



Energy Technologies Area

Lawrence Berkeley National Laboratory

U.S. Renewables Portfolio Standards Status and Trends

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2016 National Summit on RPS

Washington, D.C.

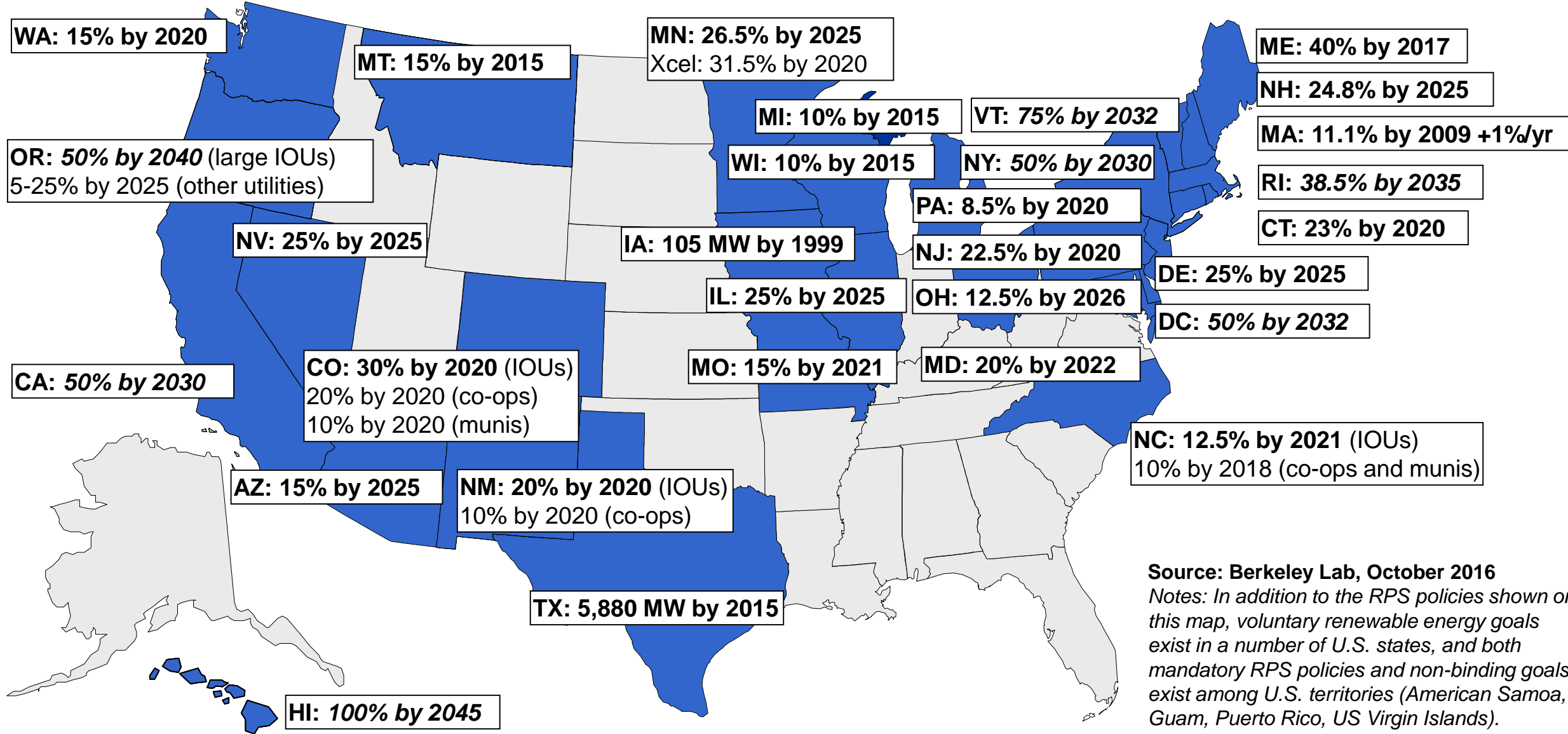
November 30, 2016

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- **Evolution of state RPS programs**
- RPS impacts on renewables development to-date
- Historical compliance levels, REC prices, and compliance costs
- Future RPS demand and incremental needs
- Outlook

RPS Policies Exist in 29 States and DC

Apply to 56% of Total U.S. Retail Electricity Sales

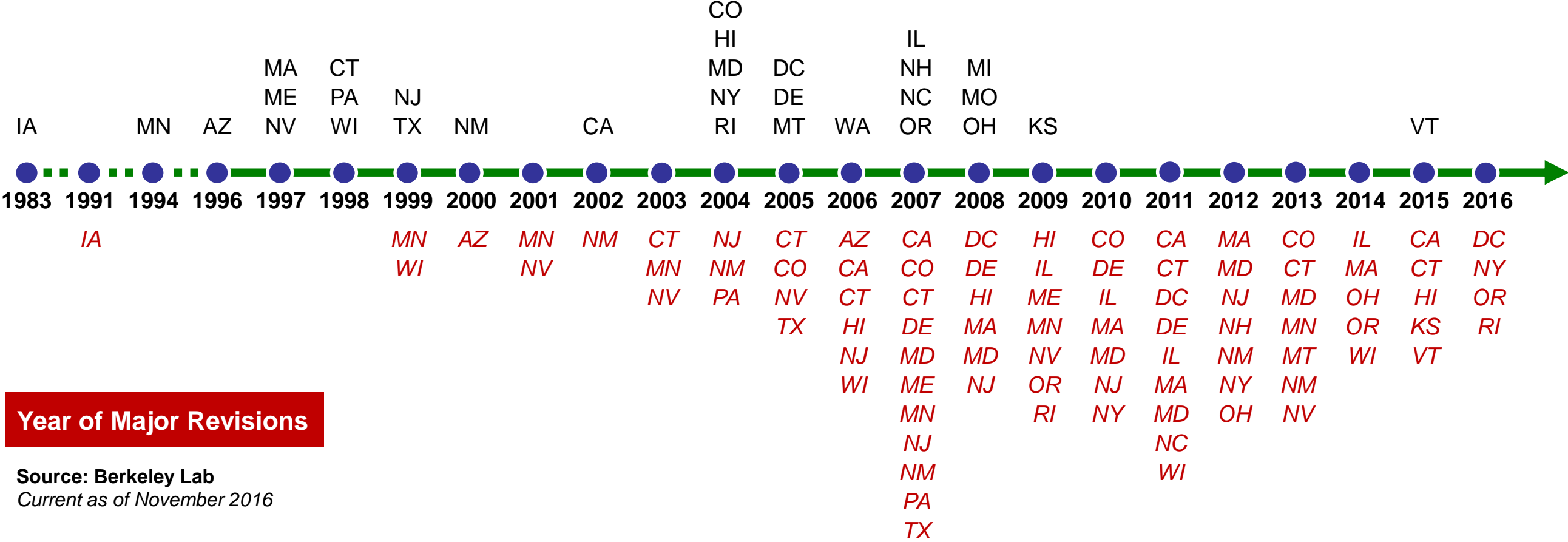


Source: Berkeley Lab, October 2016
 Notes: In addition to the RPS policies shown on this map, voluntary renewable energy goals exist in a number of U.S. states, and both mandatory RPS policies and non-binding goals exist among U.S. territories (American Samoa, Guam, Puerto Rico, US Virgin Islands).

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 November 2016

General Trends in RPS Revisions

Increase and extension of RPS targets: Roughly half of all RPS states have raised their overall RPS targets or carve-outs since initial RPS adoption

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

Most proposals sought to strengthen or make small technical changes

RPS-Related Bills Introduced and Enacted in 2016

	Strengthen	Weaken	Neutral	Total
Introduced	37	9	32	78
Enacted	3	0	2	5

Data Source: EQ Research

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

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

Significant RPS revisions in 2016 (legislative and administrative):

- **DC:** Increased and extended RPS to 50% by 2032
- **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

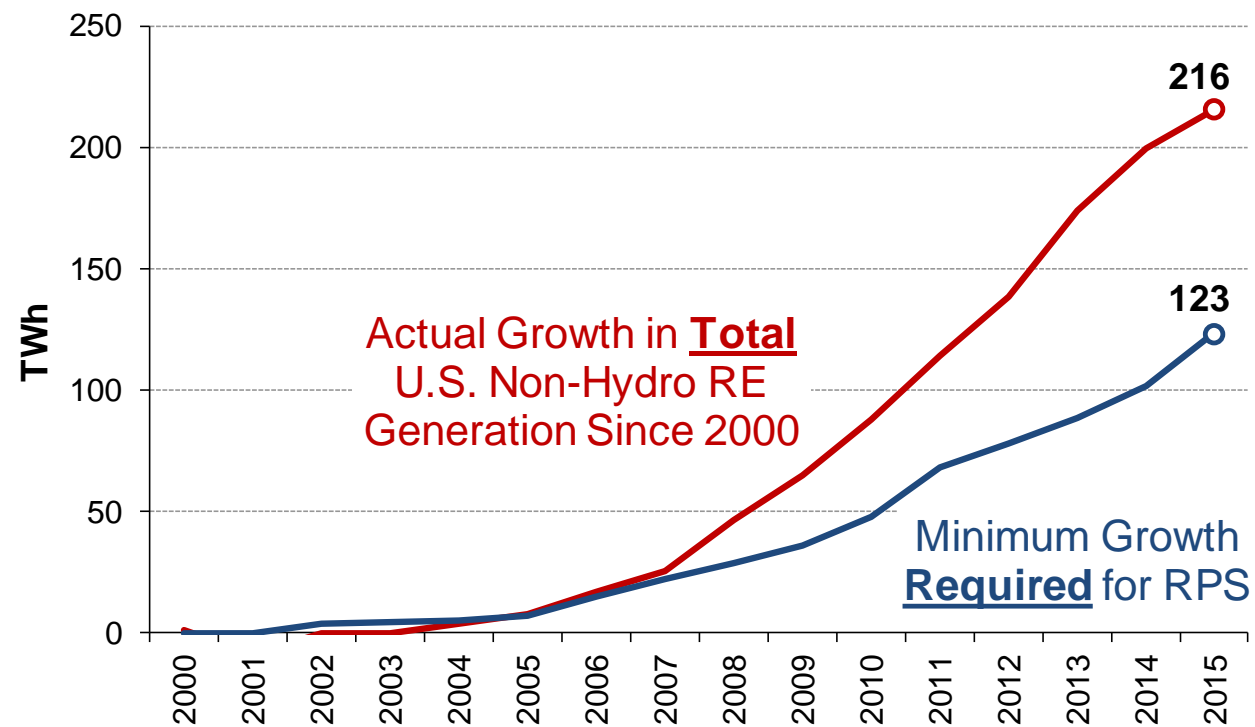
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RPS Policies Have Been One Key Driver for RE Generation Growth

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

Growth in Non-Hydro Renewable Generation: 2000-2015



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. See Supplementary Notes for additional details.

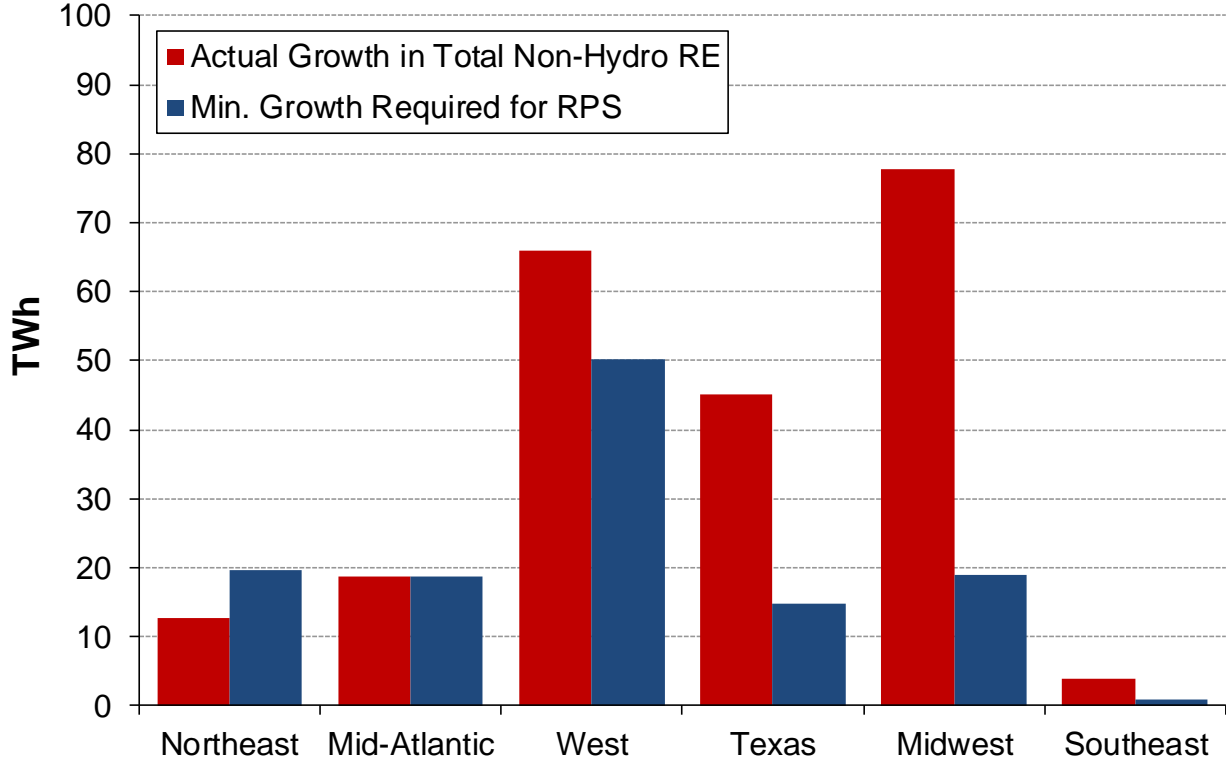
Many factors have contributed to renewables growth

- Total non-hydro RE generation in the U.S. grew by 216 TWh from 2000-2015
- RPS policies required 123 TWh increase over that period (57% of total growth)
 - Not strict attribution: some of that would have occurred without RPS
- Additional RE growth associated with:
 - Voluntary green power markets
 - Economic purchases
 - 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: 2000-2015



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's 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

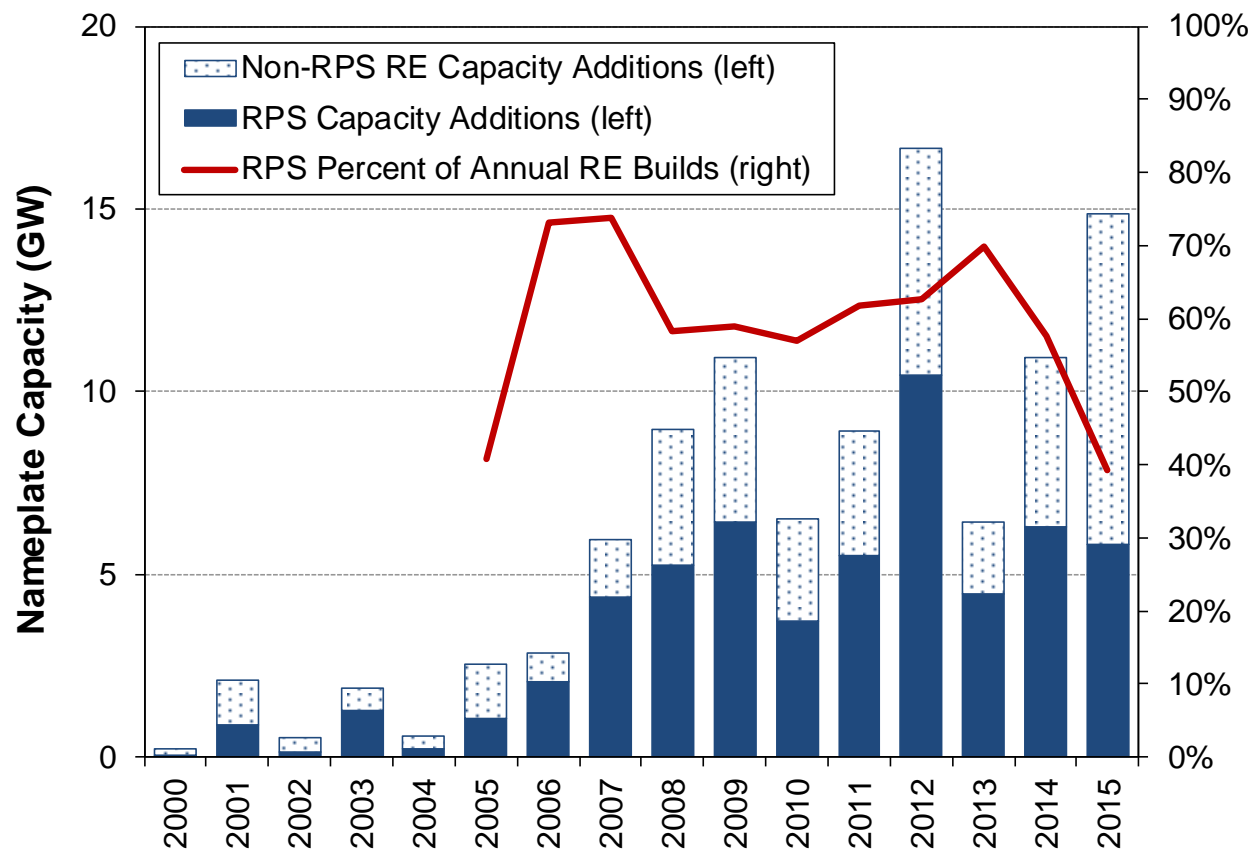
Southeast

- 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



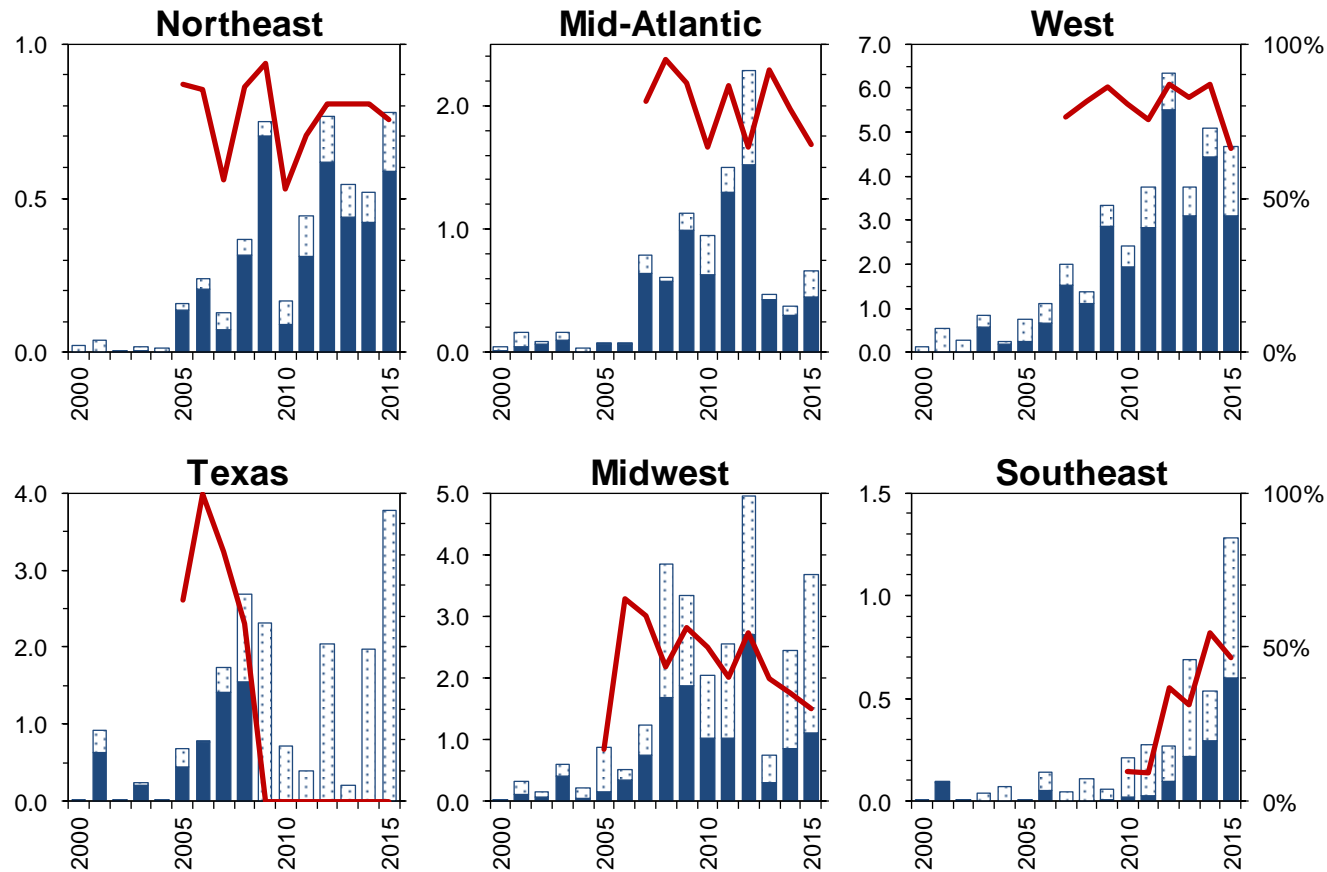
Notes: RPS Capacity Additions consists of RE capacity contracted to entities with active RPS obligations or sold on a merchant basis into regional RPS markets (see Supplementary Notes for additional details and exceptions).

- Cumulatively, 100 GW of RE capacity added in the U.S. since 2000
 - Just over half of that capacity (58%) consist of projects (at least partially) driven by RPS obligations
 - Mirrors earlier trends for growth in RE *generation*
- Over the past decade, 5 GW/year of RE capacity added for RPS demand
 - Representing 40-70% of all new RE builds each year
 - Has provided a floor in “down years” (e.g., 2013)
- In the past couple years, the RPS-portion of new RE builds has declined
 - Mostly due to rebounding wind growth in TX and Midwest
 - 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

70-80% of 2015 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).

Northeast: Relatively low growth (<1 GW/yr), but almost all capacity additions serve RPS demand

Mid-Atlantic: Recent RPS capacity additions are modest and mostly for solar carve-out requirements

West: Represents the bulk of U.S. RPS capacity additions in recent years; 2015 growth split evenly between CA and other states

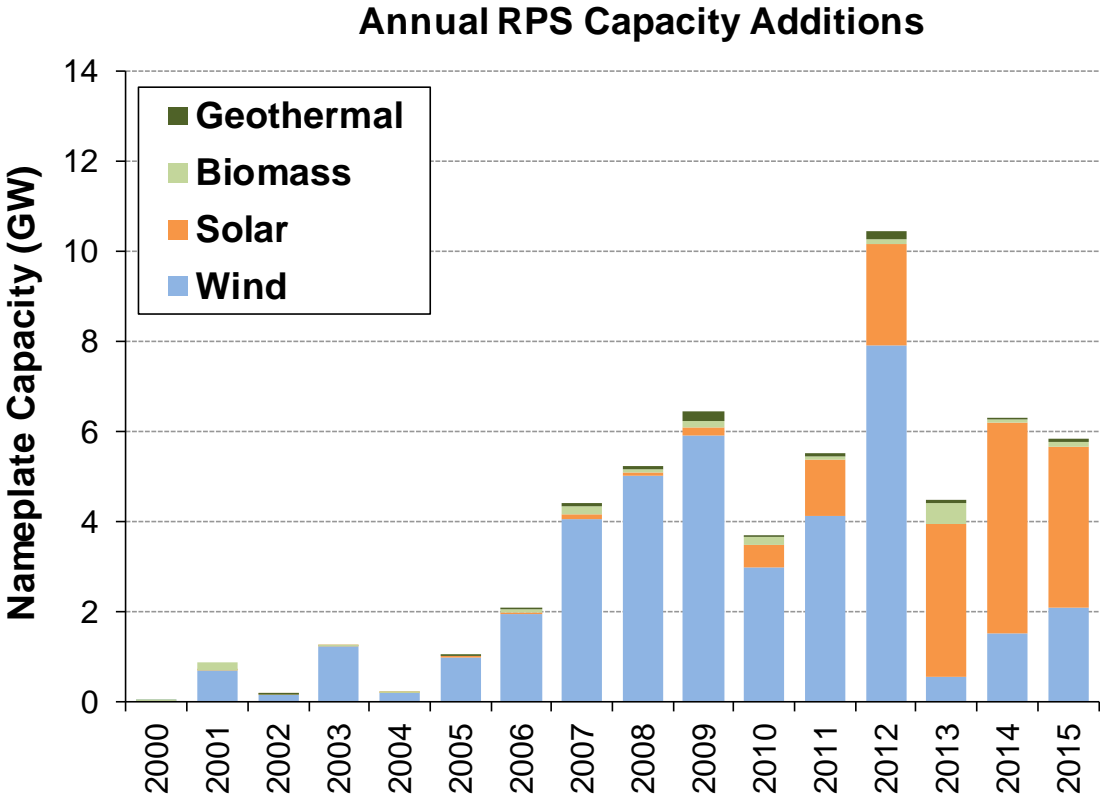
Texas: Achieved its final RPS target in 2008 (7 years ahead of schedule); all growth since is thus Non-RPS

Midwest: Lots of wind development throughout the region, some contracted to utilities with remaining RPS needs

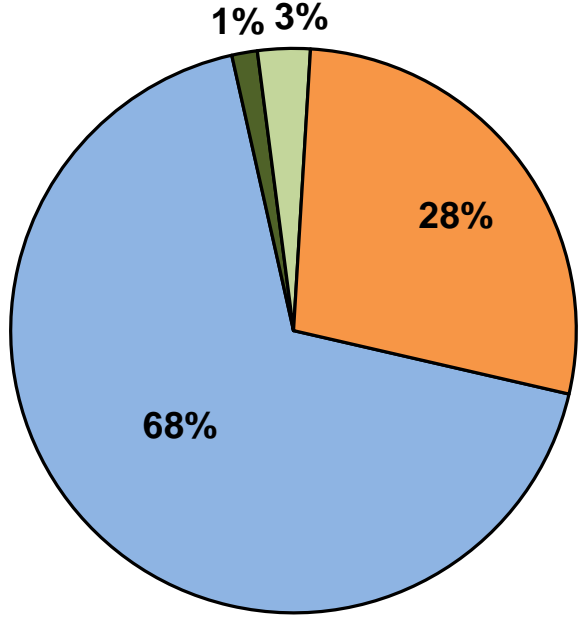
Southeast: RE growth is almost all utility-scale PV in NC, a portion of which is RPS qualified; PURPA has been a key driver in tandem with RPS demand

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 68% of all RPS builds to-date, but solar was 62% of 2015 adds

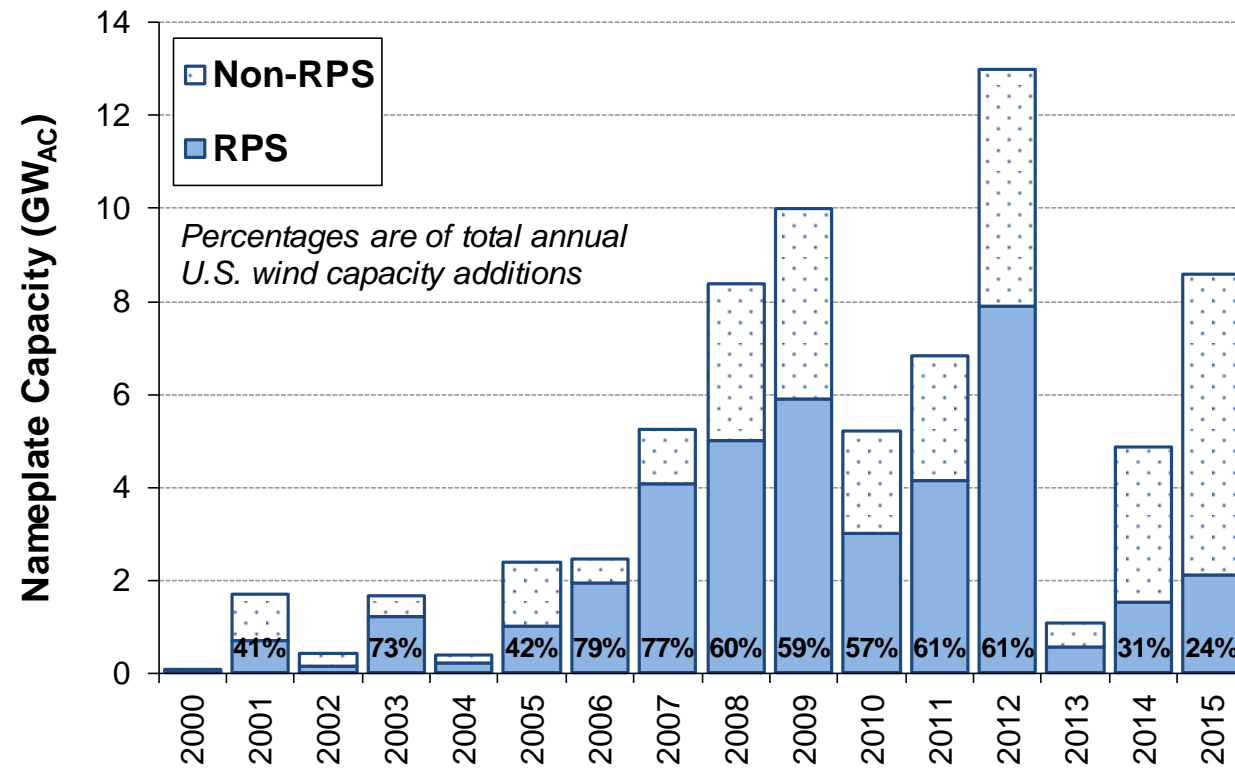
- Growing role of solar for RPS reflects:
 - Ramping up of solar carve-out requirements
 - Increasing cost-competitiveness of utility-scale solar vis-à-vis wind
- Wind capacity growth still strong, but recent additions primarily not for RPS

Notes: "RPS Capacity Additions" represent RE capacity contracted to entities subject to an RPS or sold on a merchant basis into regional RPS markets (see Supplementary Notes). 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. See Supplementary Notes for data sources and methodological details.

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

In 2015, **24%** of all wind additions were dedicated to RPS demand, compared to **57%** for solar (42% for general RPS obligations + 15% for carve-outs)

Wind Capacity Additions



Solar Capacity Additions

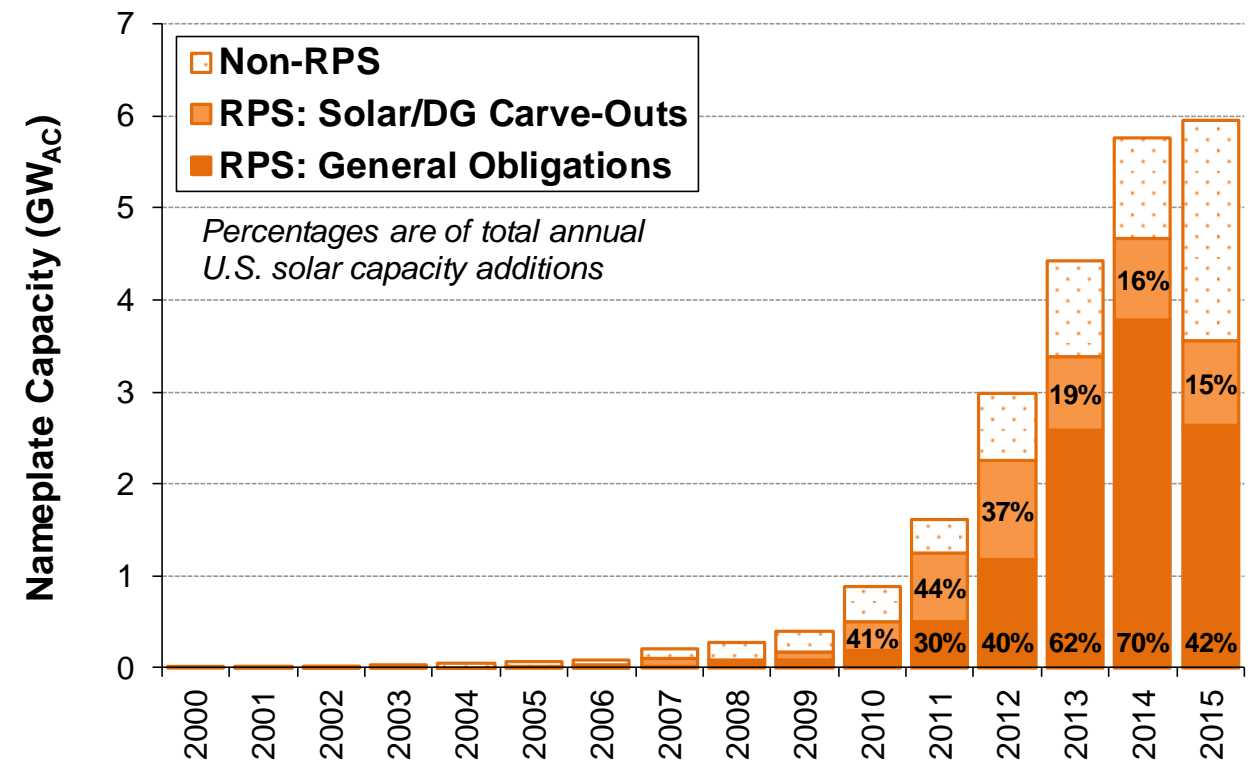


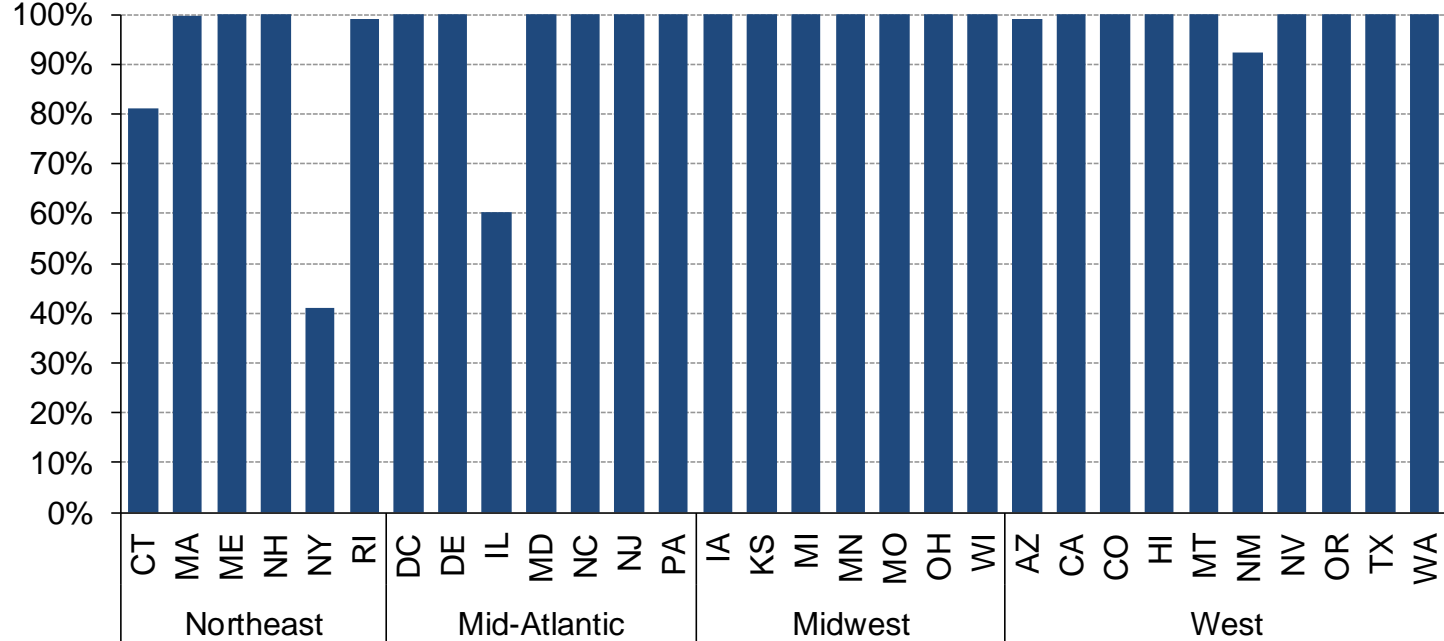
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Most States Fully Met Interim RPS Targets in Recent Years

Limited instances of shortfalls often associated with cost containment

Percentage of Primary-Tier/General RPS Obligations Met with RECs or Renewable Energy (for most-recent compliance year available in each state)

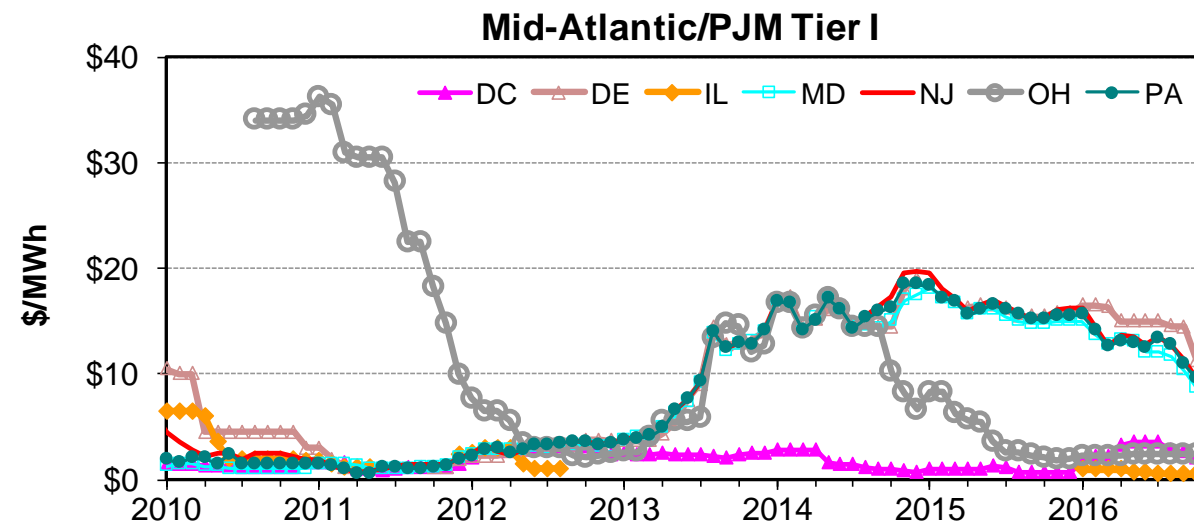
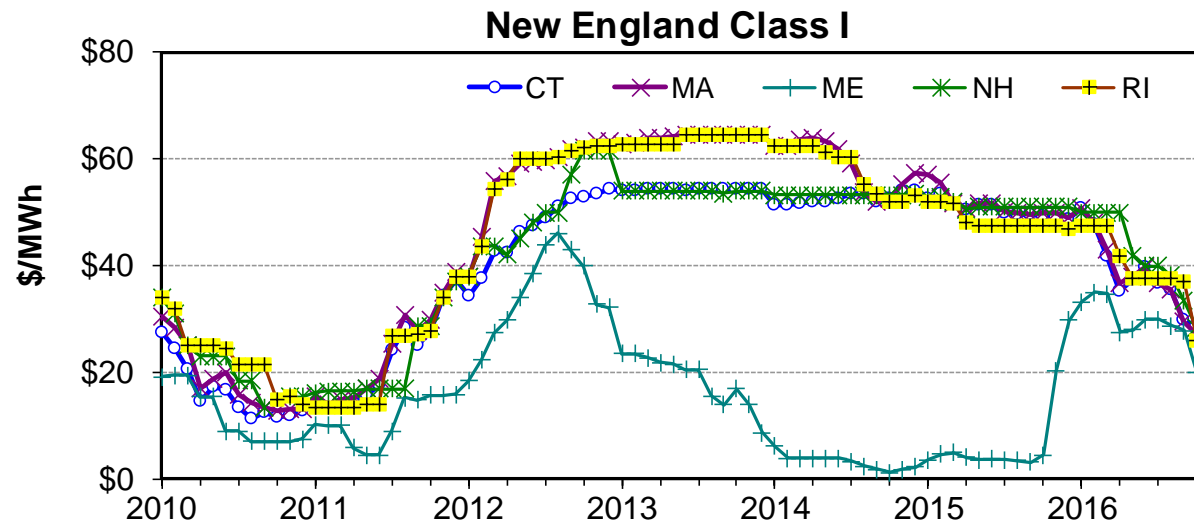


Notes: The values represent the percentage of annual RPS targets met with RE or RECs retired for RPS compliance each year, focusing on general or primary-tier (new, Class I, or Tier I) RPS obligations—i.e., excluding technology carve-outs or secondary (existing, Class II or Tier II) resource tiers. For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

- RPS targets generally fully achieved by all obligated LSEs, often relying on banked RECs from prior years
- Notable shortfalls occurred in just 4 states in 2014 and 2015
 - **CT:** Some shortages due to lower ACP than neighboring states
 - **NY:** Procurement has lagged targets, partly due to budget constraints
 - **IL:** Alternative retail suppliers are required to meet 50% of RPS with ACPs
 - **NM:** RPS cost caps curtailed procurement for one utility

Primary Tier REC Prices Trended Downward in 2016

Current pricing well below ACP levels in New England and Mid-Atlantic markets



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 in restructured states reflect regional supply-demand balance and ACPs

New England:

- Growing regional supplies have pushed prices to near a 5-year low (<\$30/MWh, compared to \$55-65 ACP levels)

Mid-Atlantic/PJM:

- Bifurcated market based on geographic eligibility rules (more restrictive rules & higher prices in DE/MD/NJ/PA)
- Growing Midwestern wind may be driving down prices

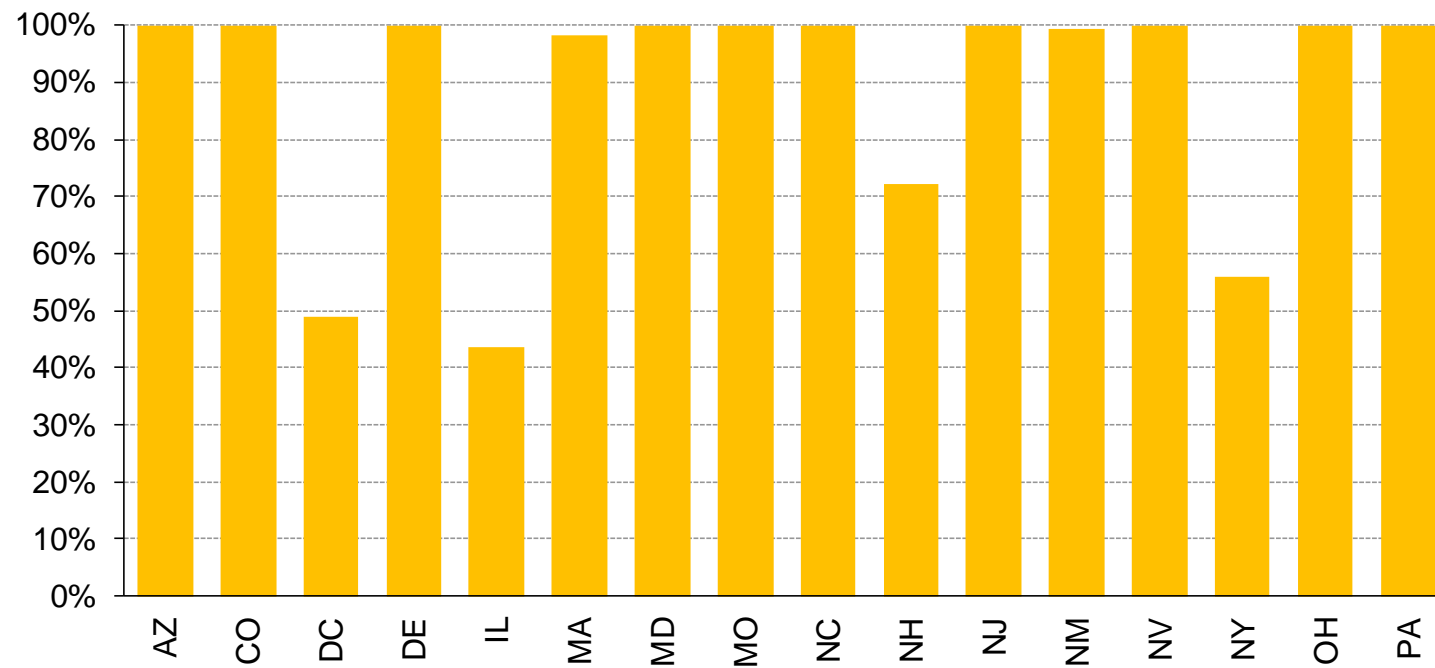
Elsewhere:

- NYSERDA 2015 RFP for long-term REC contracts averaged \$23/MWh
- TX prices remain low (\leq \$1/MWh); acute surplus

Solar/DG Carve-Out Interim Targets Also Mostly Achieved

Exceptions are DC, IL, NH, and NY

Percentage of Solar/DG Carve-Out Obligations Met
with RECs or Renewable Energy
(for most-recent compliance year available in each state)

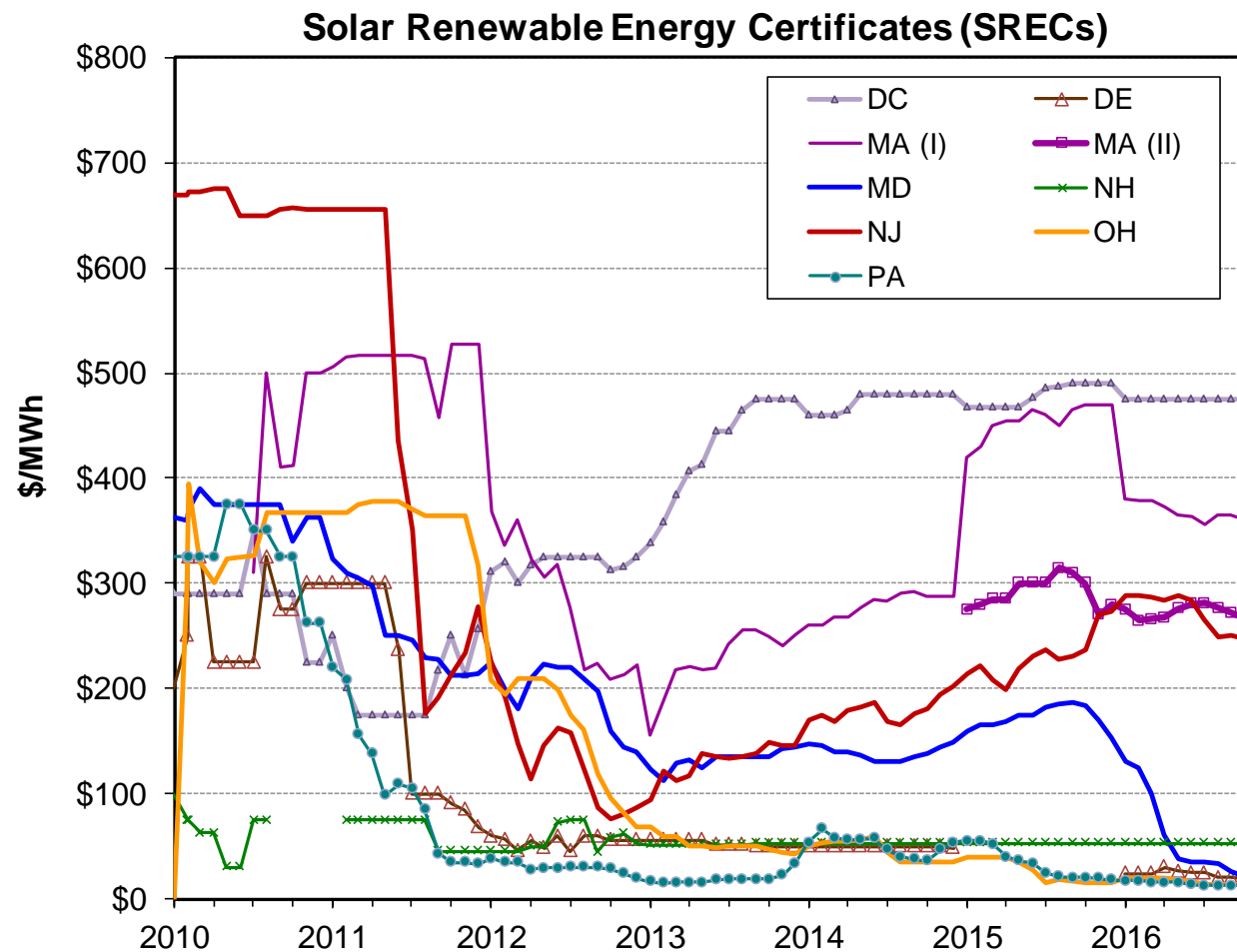


Notes: The values represent the percentage of annual carve-out targets met with RE or RECs retired for RPS carve-out compliance in each year. For states with compliance years beginning in the middle of calendar years, compliance years are mapped to the chart based on their start date.

- Many states well ahead of their solar/DG targets
- But 4 states missed their interim targets, for different reasons
 - **DC:** Acute undersupply due to in-district requirements
 - **IL:** Alternative retail suppliers can meet their requirements less expensively with ACPs
 - **NH:** Competition from more-lucrative neighboring markets for NH SRECs
 - **NY:** Large amount of additional capacity under contract but not yet installed

Solar REC Pricing Trends Are Highly State-Specific

The most significant movements in 2016 were in Maryland



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 REC 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
- **NJ:** Supply-demand roughly in balance
- **MA:** Price movements bounded by clearinghouse floor and SACP
- **PA** and **OH** heavily oversupplied, in part due to eligibility of out-of-state projects
- **NH:** Undersupplied, but low SACP (\$55/MWh)
- **DE:** Large portion of solar carve-out met through long-term contracts

RPS Compliance Costs Rising with Increasing Targets

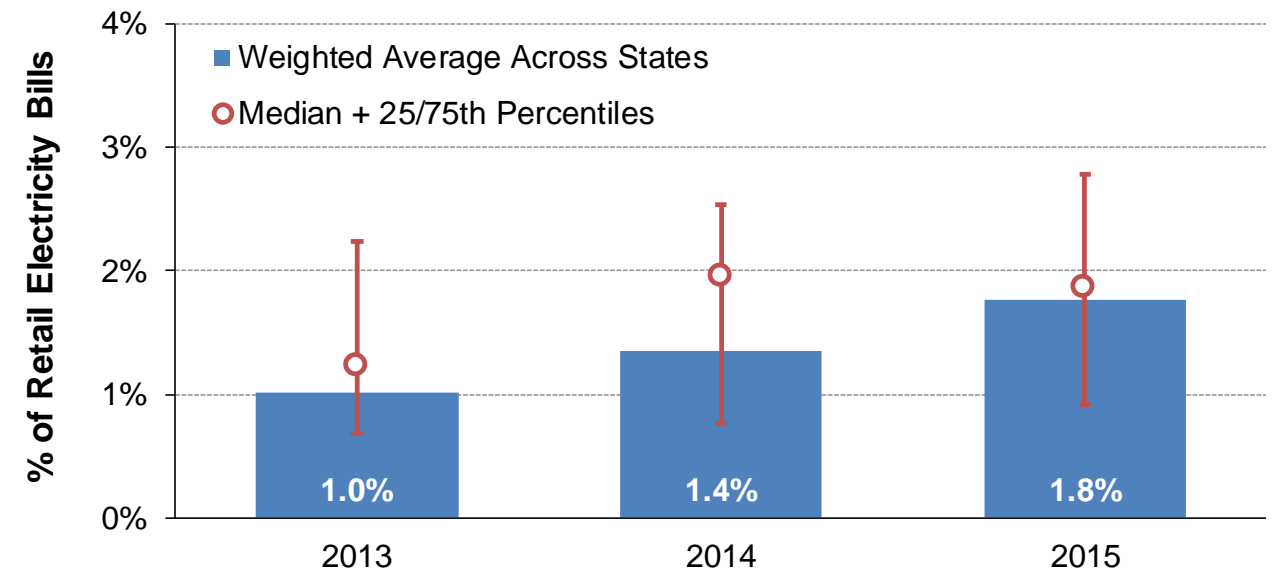
Weighted average of 1.8% of retail electricity bills in 2015, up from 1.4% in 2014

RPS Compliance Costs: Based on REC+ACP expenditures (restructured markets) and estimated above-market costs of bundled RE purchases (regulated markets)

- Impact of rising RPS targets moderated by falling REC prices in some markets
- RPS compliance costs vary across states (most ranging from 1-3% in 2015)
- Reflecting differences in: RPS target levels, resource tiers/mix, REC prices, wholesale electricity prices, reliance on pre-existing resources, and cost calculation methods
- Cost containment mechanisms will limit growth in RPS costs going forward

RPS Compliance Costs Percentage of Average Retail Electricity Bill

A rough proxy for rate impact



Notes: Averages are weighted based on each state's total revenues from retail electricity sales. See Supplementary Notes for data sources and additional methodological details.

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States Are Starting to Approach Final Target Years

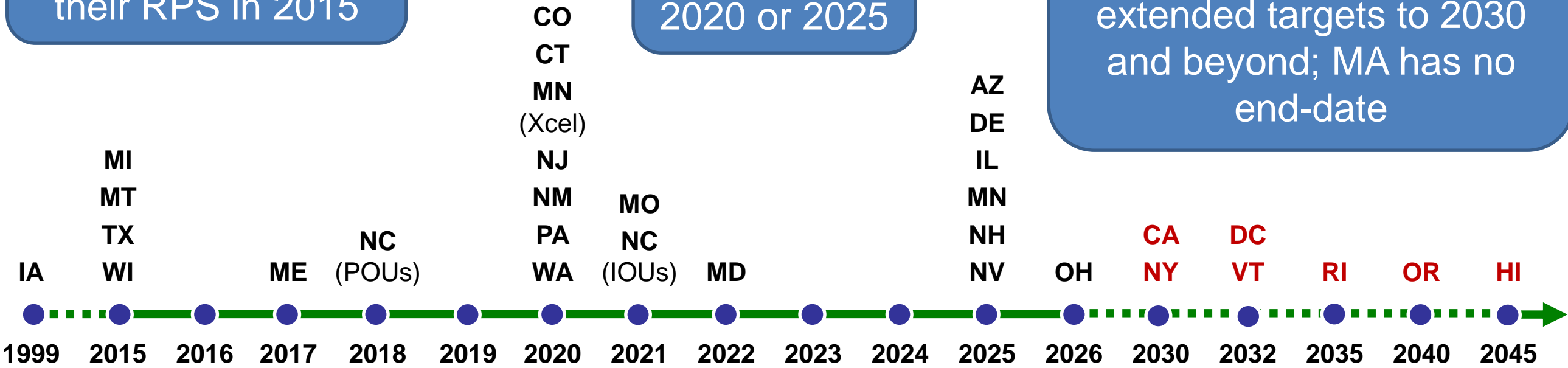
Though many have until 2025 or beyond

Year of Final RPS Target

Four states reached the terminal year of their RPS in 2015

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 end-date



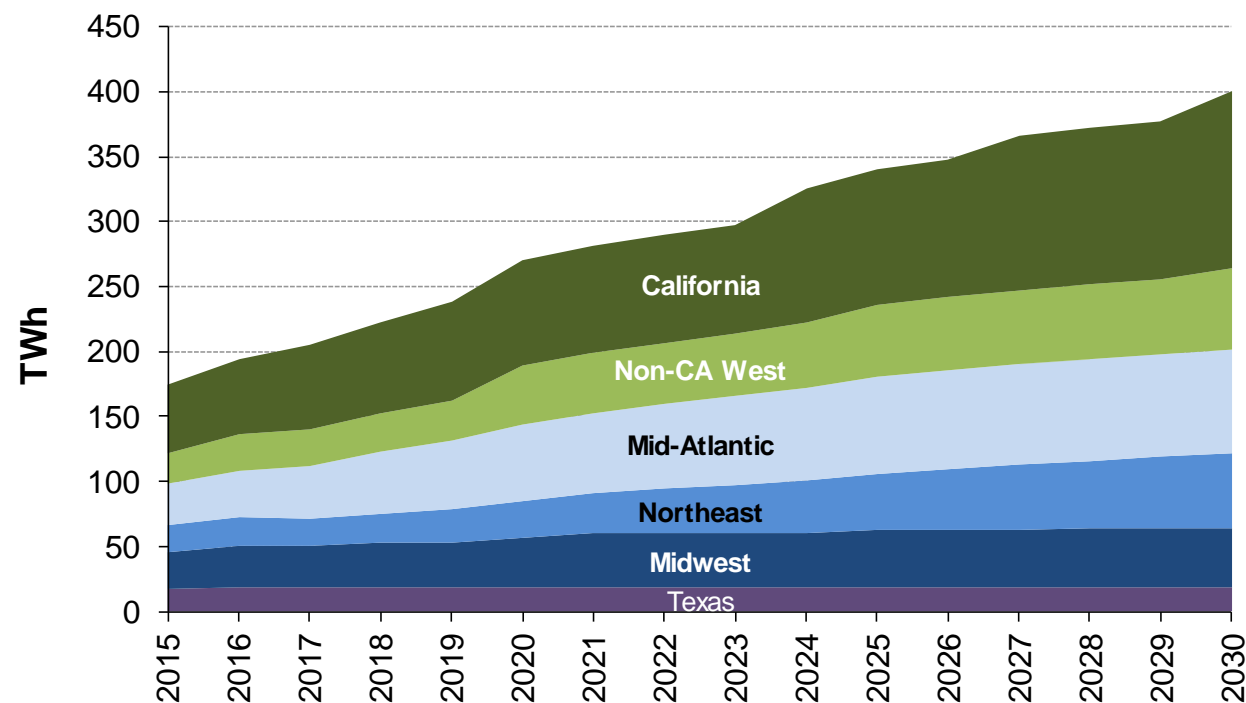
RPS needs will continue to grow after final targets, due to load growth and RE retirements

Substantial Growth in RPS Demand Remains

Total U.S. RPS demand roughly doubles by 2030

Projected RPS Demand (TWh)

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.

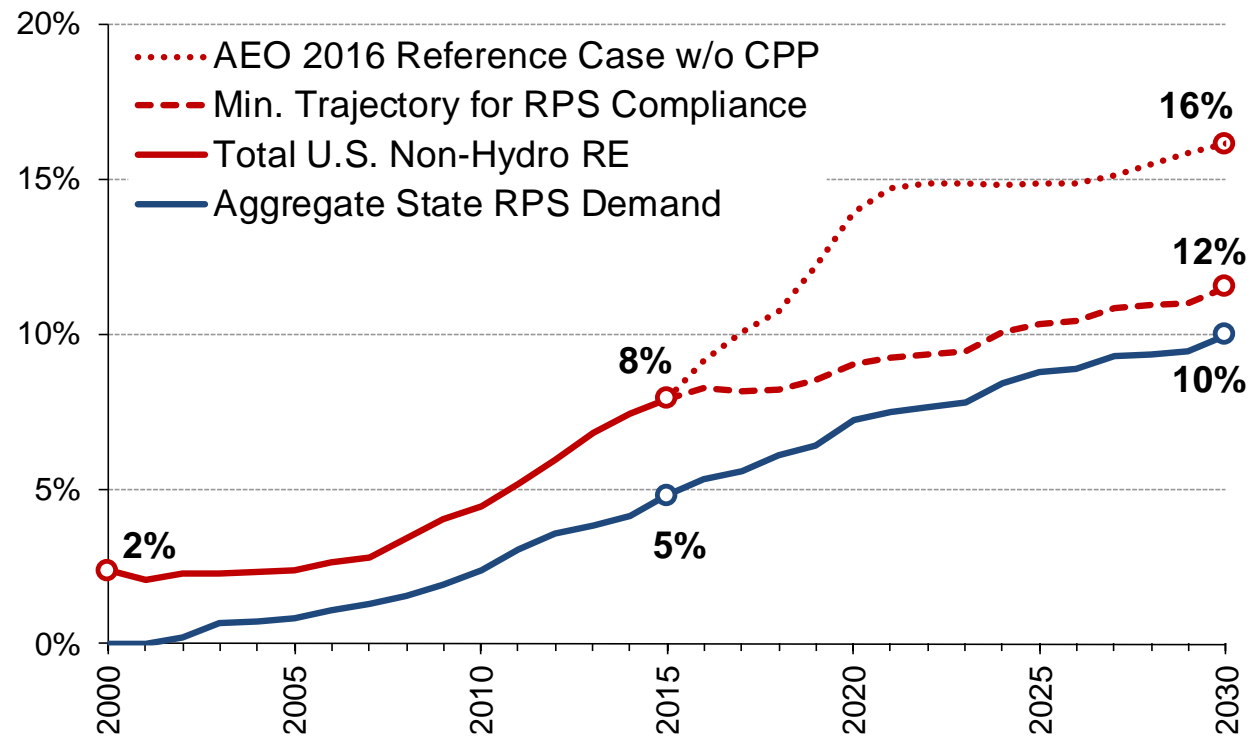
- Under current targets, total RPS demand increases from 200 TWh in 2016 to 400 TWh in 2030
 - Latest RPS revisions in CA and NY added >70 TWh in 2030
- However, increased demand does not equate to required increase in supply:
 - Some utilities and regions are ahead of schedule, while others are behind
 - Full compliance may or may not be achieved

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

U.S. RE Generation Must Increase to Keep Pace

Must reach ~12% of retail sales by 2030 to meet minimum RPS requirements

Projected RPS Demand vs. RE Supply (% of Retail Electricity Sales)



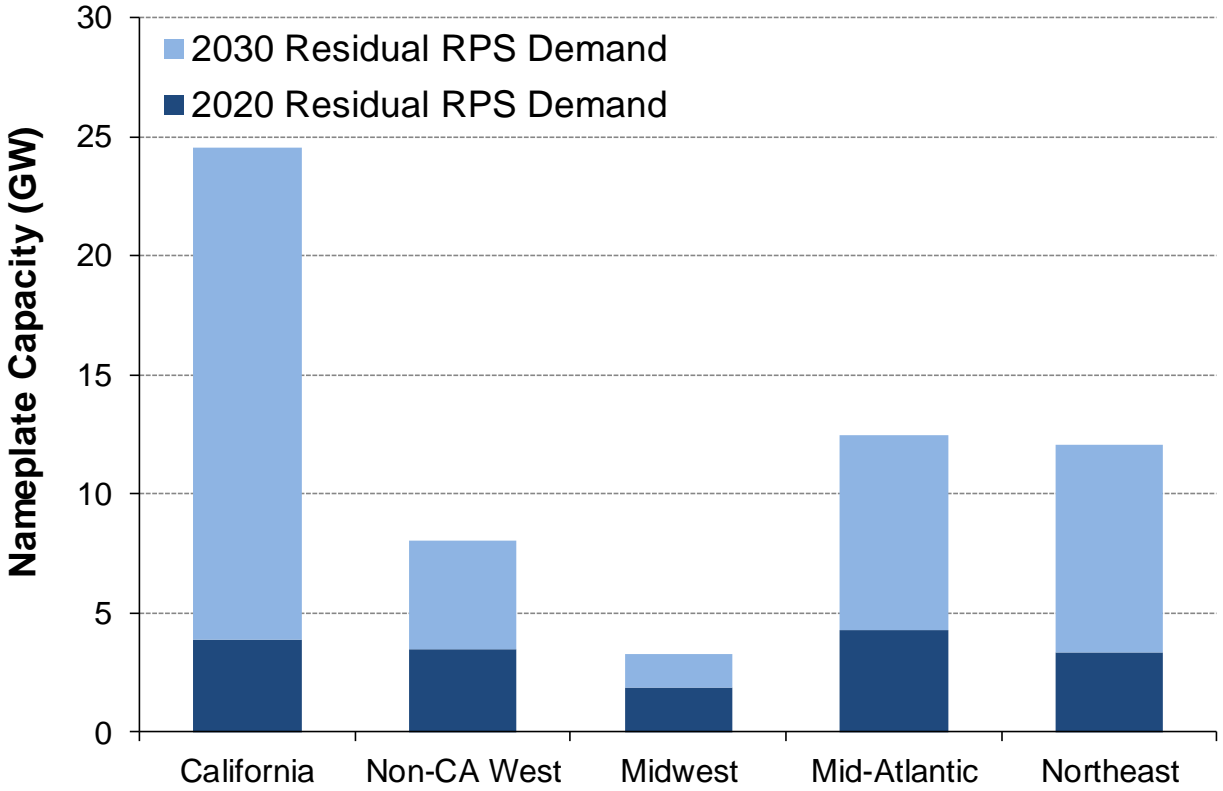
Notes: State RPS demand is based on current targets, accounting for exempt load, likely use of credit multipliers, offsets, and other state-specific provisions. Likely contributions by hydro, MSW, and non-RE technologies are deducted from the totals for consistency across states. Underlying retail electricity sales are based on the EIA Annual Energy Outlook reference case growth rates for each region.

- Total RPS demand rises to 10% of U.S. retail electricity sales in 2030
- Current RE supplies = 8% of sales, but not all is available for RPS
- Total U.S. RE supply would need to reach 12% by 2030 just to meet minimum RPS demand
- Other drivers may push RE growth higher
 - E.g., AEO 2016 projects rapid growth prior to expiration of ITC/PTC in early 2020's

RE Capacity Needed for RPS Demand Growth

17 GW of additional RE capacity needed by 2020, 61 GW by 2030

Residual RPS Demand Relative to “Available RPS Supply”



Notes: Residual RPS demand is computed on a regional basis for NEPOOL and PJM states, but otherwise estimated for each state individually, and then aggregated to the regions shown here. No residual RPS demand for Texas or the Southeast.

- Represents roughly a doubling of total RPS-builds through 2015 (58 GW)
- Some of the near-term residual need may be met with RE capacity under development
- Near-term needs distributed somewhat evenly across regions; long-term concentrated in California
- Residual demand in Mid-Atlantic/Northeast could be lower, depending on availability of imports from Midwest/Canada

“Available RPS supply”: For most regions, based on projects under contract to retail suppliers with RPS obligations or sold on merchant basis into RTO markets. For Mid-Atlantic, derived from REC tracking system data on REC generation/eligibility.

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

- ➔ RPS compliance costs and ACPs/cost caps
- ➔ Legislative and legal challenges
- ➔ Whether states extend RPS targets as they approach final year
 - And if so, whether they retain the same basic design or are “re-tooled”
- ➔ Other ongoing refinements to key RPS design elements
 - For example, REC banking and shelf-life, long-term contracting programs, eligibility rules
- ➔ The many related issues affecting RE deployment and market access
 - Transmission, integration, siting, net metering, etc.

For Further Information

RPS reports, presentations, data files, resources

rps.lbl.gov



All renewable energy publications

emp.lbl.gov/reports/re

Follow the Electricity Markets & Policy Group on Twitter @BerkeleyLabEMP

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