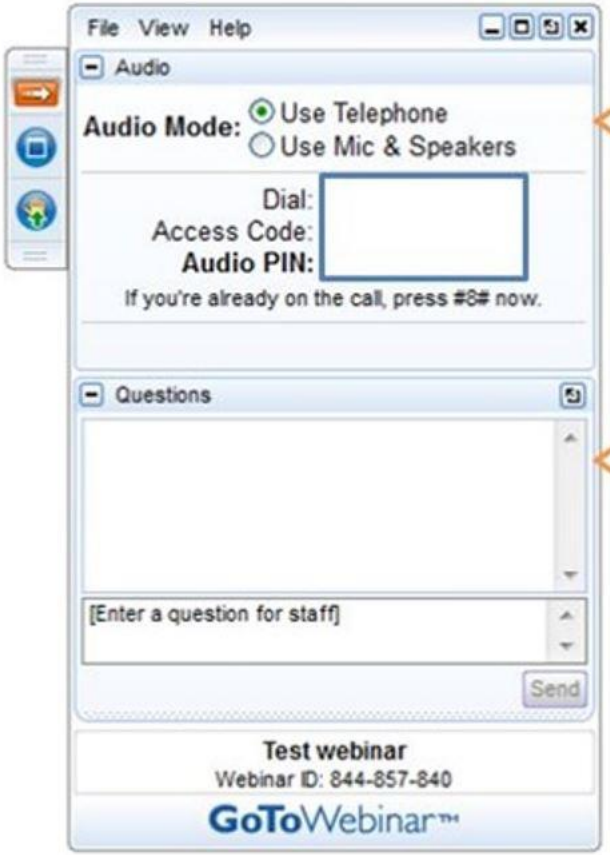
State-Federal RPS Collaborative Webinar

Renewable Portfolio Standards: Overview of Status and Key Trends

Hosted by
Warren Leon, Executive Director, CESA

January 26, 2016

Housekeeping



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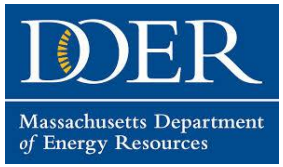
Renewable Development Fund



State-Federal 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/state-federal-rps-collaborative

Today's Guest Speaker

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

Environmental Energy Technologies Division Lawrence Berkeley National Laboratory

U.S. Renewables Portfolio Standards:

Overview of Status and Key Trends

Galen Barbose

Lawrence Berkeley National Laboratory

Clean Energy States Alliance Webinar

January 26, 2016

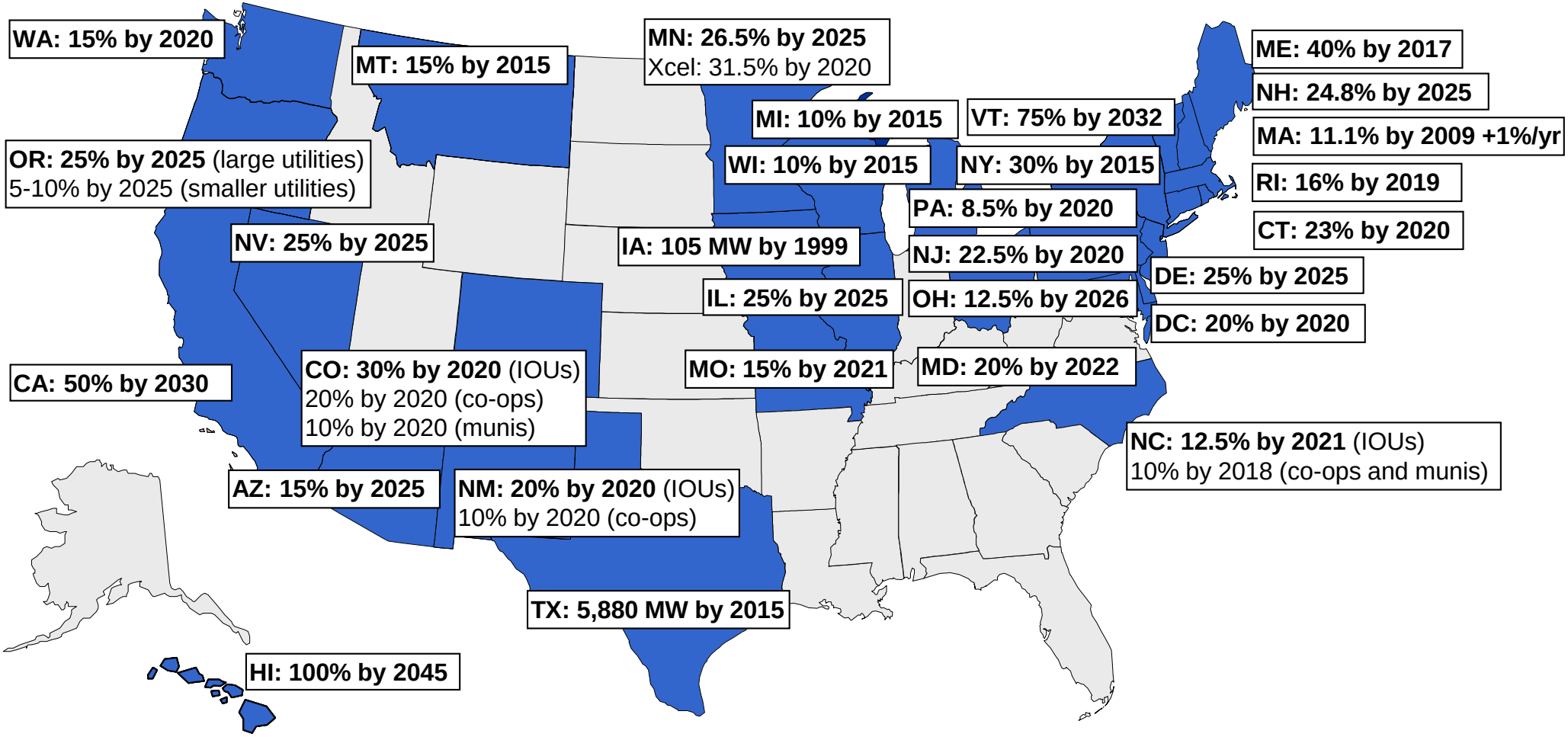
This analysis was funded by the National Electricity Delivery Division of the Office of Electricity Delivery and Energy Reliability of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Outline

- **Evolution of state RPS programs**
- RPS impacts on renewables development to-date
- Future RPS demand and incremental needs
- RPS compliance levels
- RPS costs
- Summary and outlook

RPS Policies Exist in 29 States and DC

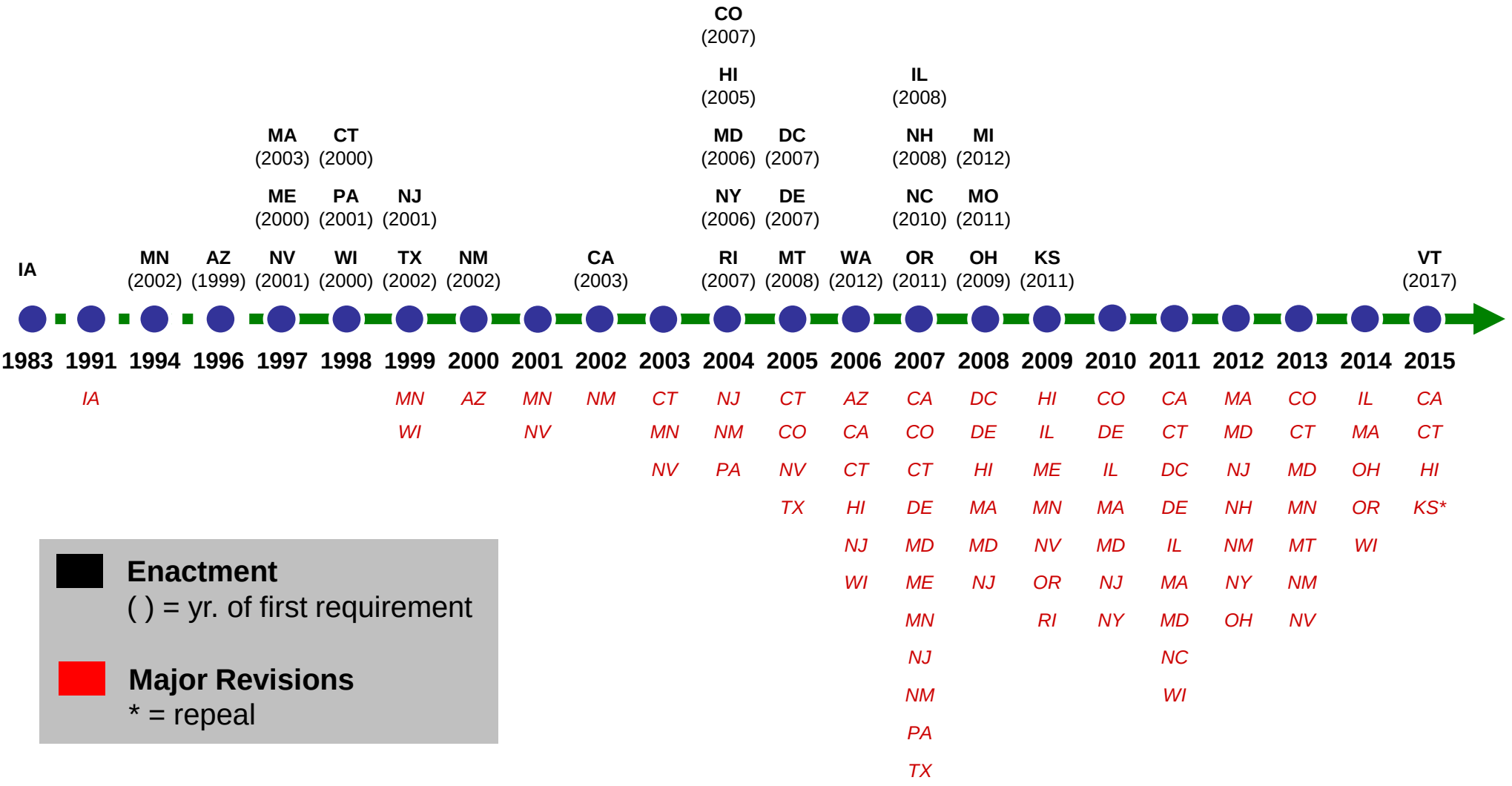
Apply to 54% of Total U.S. Retail Electricity Sales



Source: Berkeley Lab

Notes: Compliance years are designated by the calendar year in which they begin. Mandatory standards or non-binding goals also exist in US territories (American Samoa, Guam, Puerto Rico, US Virgin Islands)

Enactment of New RPS Policies Has Waned, but States Continue to Hone Existing Policies



General Trends in RPS Revisions

- Creation of resource-specific carve-outs/set-asides
- Increase and extension of RPS targets
- Long-term contracting programs or requirements
- Honing resource eligibility rules, particularly for hydro and biomass
- Proposals to repeal, reduce, or freeze existing RPS programs—but very few enacted thus far

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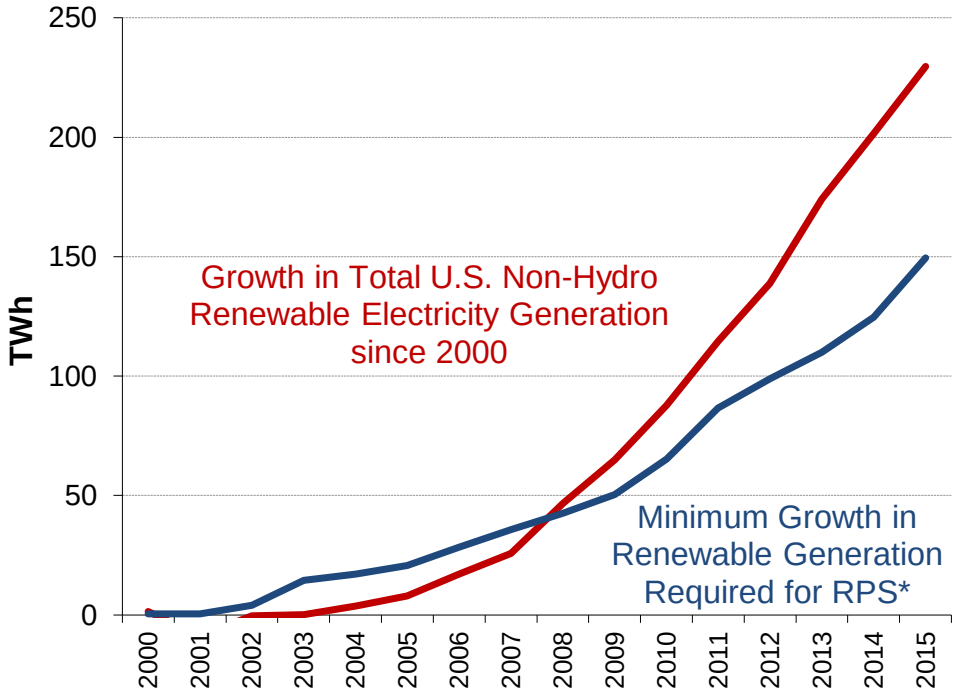
RPS Demand a Key Driver for RE Growth:

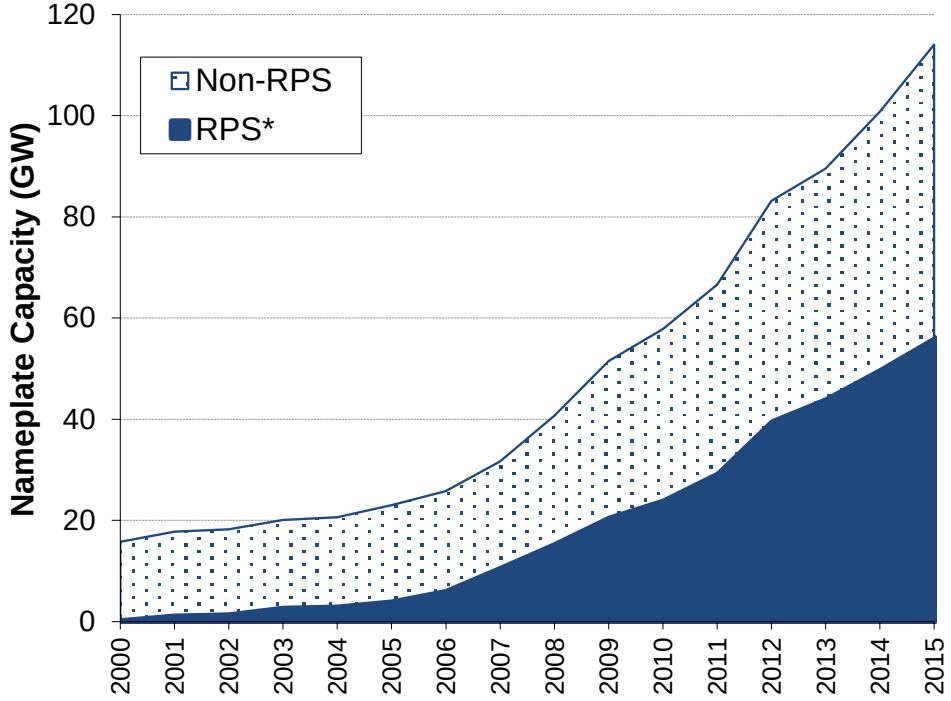
65% of Increased RE Generation, 56% of New RE Capacity

Growth in U.S. Renewable Electricity Generation (TWh)



** Min. Growth Required for RPS accounts for the use of pre-2000 vintage facilities in meeting RPS obligations, where it occurs*

Total U.S. Renewable Generation Capacity (GW)



** RPS capacity: The entity purchasing RECs is subject to an RPS but has not yet met its terminal RPS obligations, and the project commenced operation after enactment of the RPS*

Non-RPS RE Growth is mostly wind in TX and Midwest, much of it selling into voluntary green power markets

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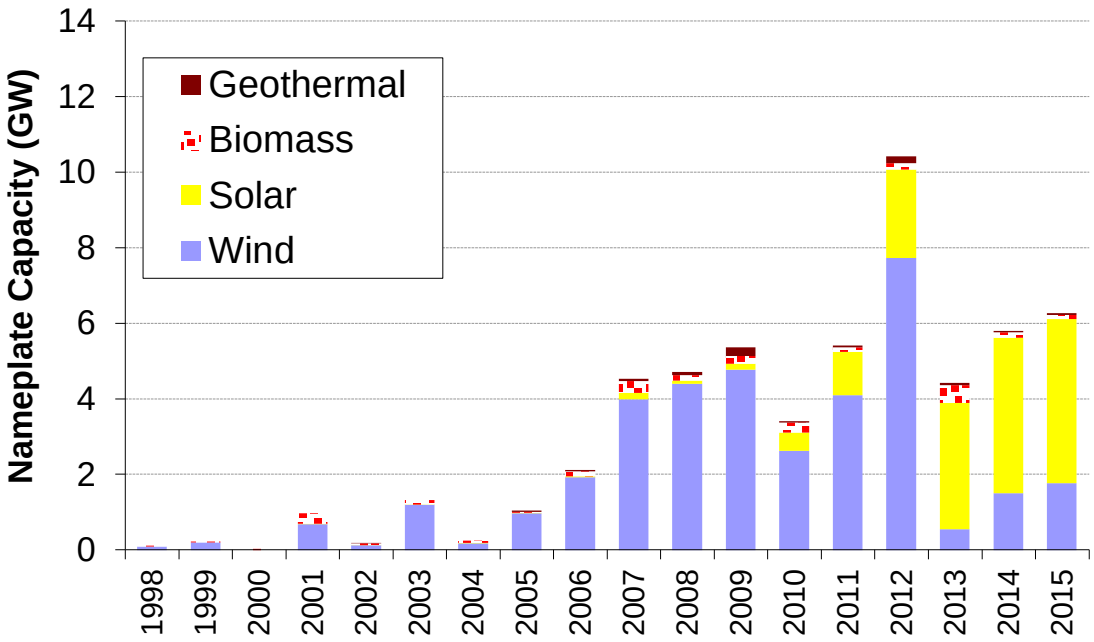
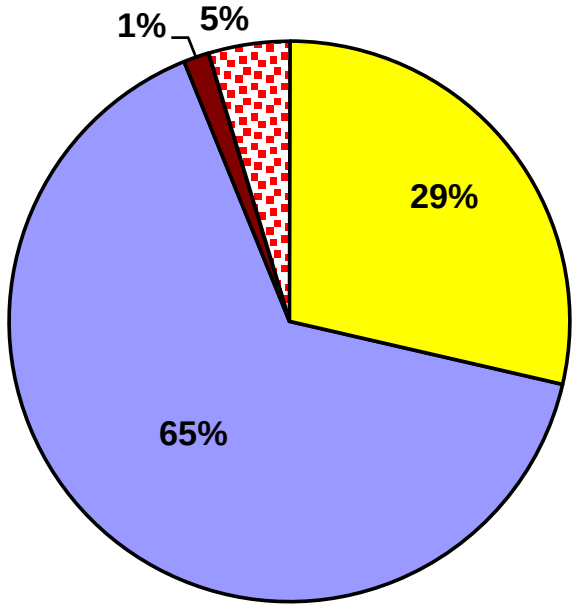
Wind Was Historically the Dominant New-Build for RPS, But Solar Has Come to the Fore

RPS Capacity Additions from 1998-2015, by Technology Type

Annual RPS Capacity Additions



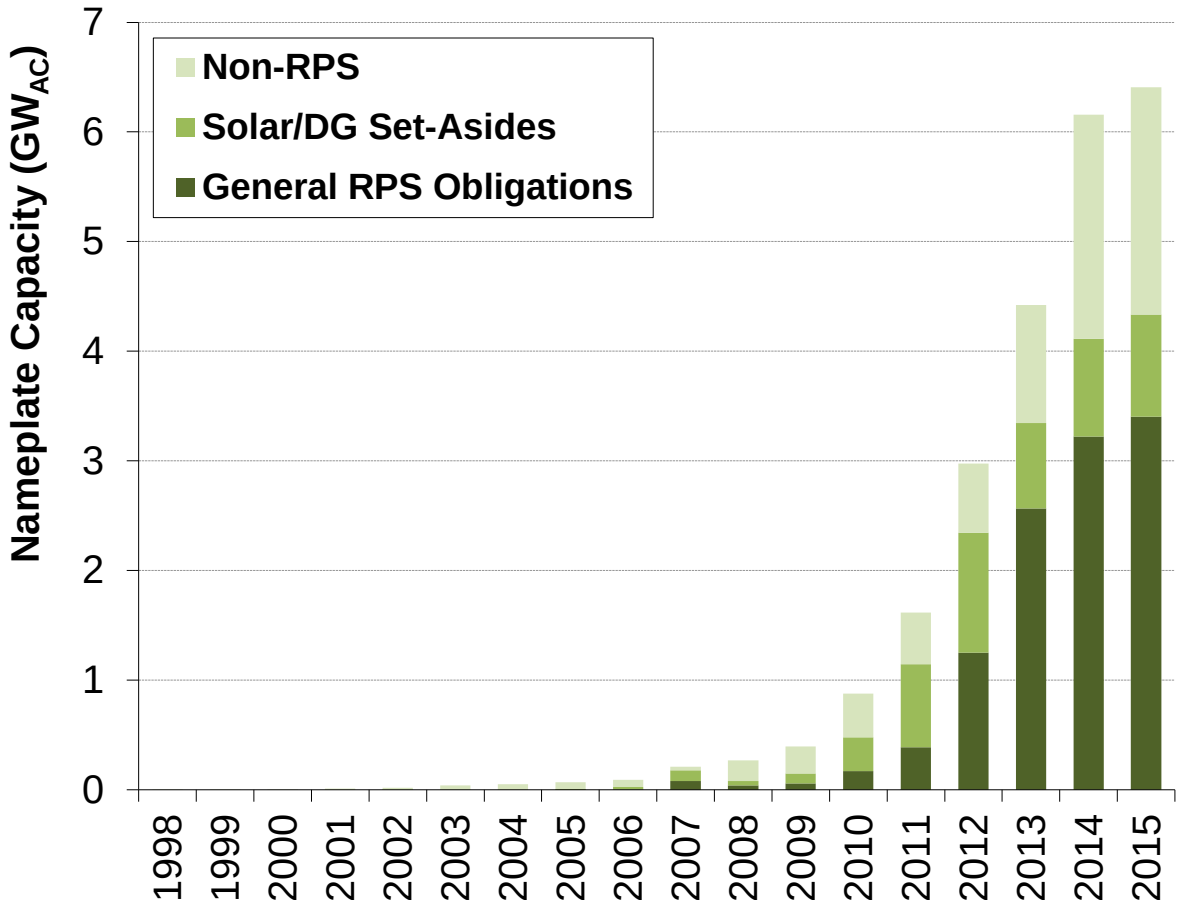
Cumulative RPS Capacity Additions



Notes: Renewable additions are counted as "RPS-related" if and only if the entity receiving RECs from the project is subject to RPS obligations, and the project commenced operation after enactment of the RPS. On an energy (as opposed to capacity) basis, wind energy represents approximately 68%, solar 15%, biomass 13%, and geothermal 4% of cumulative RPS-related renewable energy additions, if estimated based on assumed capacity factors.

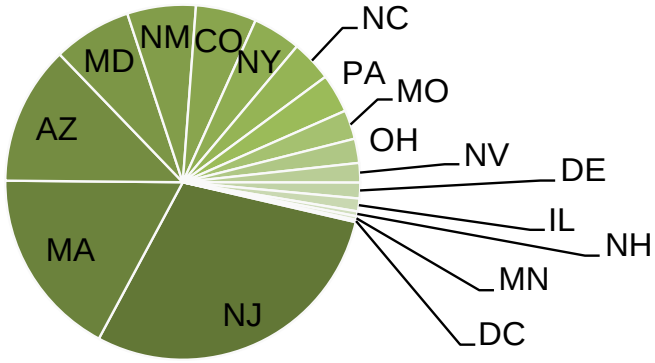
RPS Solar Additions Driven by Both General RPS Obligations and Solar/DG Set-Asides

Annual U.S. Solar Capacity Additions

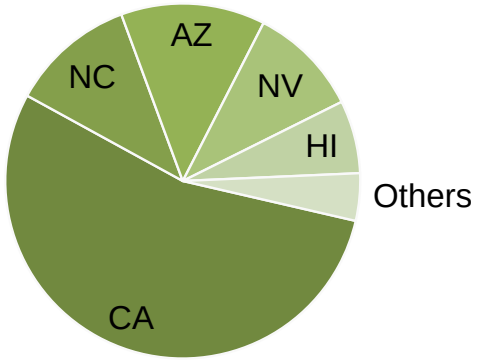


Cumulative RPS Solar Capacity Additions

Solar/DG Set-Asides (5 GW)



General RPS Obligations (11 GW)



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States Are Starting to Approach Final Targets

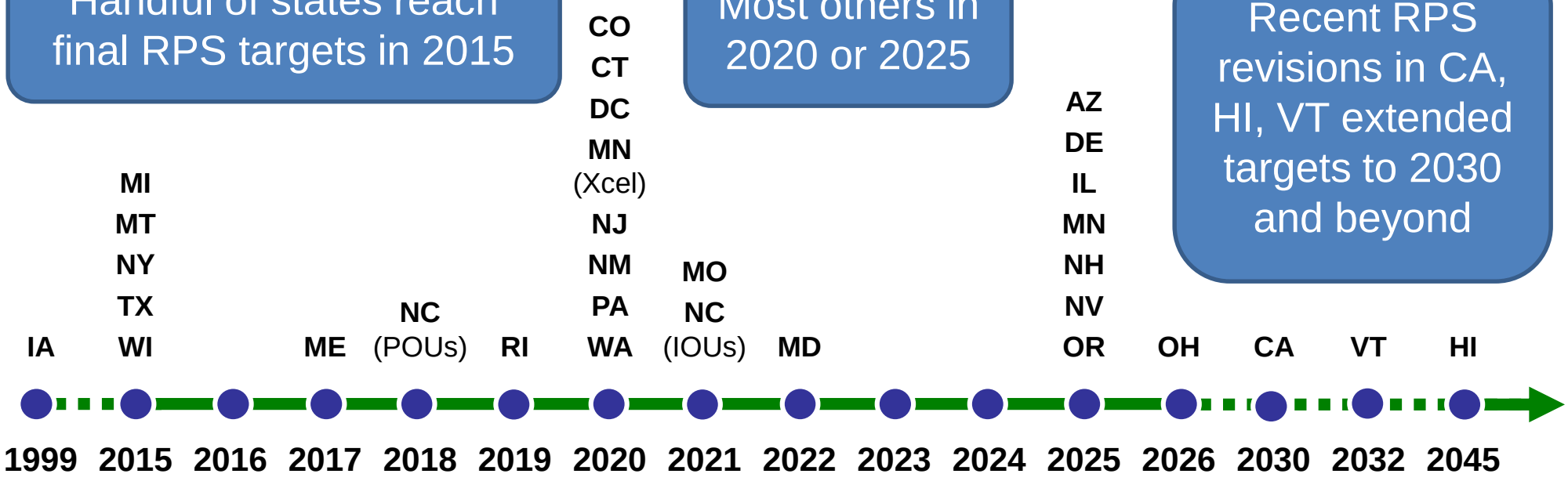
Though Most Still Have 5-10 Years

Year of Final RPS Target

Handful of states reach final RPS targets in 2015

Most others in 2020 or 2025

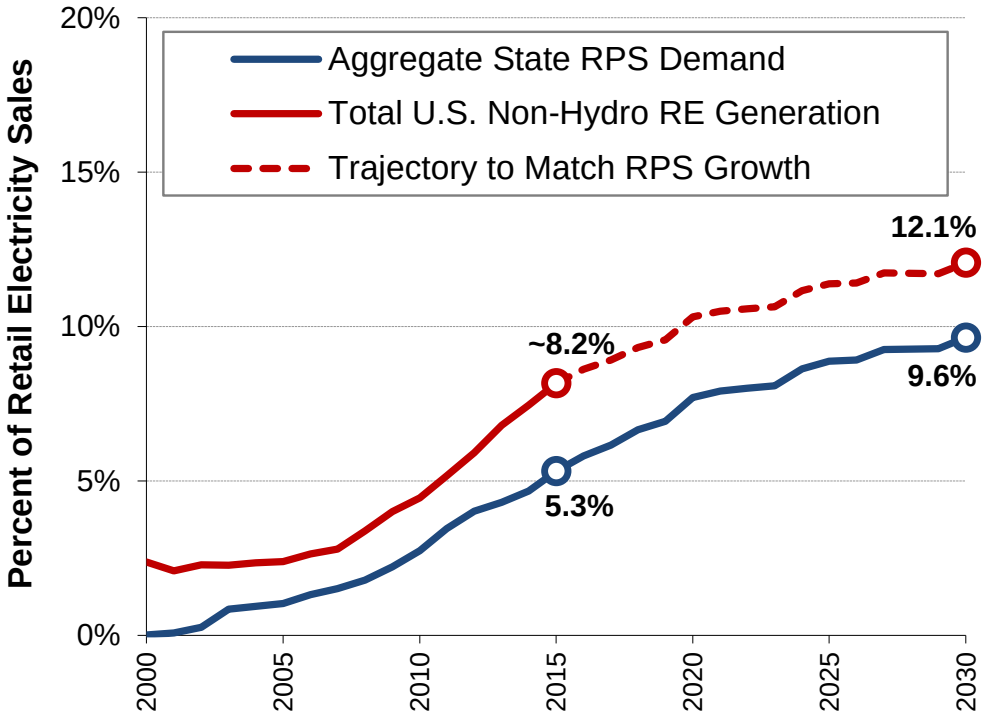
Recent RPS revisions in CA, HI, VT extended targets to 2030 and beyond



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

Substantial Growth in RPS Demand Remains

Projected U.S. RPS Demand Compared to U.S. RE Supply

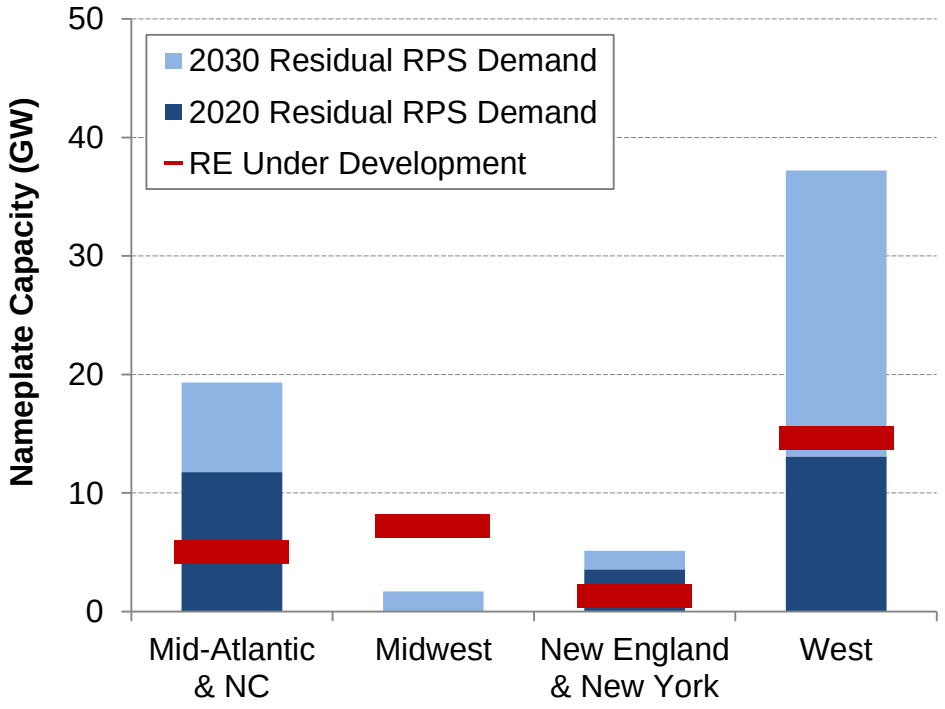


Notes: Projected RPS demand estimated based on current targets, accounting for exempt load, likely use of credit multipliers, and other state-specific provisions. Underlying retail electricity sales forecasts are based on growth rates from most-recent EIA Annual Energy Outlook reference case.

- Under current state targets, total U.S. RPS demand will increase from **5.3%** of U.S. retail electricity sales in 2015 to **9.6%** in 2030
- CA represents ~40% of that growth; most of the remainder is associated with relatively large states
- Total U.S. RE supply would need to grow to 12.1% of retail sales in 2030 to keep pace with RPS demand growth
- However, some of current RE surplus may be applied to RPS demand growth
  - Utilities that have over-procured relative to current RPS requirements
  - Voluntary green power supplies

Significant Additional RE Capacity is Needed to Meet Growing RPS Demand

Residual RPS Demand Relative 2015 Available RPS Supply



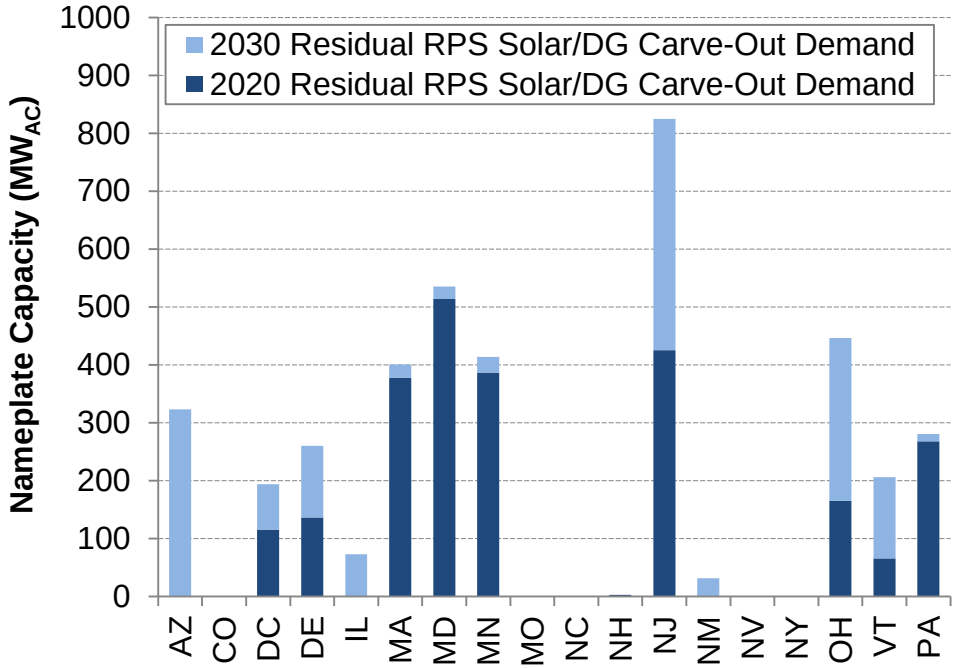
Notes: Residual RPS demand is measured relative to RE capacity under contract to RPS-obligated entities or sold on a merchant basis into regional RPS markets in 2015. Capacity under development includes plants permitted or under construction as of Jan. 2016, based on data from the Ventyx/ABB Velocity Database.

- Meeting future RPS demand will require an additional 28 GW of RE by 2020 and **63 GW by 2030**
- To put that into context:
  - RPS-builds to-date = 56 GW
  - Total U.S. RE in 2015 = 114 GW
- Some of that residual RPS demand may be met with RE capacity under development (28 GW currently)
  - Though not all of that capacity will be built
  - And not all will be available for RPS compliance or fungible within each region

Residual Solar Carve-Out Demand Remains, Despite Over-Supplies in Some Markets

- Total solar demand under current RPS solar and DG carve-outs rises from **4 GW** in 2015 to 7.5 GW in 2020 and **9 GW** in 2030
- Many states over-supplied relative to current solar carve-out targets, and some states have already met their final carve-out targets
- Remaining residual carve-out demand will require an add'l 2-3 GW by 2020 and 4 GW by 2030
- Greatest near-term residual demand in MA, MD, MN, and NJ

Residual Solar/DG Carve-Out Demand Relative to Eligible 2015 Supply



Notes: For most states, eligible 2015 supply is equal to total in-state solar capacity through 2015. For AZ, CO, and NM, it is based on data from utility RPS compliance plans. For IL, OH, and PA, eligible supply is based on facilities registered in PJM-GATS, allocated according to each state's total 2020 demand. For MO, no residual demand is assumed to exist, given unrestricted use of out-of-state solar.

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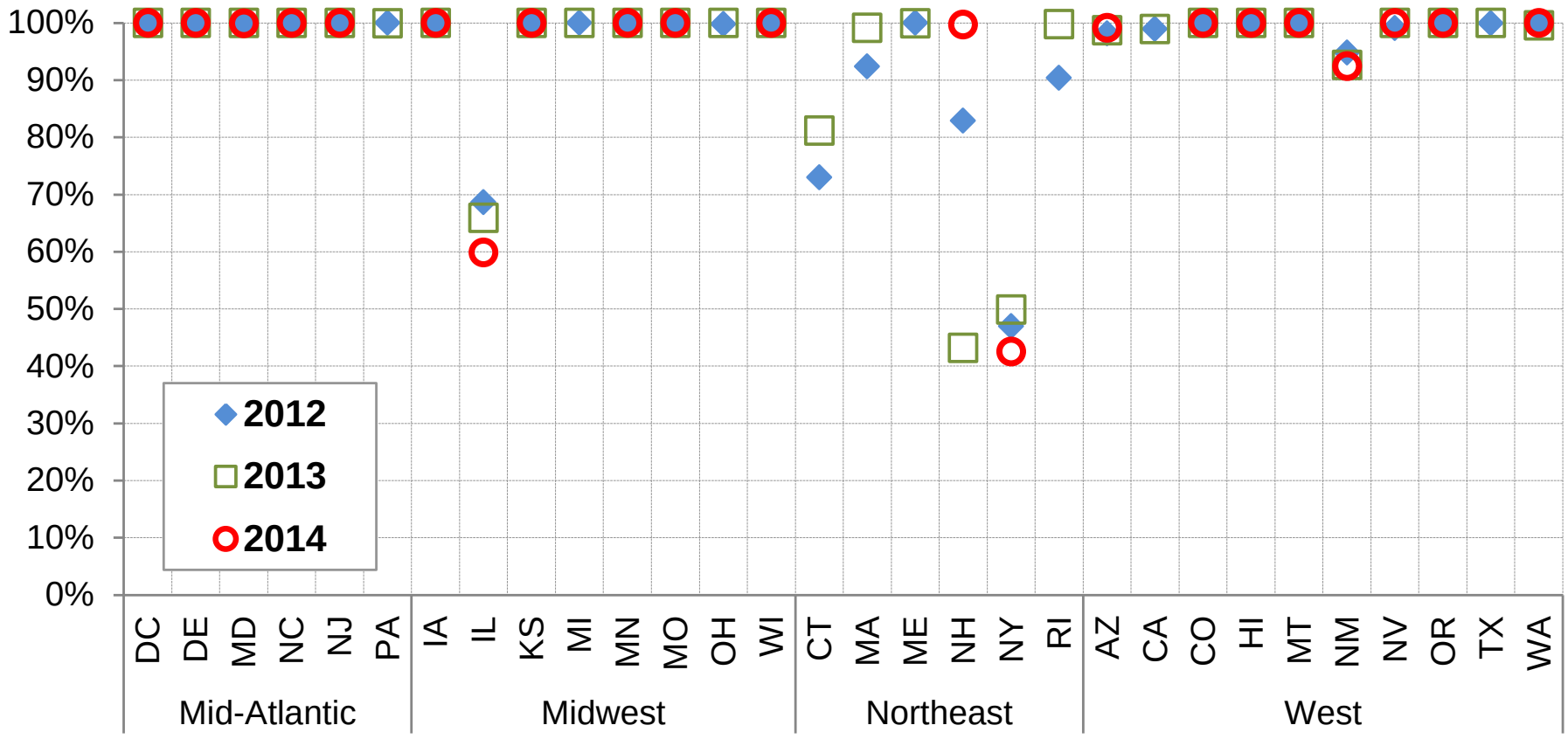
Main Tier RPS Targets Largely Achieved

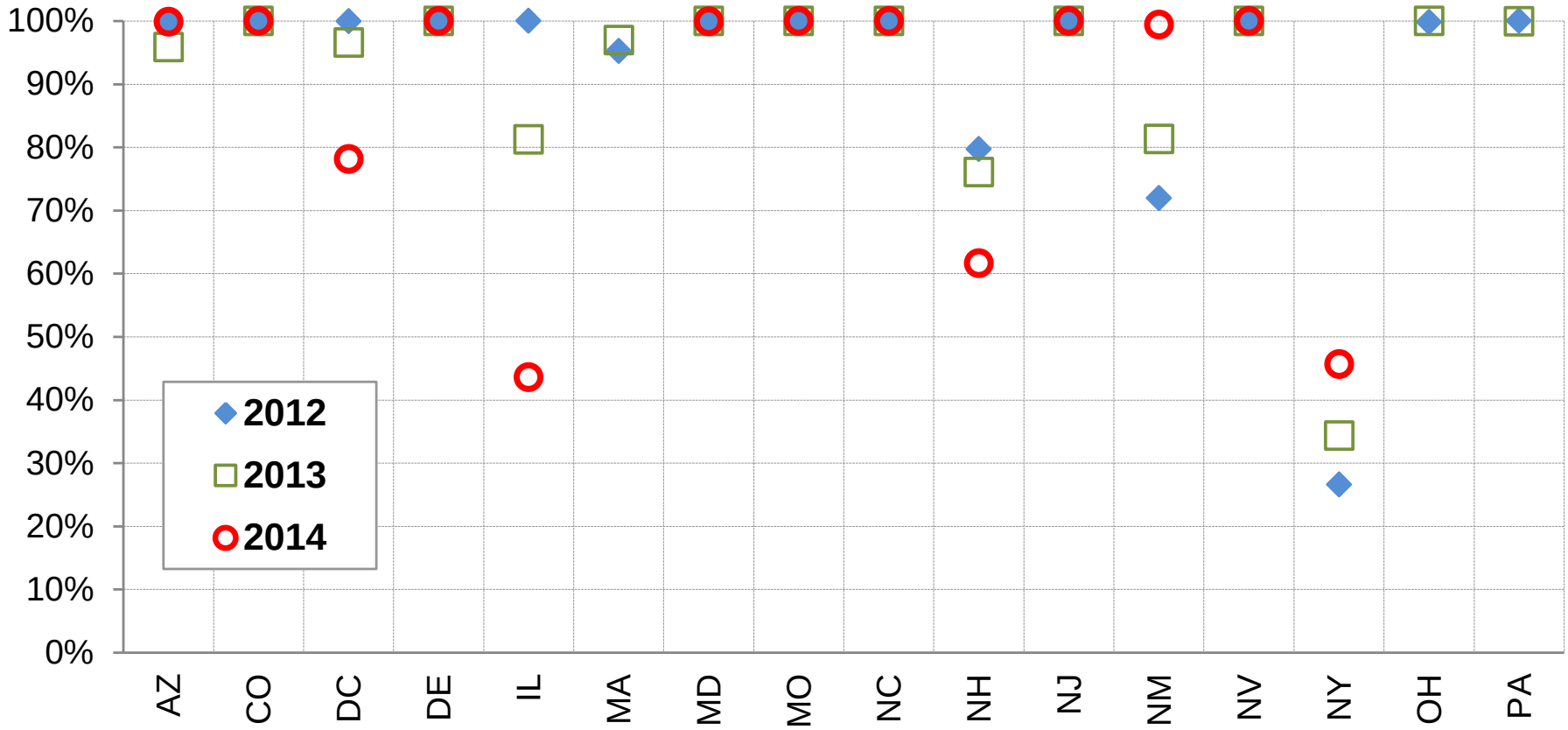
Percent of Main Tier RPS Target Met with Renewable Electricity or RECs
(including available credit multipliers and banking, but excluding ACPs)



Note: Percentages less than 100% do not necessarily indicate that "full compliance" was not technically achieved, because of ACP compliance options, funding limits, or force majeure events.

Achievement of Solar/DG Carve-Out Targets Has Been More Mixed, but Generally Strong

Percent of Solar/DG Set-Aside Target Met with Solar/DG Electricity or SRECs
(including available credit multipliers and banking, but excluding ACPs)



Note: "Percent of Solar/DG Target Met with Solar/DG Electricity or RECs" excludes ACPs but includes applicable credit multipliers. In cases where this figure is below 100%, suppliers may not have been technically out of compliance due to solar ACP compliance options, funding limits, and force majeure provisions.

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Characterizing RPS Compliance Costs

RPS Compliance Costs: The net cost to the utility or other LSE, above and beyond what would have been incurred in the absence of the RPS

Restructured Markets

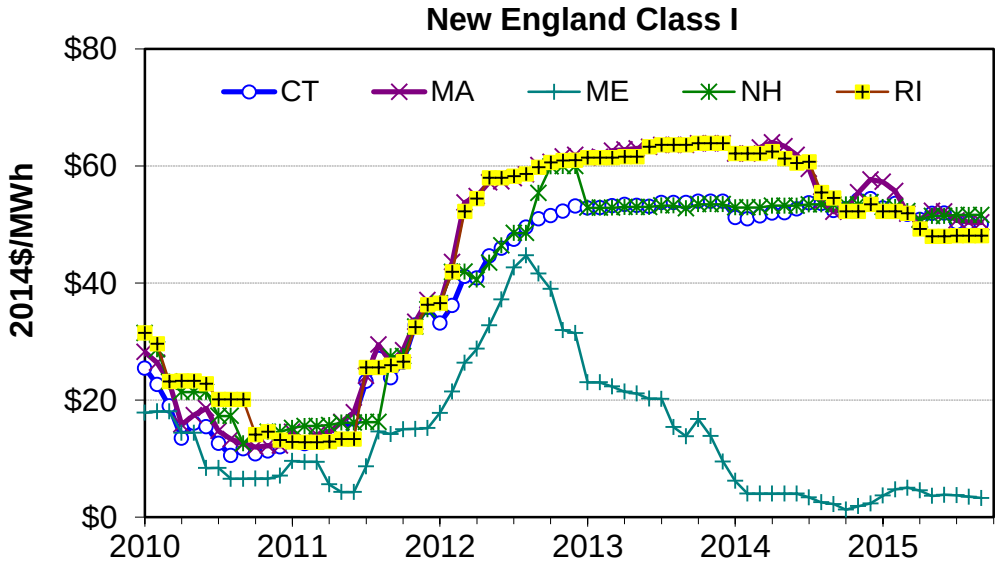
- Compliance typically occurs through retirement of unbundled RECs, historically dominated by short-term purchases
- We estimate RPS compliance costs based on REC plus ACP expenditures
- Limitations: Growing use of long-term/bundled PPAs; ignores "socialized" transmission and integration costs not paid by project; ignores merit order effect

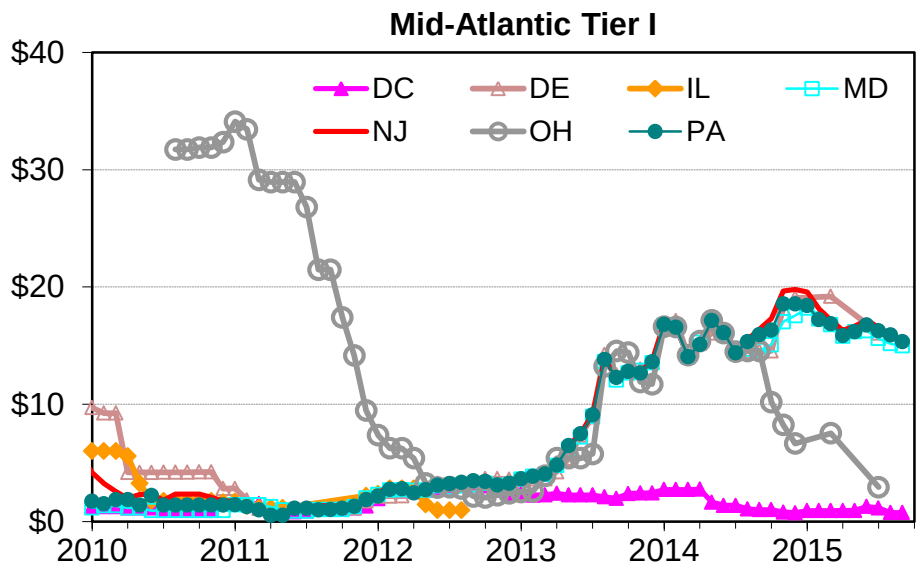
Regulated Markets

- Compliance typically occurs through bundled PPAs and/or utility-owned projects
- RPS compliance costs must be estimated by comparison to a counterfactual non-RE resource or procurement scenario; we synthesize utility and PUC analyses
- Limitations: Inconsistent methods across states/utilities; lagged/sporadic reporting

REC Pricing Reflects Regional Supply/Demand Balance and Local Market Rules

Spot Market Pricing: Class I/Tier I RECs





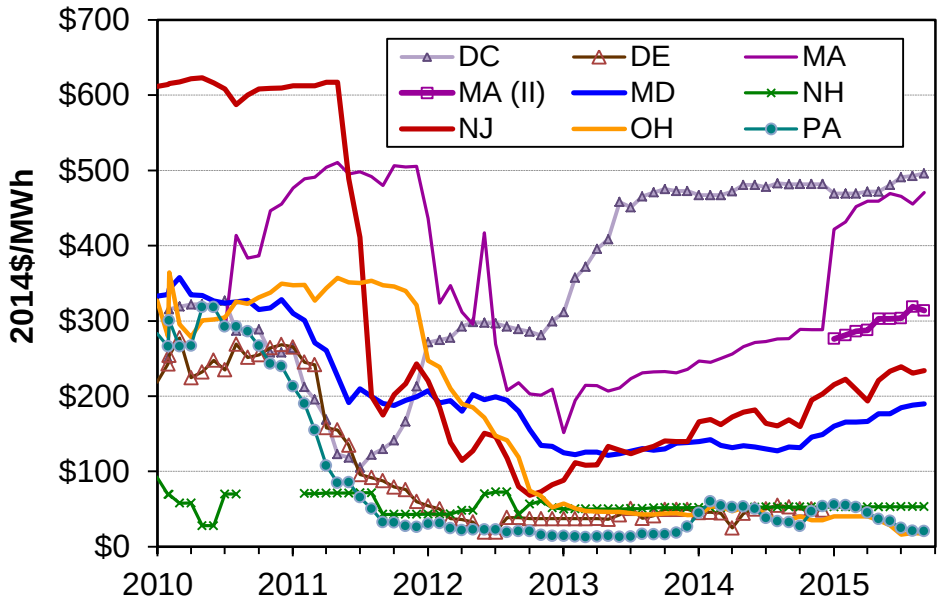
Source: Marex Spectron. Plotted values are the average monthly closing price for the current or nearest future compliance year traded in each month.

- **New England:** Tight supplies, with pricing just below CT/NH ACP levels; lower prices in ME reflect biomass resources ineligible for other states
- **Mid-Atlantic:** Pricing well below ACPs, but above historical lows, potentially reflecting anticipation of future shortages
- **Elsewhere:** TX aligned with voluntary markets (≤$1/MWh); NYSERDA 2015 RFP for long-term REC contracts averaged $23/MWh

SREC Pricing is Highly State-Specific

Due to *de facto* in-state requirements in most states

SREC Spot Market Pricing



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.

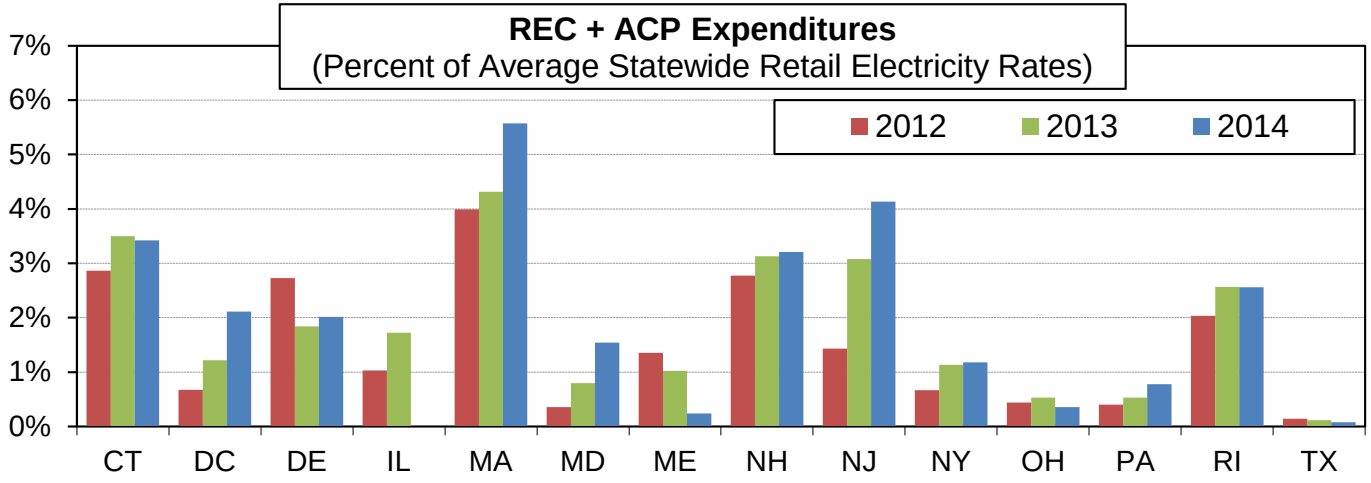
Spot prices reflect supply-demand balance, SACPs, contracting trends, and other factors:

- **DC** and **NH**: Both undersupplied, but vastly differing SACP ($500 v. $55/MWh)
- **MD** and **NJ**: Adequate supply, but possible shortages in coming years
- **MA** clearinghouse provides soft floor
- **DE**: Primarily long-term contracts
- **PA** and **OH** heavily oversupplied, in part due to eligibility of out-of-state projects

- Varying reliance on longer-term SREC products in many markets (2-5 year OTC strips, RFPs for multi-year REC contracts or PPAs)
- May be priced at a premium or discount to spot prices, depending on expectations and risk preferences of counterparties

Restructured States: RPS Compliance Costs Generally ≤3% of Average Retail Rates, But Rising

RPS compliance costs in restructured states can be approximated by REC + ACP costs and expressed as a fraction of average retail electricity rates



** Notes: Values calculated from REC and ACP prices and volumes for each compliance year, and from EIA data on avg. statewide retail electricity rates. REC prices are based on annual avg. prices reported by the PUC or utilities, if available; otherwise they are based on published spot market prices, supplemented with available data on long-term contract prices. Incremental costs for NY are based on NYSERDA's REC expenditures and procurement volumes.*

Rough approximation of "rate impact": Ignores some ratepayer costs (e.g., integration) and benefits (e.g., wholesale price suppression); also, may overstate ratepayers costs in states where ACPs are not passed-through

2014 costs ranged from 0.1% - 5.6% of avg. retail rates across states

Reflects differences in:

- RPS target levels
- Mix of resource tiers
- Underlying REC and ACP prices

Rising costs in some states due to:

- Increasing targets
- Increasing REC prices in several markets (e.g., Mid-Atlantic Tier I, MA and NJ solar)

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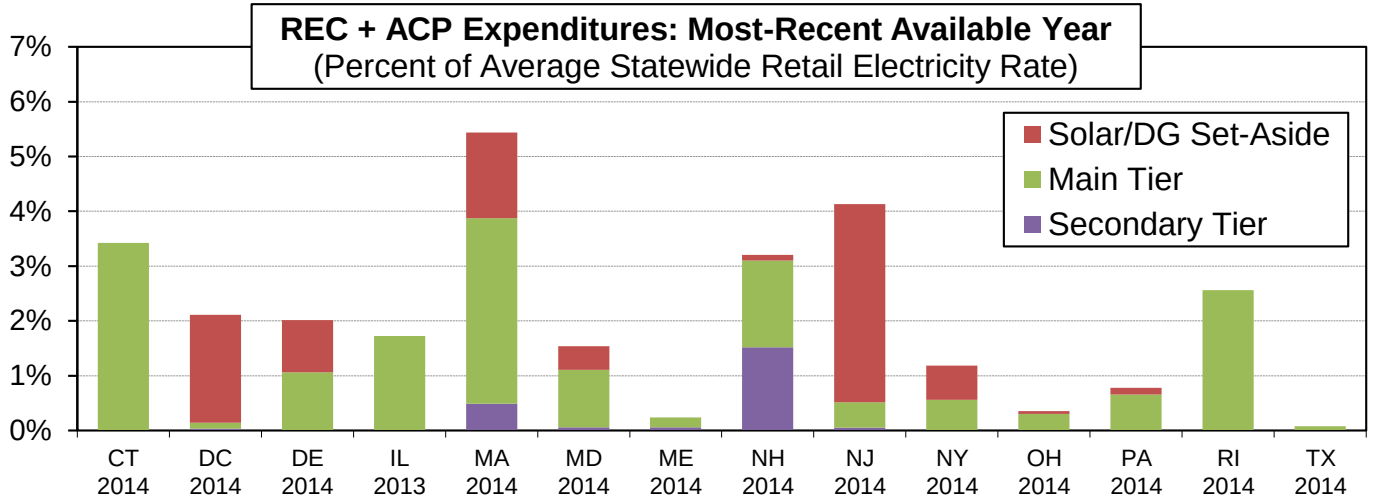
Main Tier Requirements Constitute the Bulk of Compliance Costs in Most Restructured States

Compliance Costs Disaggregated by Resource Tier



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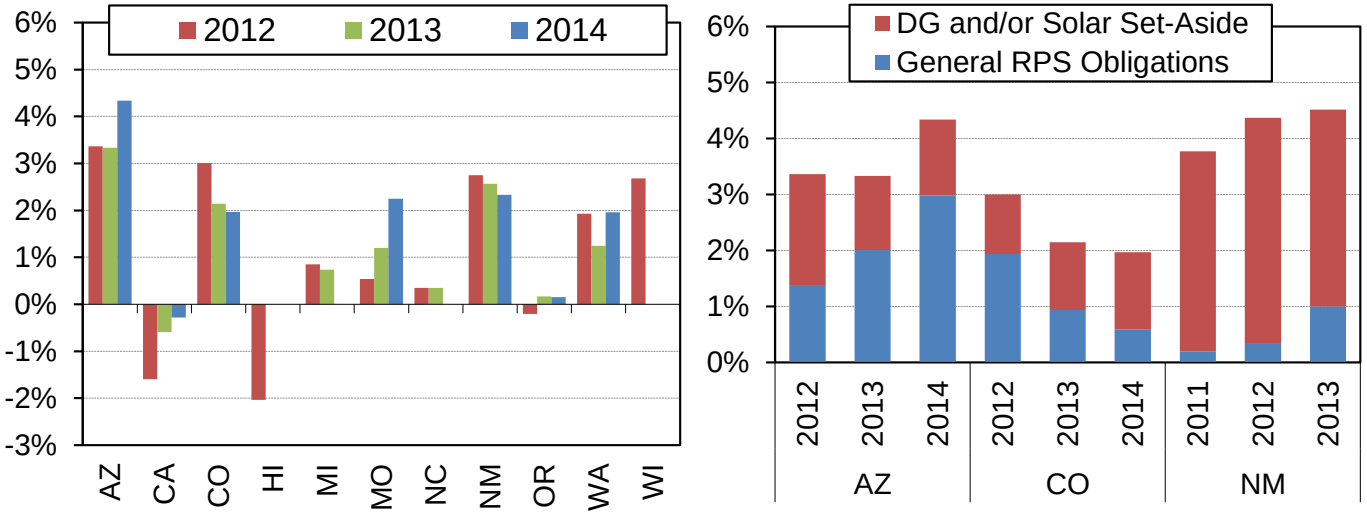
- Relatively high solar set-aside costs in states with particularly aggressive targets or high SREC prices
- Secondary tier costs in NH (pre-2006 RE) are substantial; presumably because many of those resources qualify for (and are sold into) higher-priced Class I markets in other New England states

Regulated States: Compliance Cost Estimates Vary Widely, But Are Generally ≤3% of Average Retail Rates

Utility and PUC cost estimates rely on varying methods but can nevertheless be compared

Utility or PUC Estimates of RPS Compliance Costs
(Percent of Average Statewide Retail Electricity Rate)

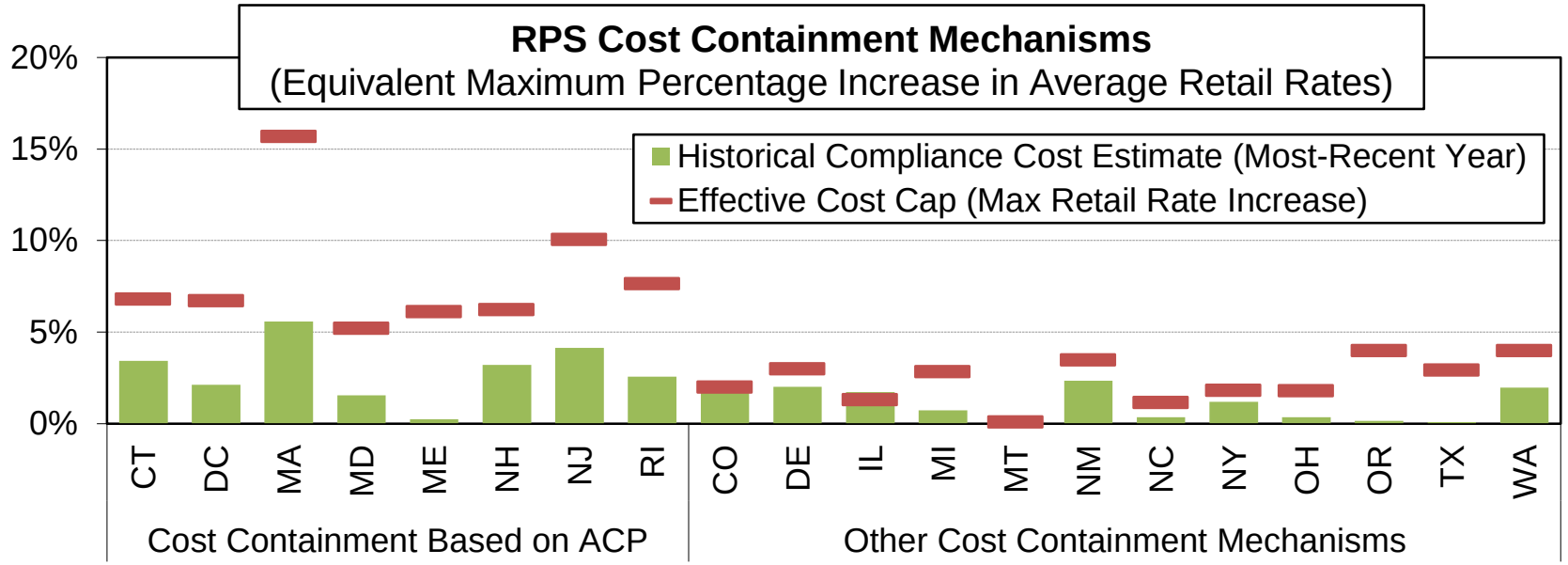


Data represent utility- or PUC-reported estimates and reflect either total RPS resources procured or only those RPS resources applied to the target each year. Data for CA are CPUC-reported estimates based on comparison to the Market Price Referent. Data for CO are for Xcel only. Data for NM include SPS and PNM in the left-hand figure, but only SPS in the right-hand figure. States omitted if data are unavailable (IA, KS, MN, MT, NV).

Utility/PUC compliance costs estimates typically based on comparisons to proxy non-RE generators or to wholesale prices, or via system modeling

- Relatively high costs in AZ, CO, and NM due partly to solar/DG set-aside costs, where costs are front-loaded
- Low costs in states with low RPS targets during analysis period and/or where targets met primarily with pre-existing renewables
- Net savings estimated in CA, HI, OR
- Lagged or sporadic reporting precludes full time series

Cost Caps Could Become Binding in Some States as Targets and Procurement Ramp Up



Notes: For states with multiple cost containment mechanisms, the cap shown here is based on the most-binding mechanism. MA does not have a single terminal year for its RPS; the calculated cost cap shown is based on RPS targets and ACP rates for 2020. "Other cost containment mechanisms" include: rate impact/revenue requirement caps (DE, IL, NM, OH, OR, WA), surcharge caps (CO, MI, NC), renewable energy contract price cap (MT), renewable energy fund cap (NY), and financial penalty (TX). Excluded from the chart are those states currently without any mechanism to cap total incremental RPS costs (AZ, CA, IA, HI, KS, MN, MO, NV, PA, WI), though many of those states have other kinds of mechanisms or regulatory processes to limit RPS costs.

- ACPs generally cap costs at 6-9% of average retail rates
- Among states with some other (non-ACP) form of cost containment, cost caps are more restrictive (1-4% rate impact), and have already become binding for several states and utilities

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Re-Cap of Key Take Aways

- RPS policies have been a significant source of U.S. RE demand
  - 65% of growth in all U.S. non-hydro renewable generation and 56% of all new RE capacity additions since 2000 being used to serve current RPS demand
- Substantial amounts of additional RE capacity still needed to meet growing RPS demand
  - 63 GW of new RE capacity needed to meet RPS demand by 2030, relative to 2015 supply
  - Much of the near-term incremental demand through 2020 may be met with the 28 GW of RE capacity already under development
- Compliance levels generally quite high
- RPS compliance costs thus far relatively modest (in the context of overall growth in utility costs)
  - 2014 compliance costs equivalent to ≤3% of average retail rates in most states
  - Future cost growth constrained by existing RPS cost containment mechanisms

The Future Role and Impact of State RPS Programs Will Depend On…

Endogenous Factors

- Legislative and legal challenges to state RPS programs
- RPS compliance costs and ACPs/cost caps
- Whether/how RPS programs are re-tuned

Exogenous Factors

- CPP compliance plans and implementation
- Federal ITC and PTC
- The many inter-related issues affecting RE deployment (integration, siting, net metering, etc.)

Thank You!

For further information:

LBNL RPS publications and resources:

rps.lbl.gov

LBNL renewable energy publications:

emp.lbl.gov/reports/re

Contact information:

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Thank you for attending our webinar

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