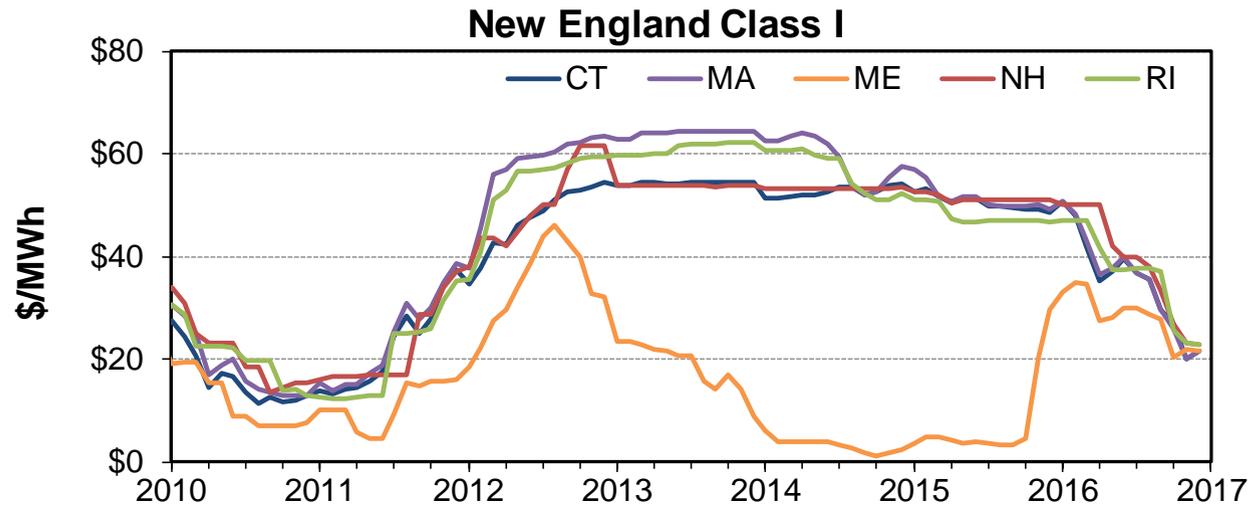
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# REC Pricing Trends for General RPS Obligations

Most markets saw significant decline in 2016



Source: Mares Spectron. Plotted values are the average monthly closing price for the current or nearest future compliance year traded in each month.

**REC prices are a function of ACP rates and current/expected supply-demand balance**

- As a result, REC prices can be volatile and are sensitive to sudden changes in eligibility rules
- Regional markets in New England and Mid-Atlantic emerge based on common pools of eligible supply

## New England:

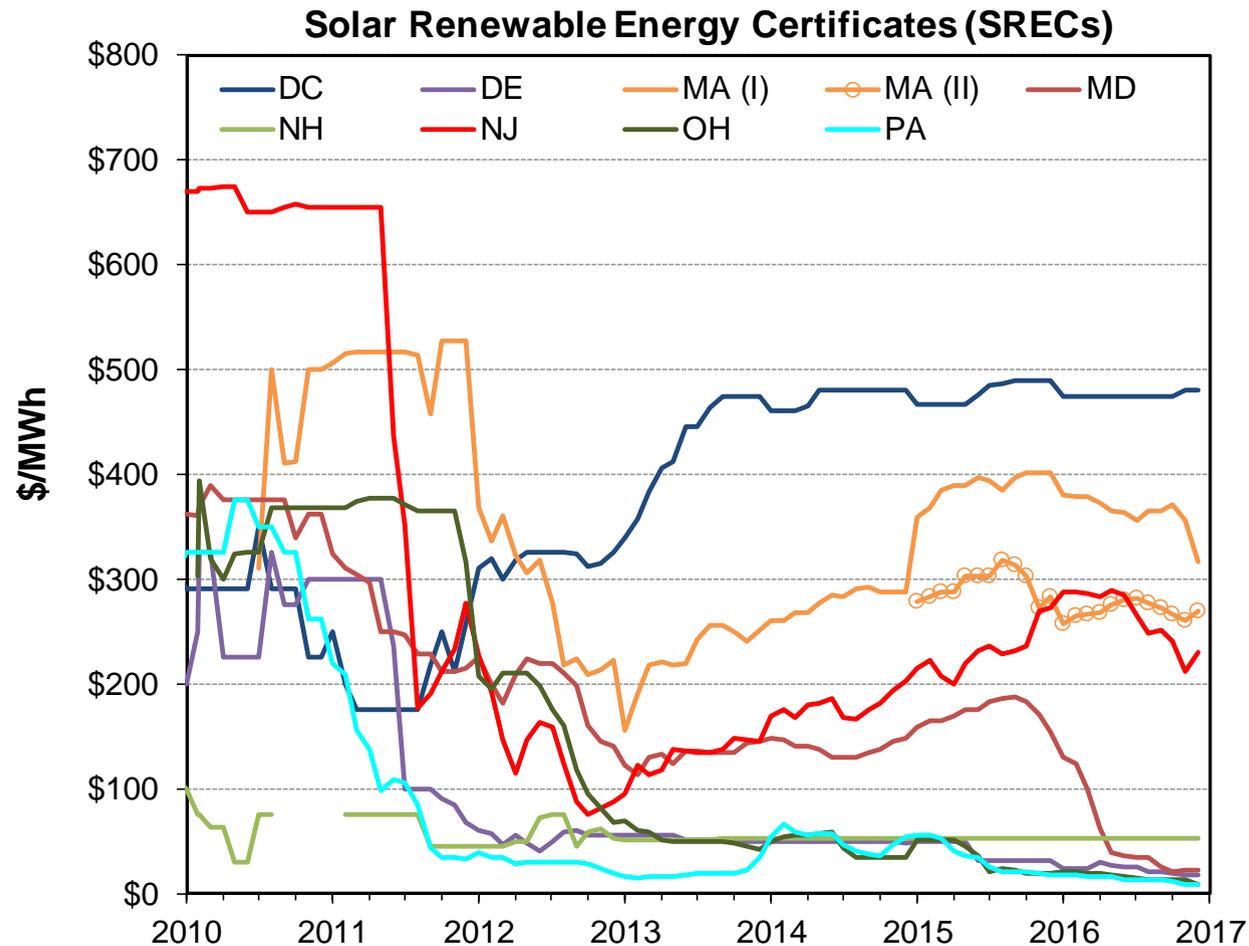
- Growing regional supplies have pushed prices to near a 5-year low (~\$20/MWh, compared to \$55-65 ACP levels)

## Mid-Atlantic/PJM:

- Bifurcated market based on geographic eligibility rules (more restrictive rules & higher prices in NJ/PA/MD/DE)
- Recent wind growth in PJM and adjacent states driving down prices

# SREC Pricing Trends for RPS Solar Carve-Outs

Varying trends by state; Maryland saw the most significant movement in 2016



Sources: Marex Spectron, SRECTrade, Flett Exchange. Depending on the source used, plotted values are either the mid-point of monthly average bid and offer prices or the average monthly closing price, and generally refer to prices for the current or nearest future compliance year traded in each month.

**SREC pricing is highly state-specific due to *de facto* in-state requirements in most states and varying ACPs**

- **MD:** Substantial over-supply emerged with completion of several 10-20 MW projects in 2015-2016
- **DC:** Acute undersupply due to in-district requirements and limited market footprint
- **MA:** Price movements bounded by clearinghouse floor and SACP
- **NJ:** Generally well-balanced market
- **DE, PA, OH** heavily oversupplied, in part due to eligibility of out-of-state projects
- **NH:** Low solar ACP (\$55/MWh)

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# RPS Compliance Costs

## Definition, data sources, and limitations

**RPS Compliance Costs:** Net cost to the load-serving entity (LSE), above and beyond what would have been incurred in the absence of RPS

### Restructured Markets

- We estimate RPS compliance costs based on REC plus ACP expenditures
- Rely wherever possible on PUC-published data on actual REC costs
- **Limitations:** Growing use of bundled PPAs; ignores merit order effect and some transmission/integration costs

### Regulated Markets

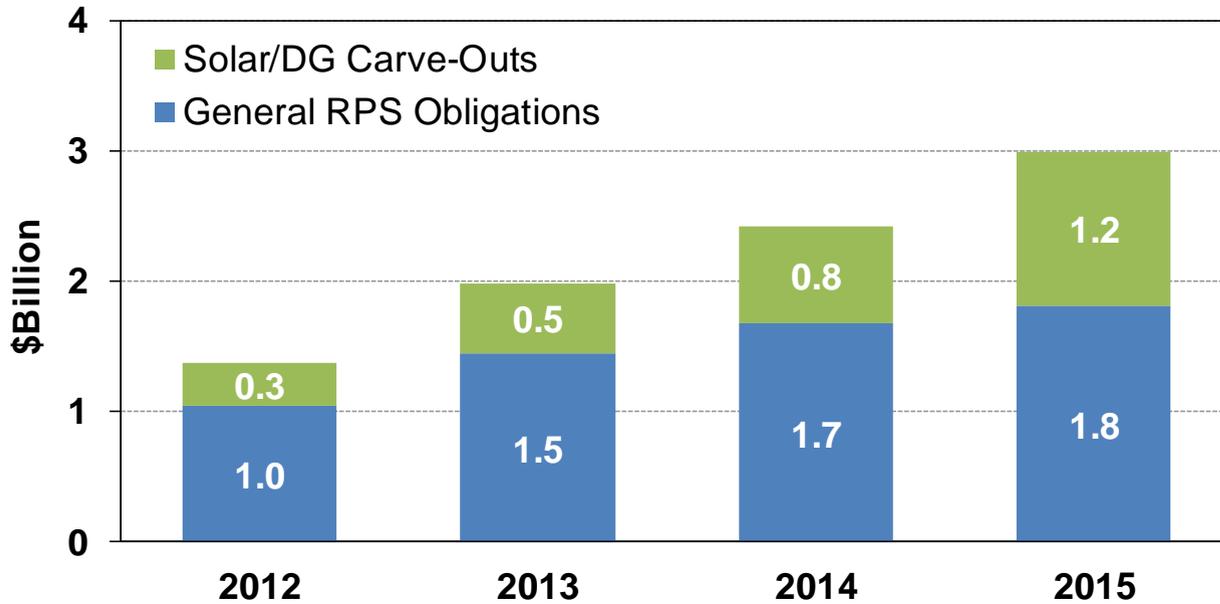
- Estimated by comparing gross RPS procurement costs to a counterfactual (e.g., market prices, long-term avoided costs)
- We synthesize available utility and PUC compliance cost estimates
- **Limitations:** Varying methods across states; incomplete or sporadic reporting (no data for several states)

**Compliance cost reporting is lagged → Data available for many states only through 2015**

# Aggregate U.S. RPS Compliance Costs

Totaled roughly \$3.0B in 2015, up from \$2.4B in 2014

## Total RPS Compliance Costs



Notes: General RPS obligations consist of all non-solar/DG carve-out requirements, including both primary and secondary tiers. Costs were extrapolated to several states/utilities without available data, based on other states/utilities in the region.

**These data should be considered a rough approximation given diverse methods used to estimate compliance costs across states**

- Cost growth year-over-year associated with increasing targets, dampened by falling REC prices in some markets
- Solar/DG carve-outs a growing share of aggregate RPS compliance costs
- Important note: Total U.S. RPS compliance costs highly sensitive to California
  - We use PUC estimates, which rely on the all-in cost of a combined-cycle gas turbine as the basis for avoided costs
  - Alternate IOU avoided cost estimates based on short-term market prices yield RPS compliance costs roughly \$2.8B higher in 2015 (increasing total U.S. costs to \$5.8B)\*

\* The CPUC has noted several concerns with the IOUs' approach: namely, that many of the IOUs' other generation resources, including nuclear and large hydroelectric generation, also would not be cost-effective compared to spot market prices, and that the utilities likely would not be able to procure such a large volume in the spot market. In addition, relying on actual realized spot market prices does not account for the merit order effect.

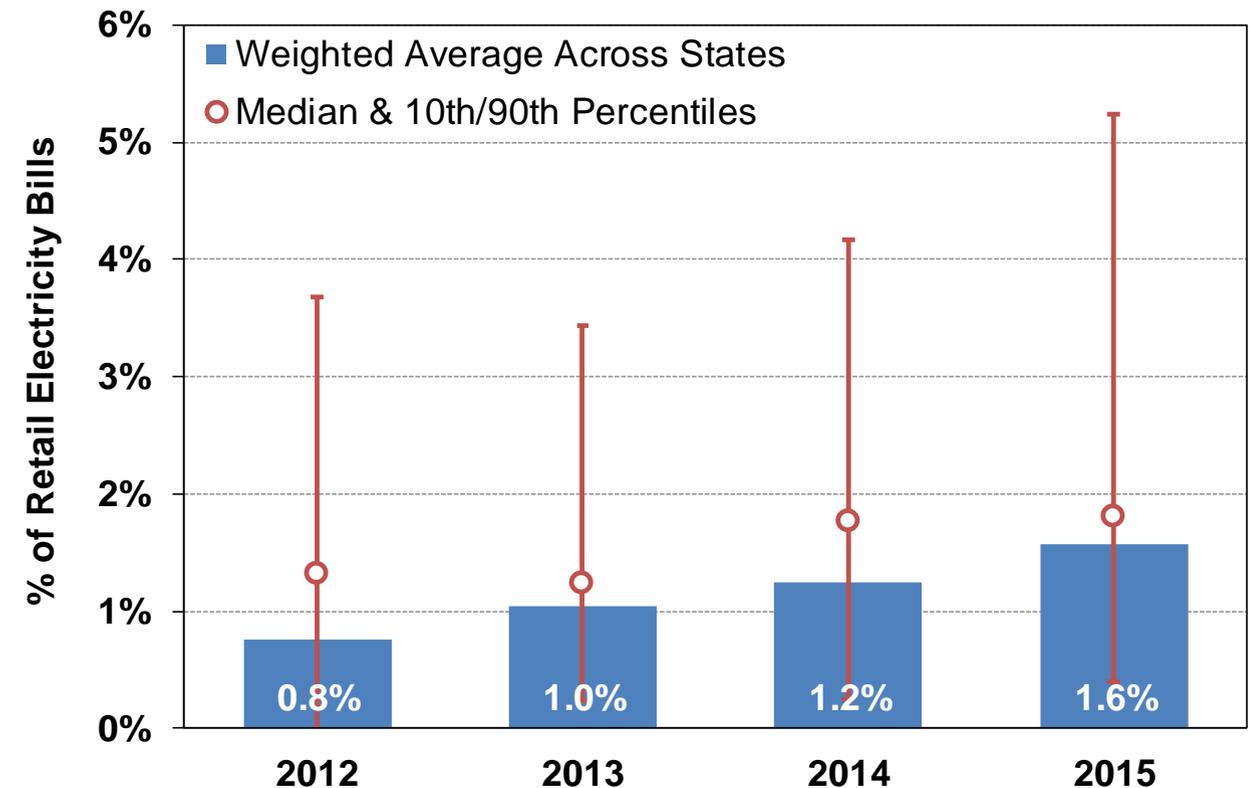
# RPS Compliance Costs as a Percentage of Customer Bills

Averaged 1.6% of retail electricity bills in 2015

## A proxy for “rate impact”, albeit a rough one:

- Some impacts (merit order effect, integration costs) not fully captured
  - Compliance costs borne by LSE not always fully or immediately passed through to ratepayers
  - ACPs may be credited to ratepayers or recycled through incentive programs
- Costs as a percent of retail bills have risen over time with rising targets, as discussed on previous slide
  - Wide variability across states, as evident by percentile bands, ranging from 0.4% to 5.2% in 2015 (10<sup>th</sup> to 90<sup>th</sup> percentile range) → more detail on next slide

## RPS Compliance Costs Percentage of Average Retail Electricity Bill

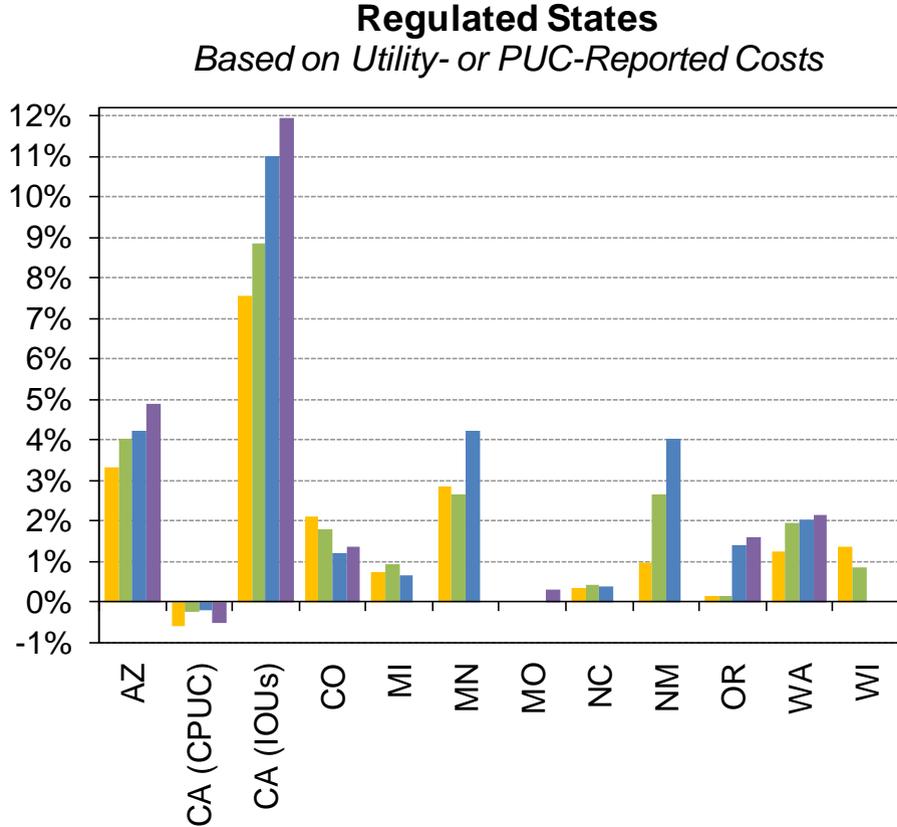
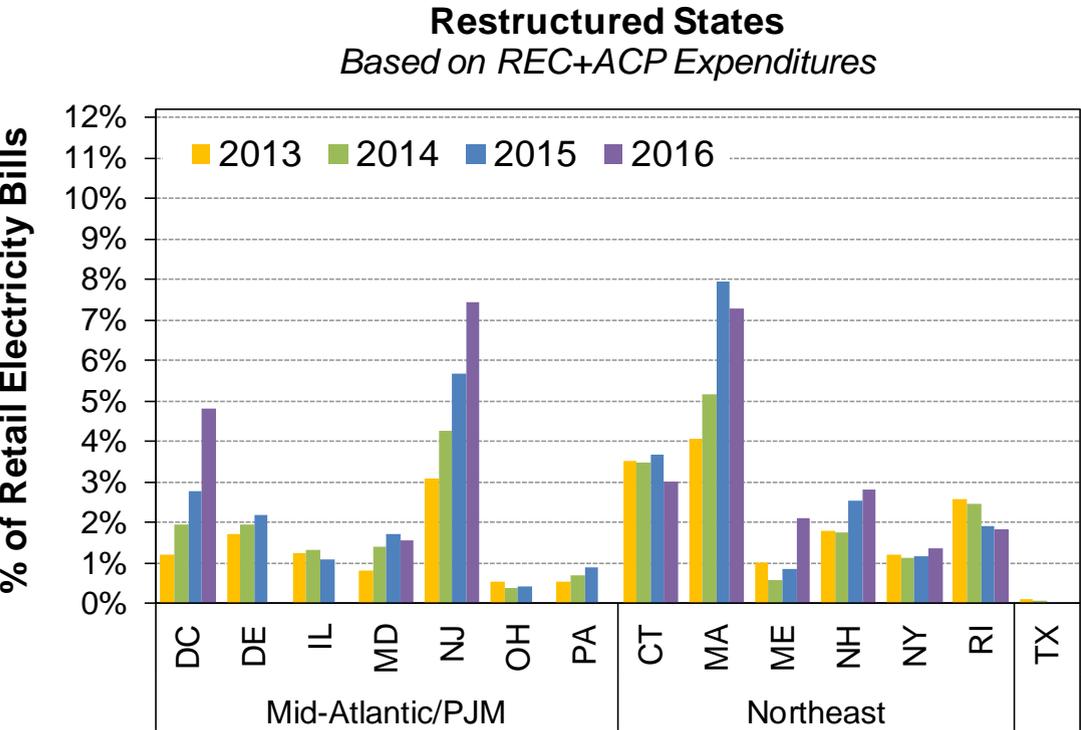


Notes: Annual averages are weighted based on each state's total revenues from retail electricity sales. Using IOU avoided cost estimates for CA, rather than the CPUC's estimates, would raise the U.S. weighted average costs substantially (e.g., to 3.1% of retail electricity bills in 2015).

# State-Specific RPS Compliance Costs

Including 2016 data where available

## RPS Compliance Costs (Percentage of Average Retail Electricity Bill)



### Cross-state cost variation reflects differences in:

- RPS target levels
- Resource tiers/mix
- REC prices
- Wholesale electricity prices
- Reliance on pre-existing resources
- State-specific cost calculation methods (see notes regarding CA)

### Falling REC prices in 2016 lead to declining RPS costs in a number of restructured states

Notes: RPS compliance cost estimates for restructured states are based, whenever possible, on the average cost of all RECs retired for compliance, including both spot market purchases and long-term contracts. For states with compliance years that begin in the middle of each calendar year (i.e., DE, IL, NJ, and PA), compliance years are mapped to the table based on the start date of each compliance year. Among regulated states, compliance cost data are wholly unavailable for IA, HI, MT, NV; these states are therefore omitted from the chart. The two sets of values for CA reflect alternate avoided-cost estimates (see earlier slide for explanation and discussion).

# RPS Cost Containment Mechanisms

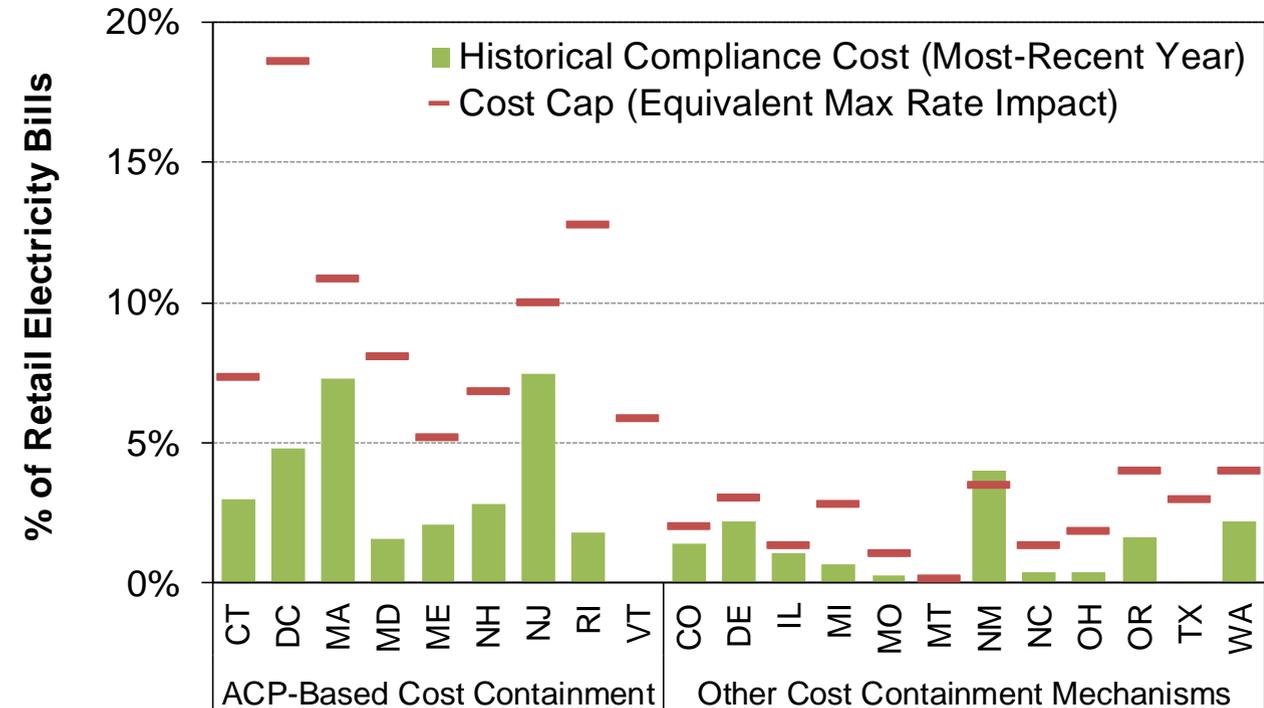
Will cap growth in RPS compliance costs in most states

## RPS policies have various cost containment mechanisms

- ACPs (which cap REC prices)
- Caps on rate impacts or revenue-requirements
- Caps on surcharges for RPS cost recovery
- RE contract price caps
- Renewable energy fund caps
- Financial penalties
- Regulatory oversight of procurement

- Highest cost caps (5-20% of electricity bills) occur in states relying only on ACPs for cost containment and with relatively aggressive targets and/or high ACP rates
- Cost caps in states with other cost containment mechanisms are generally more restrictive (1-4% of bills)
  - Have already led to curtailed procurement in NM, and are close to binding in several other states (DE, IL)

## Recent Costs Compared to Cost Caps



Notes: Each state's cost containment mechanism was translated into the equivalent maximum allowed rate impact for the final year in the RPS. For states with an ACP, this corresponds to the scenario in which the entire RPS obligation in the final RPS year is achieved with ACPs or RECs priced at the ACP rate. For MA, the year 2030 is used as the final target year, and the estimated cap does not yet account for the SMART program. Excluded from the chart are states currently without any explicit mechanism to cap incremental RPS costs (AZ, CA, IA, HI, MN, NV, NY, PA, WI), though many of those states have other kinds of mechanisms or regulatory processes to limit RPS costs.

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- Evolution of state RPS programs
- Historical impacts on renewables development
- Future RPS demand and incremental needs
- RPS target achievement to-date
- REC pricing trends
- RPS compliance costs and cost caps
- **Outlook**

# The Future Role & Impact of State RPS Programs Will Depend On...

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- ➔ RPS compliance costs and ACPs/cost caps
- ➔ Legislative and legal challenges to state RPS programs, including possible federal pre-emption
- ➔ Whether additional states decide to increase and extend RPS targets as they approach their final target year
- ➔ Other ongoing refinements (e.g., REC banking rules, long-term contracting programs, eligibility rules, etc.)
- ➔ The many related issues affecting RE deployment (integration, transmission, siting, net metering, etc.)

# For Further Information

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## RPS reports, presentations, data files, resources

*[rps.lbl.gov](https://rps.lbl.gov)*

## All renewable energy publications

*[emp.lbl.gov/reports/re](https://emp.lbl.gov/reports/re)*

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# Thank you for attending our webinar

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