U.S. Renewables Portfolio Standards:

Overview of Status and Key Trends

Galen Barbose
Lawrence Berkeley National Laboratory

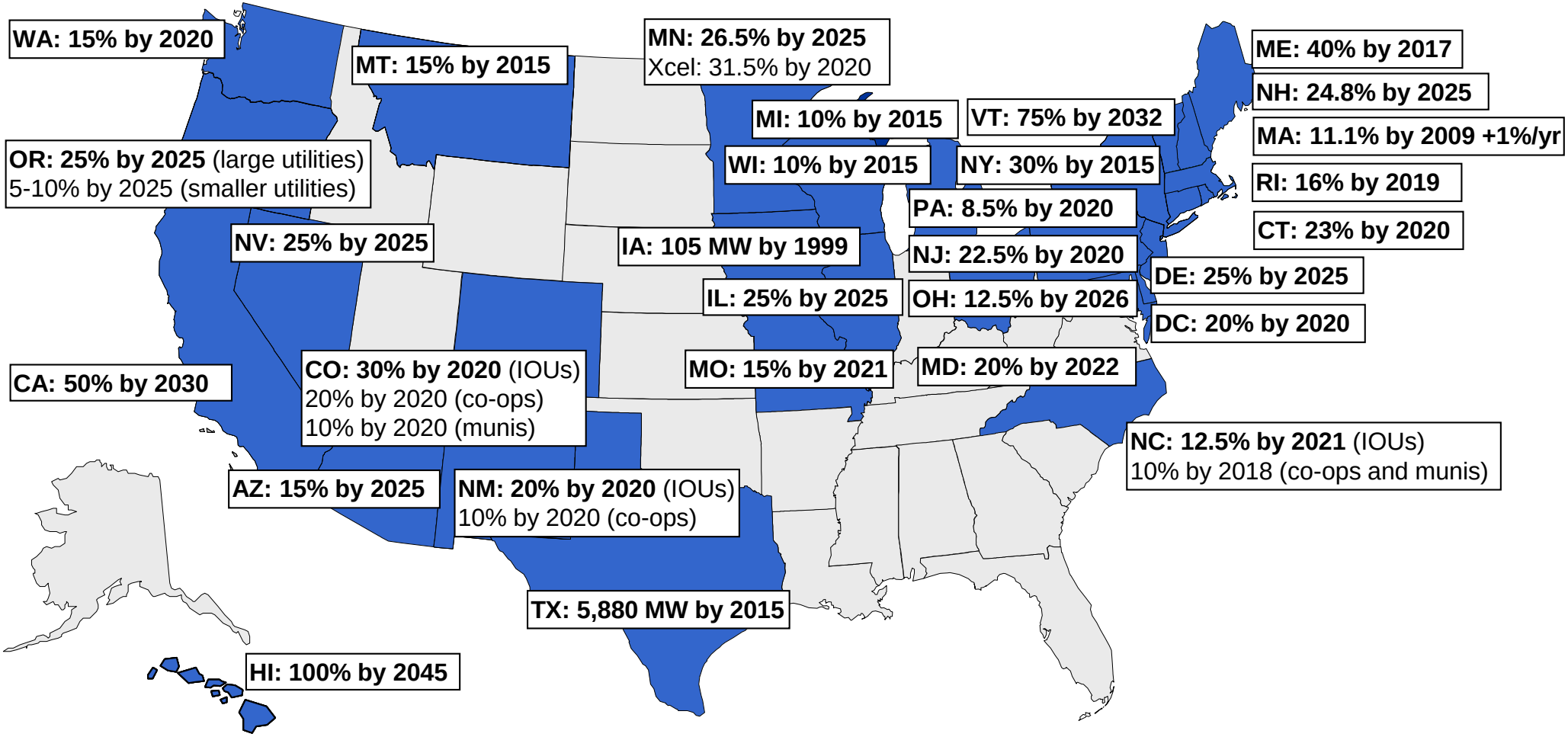
2015 National Summit on RPS
Washington, D.C.
November 5, 2015

Outline

- **RPS impacts on renewables development to-date**
- Future RPS demand and incremental needs
- RPS compliance costs
- Summary and outlook

RPS Policies Exist in 29 States and DC

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



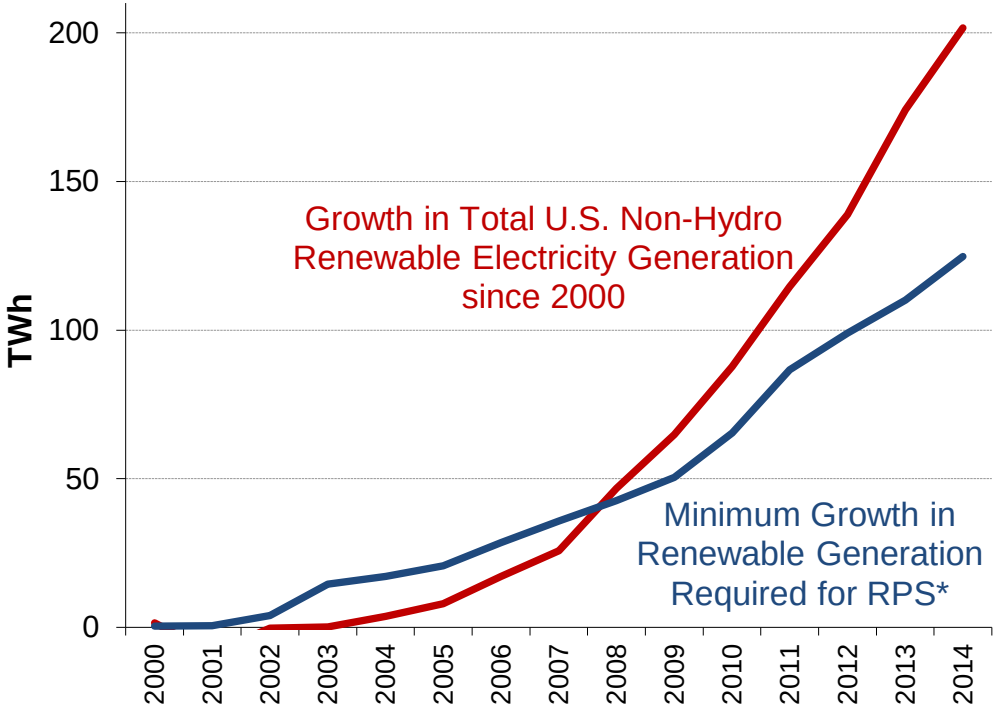
Source: Berkeley Lab

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)

RPS Demand a Key Driver for RE Growth:

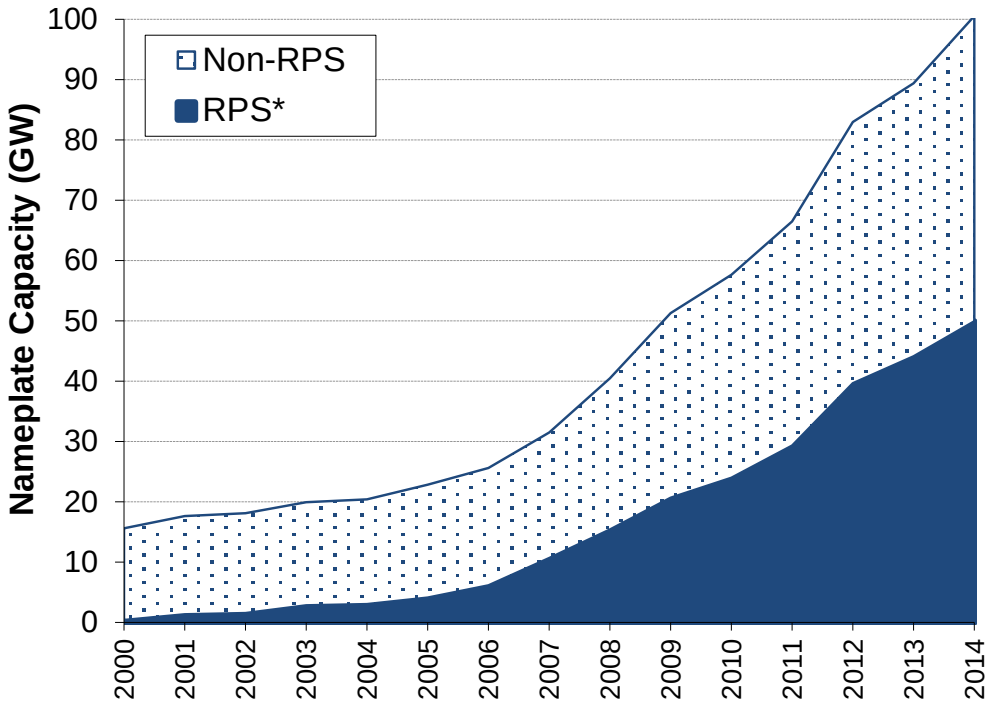
62% of Increased RE Generation, 58% of New RE Capacity

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)

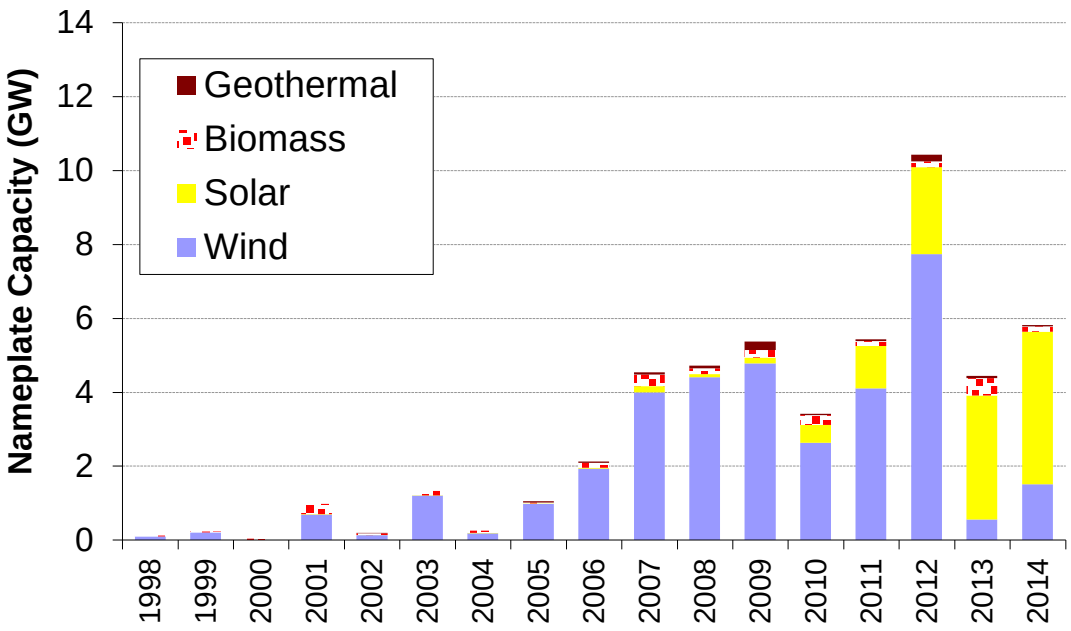


** RPS capacity: The entity purchasing RECs is subject to an RPS but has not yet met its terminal RPS obligations, and the project commenced operation after enactment of the RPS*

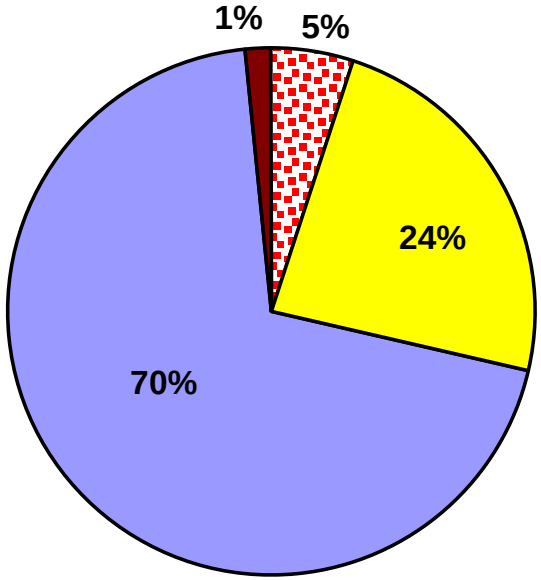
Wind Was Historically the Dominant New-Build for RPS, But Solar Has Come to the Fore

RPS Capacity Additions from 1998-2014, by Technology Type

Annual RPS Capacity Additions



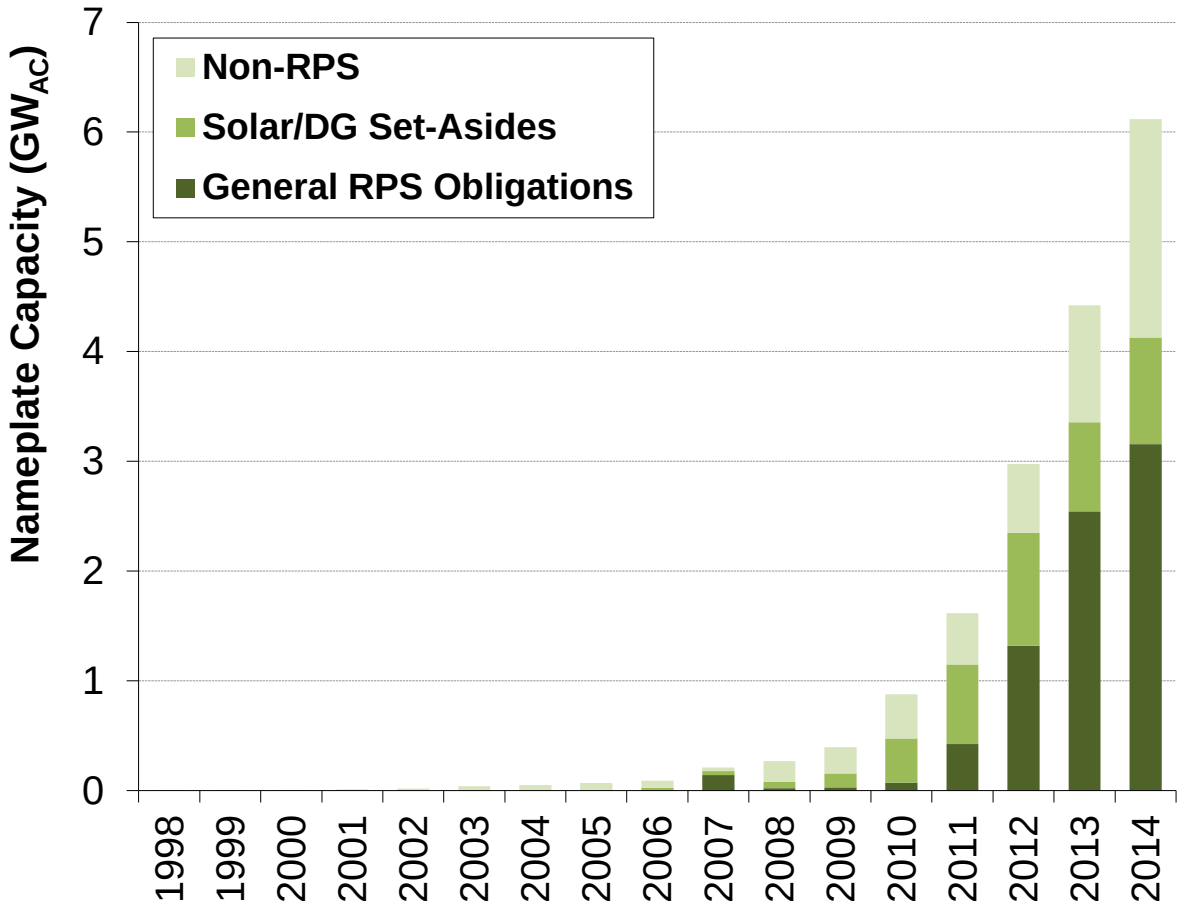
Cumulative RPS Capacity Additions



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 71%, biomass 13%, solar 12%, and geothermal 4% of cumulative RPS-related renewable energy additions, if estimated based on assumed capacity factors.

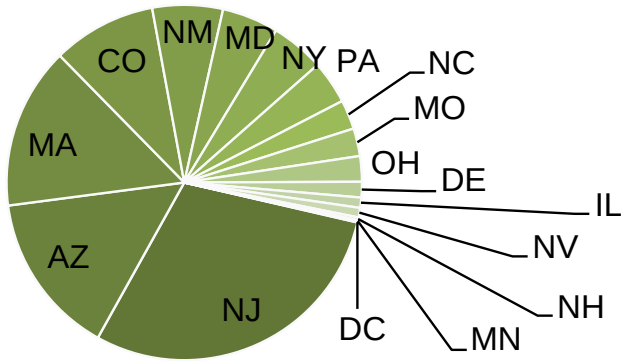
RPS Solar Additions Driven by Combination of General Obligations and Solar/DG Set-Asides

Annual U.S. Solar Capacity Additions

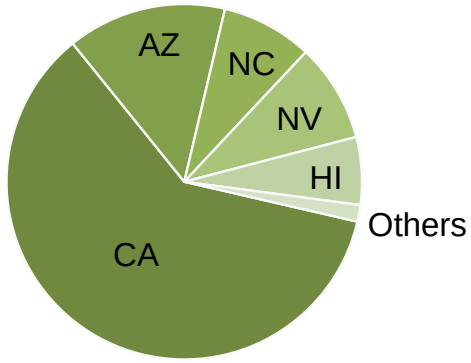


Cumulative RPS Solar Capacity Additions

Solar/DG Set-Asides (4.2 GW)



General RPS Obligations (7.7 GW)



Outline

- RPS impacts on renewables development to-date
- **Future RPS demand and incremental capacity needs**
  - General RPS Obligations
  - Solar/DG Set-Asides
- RPS compliance costs
- Summary and outlook

States Are Starting to Approach Final Targets

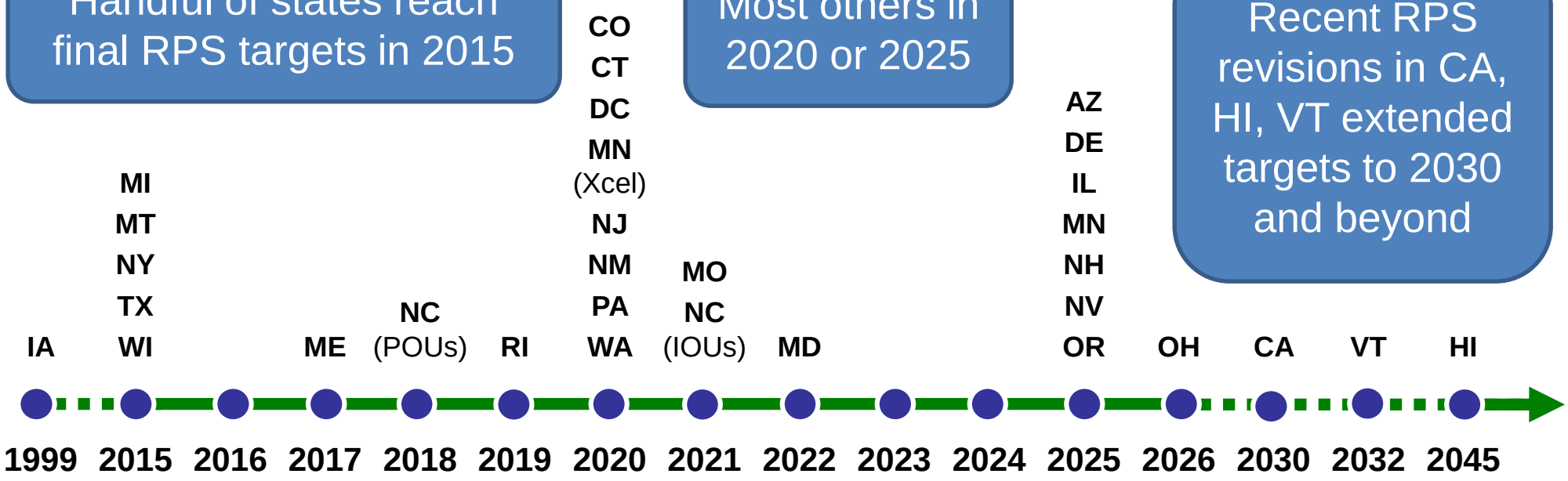
Though Most Still Have 5-10 Years

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

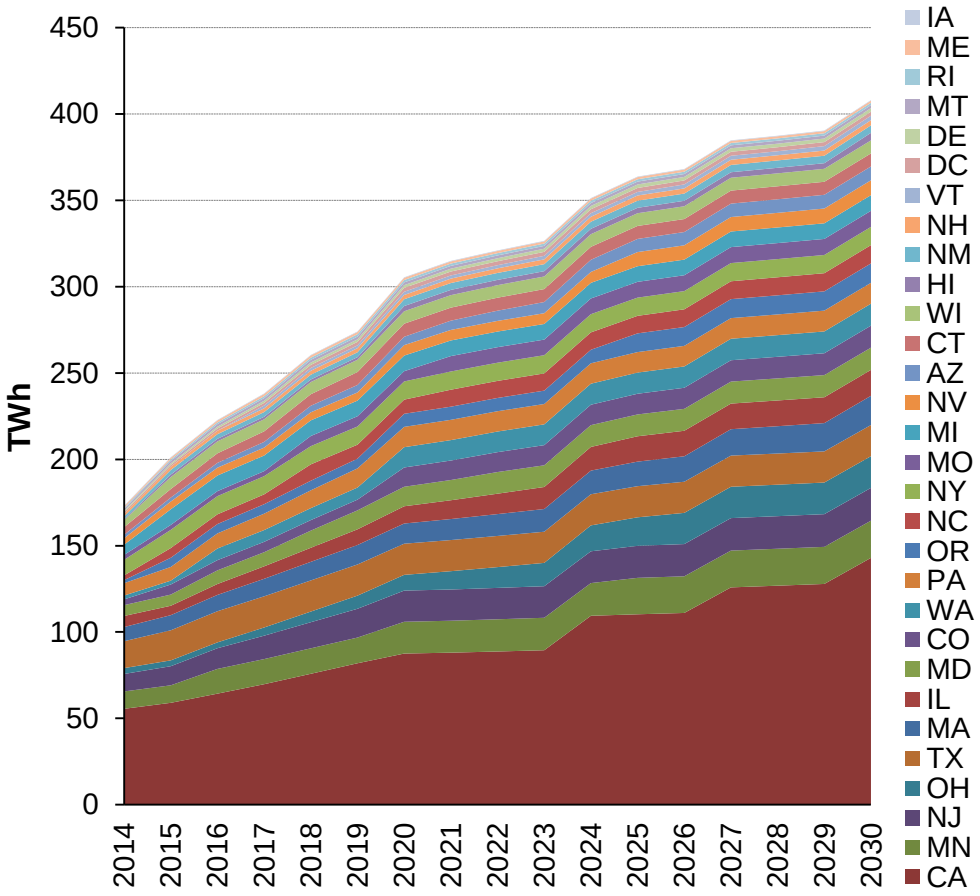


RPS demand will grow slowly after final targets, due to load growth and RE retirements

Remaining Ramp-Ups in RPS Targets Are Sizable

Total U.S. RPS Demand Will Double by 2030

Projected U.S. RPS Demand



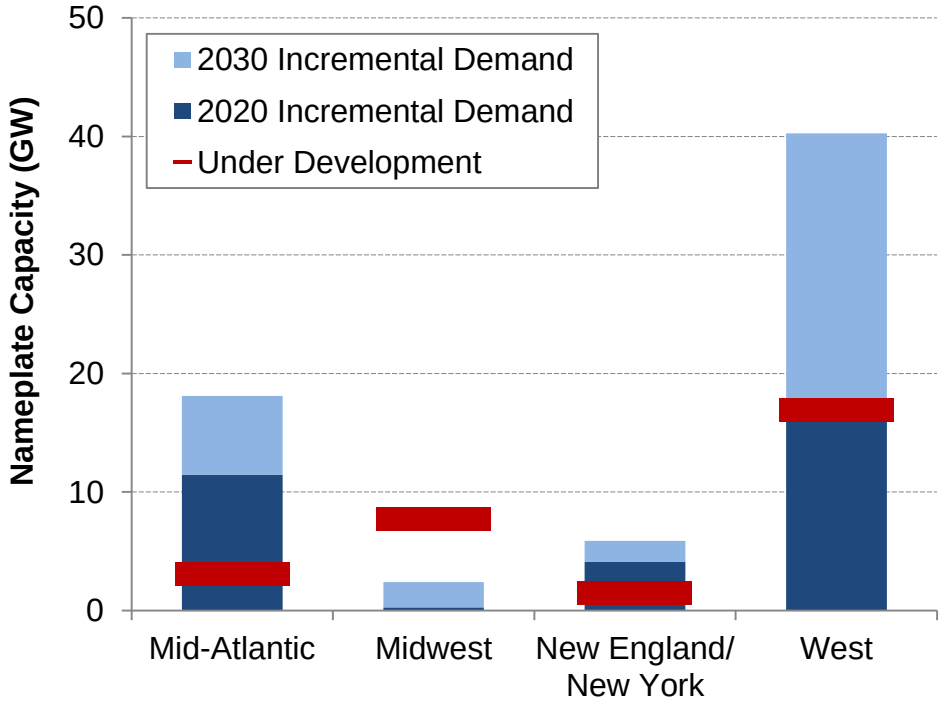
Notes: Projected RPS demand estimated based on current targets, accounting for exempt load, likely use of credit multipliers, and other state-specific provisions. Underlying retail electricity sales forecasts are based on growth rates from most-recent EIA Annual Energy Outlook reference case.

- Under current state targets, total U.S. RPS demand will increase from roughly **200 TWh in 2015** to 300 TWh in 2020 and **400 TWh in 2030**
- CA represents ~40% of that growth
- Much of the remaining growth is associated with relatively large states: OH, MN, WA, IL, MA, NJ, CO, MO, MD
- Recent downward revisions to LBNL RPS demand projections due to lower underlying retail electricity sales growth

Some utilities are well-ahead of schedule, with RE purchases in excess of current requirements

Significant Residual RPS Demand Remains, Relative to Available Supply

Incremental RPS Demand Relative to 2014 RPS Supply Delivered to Obligated LSEs

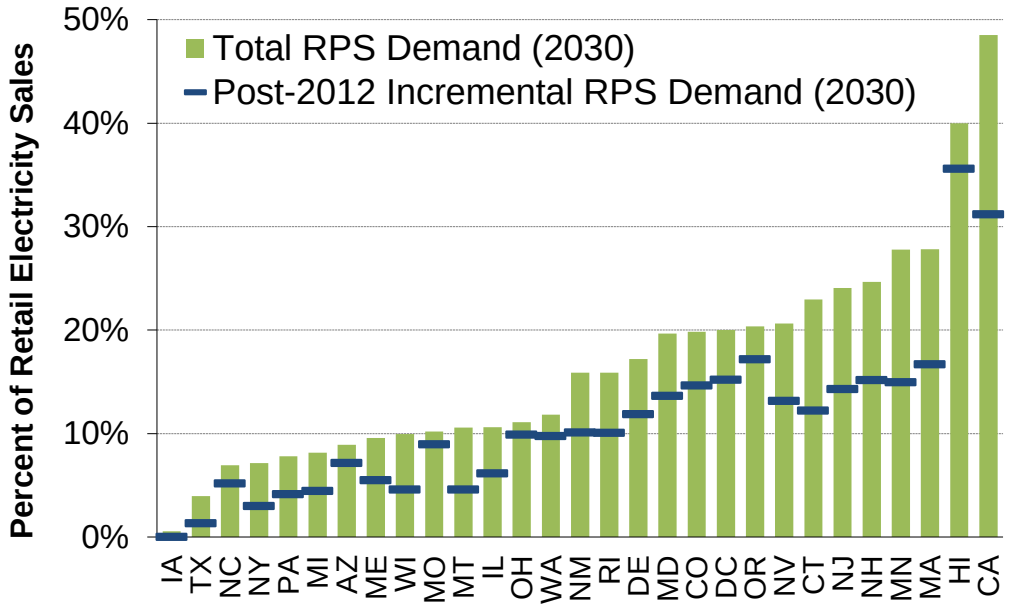


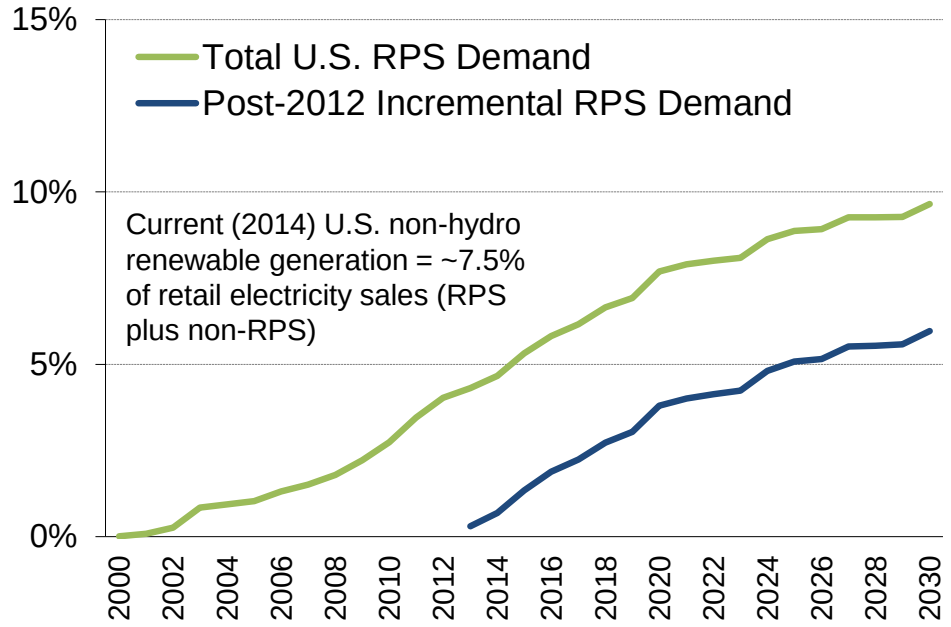
Notes: Incremental demand is measured relative to 2014 supply under contract to RPS-obligated entities only. Capacity under development includes plants permitted or under construction as of Sept. 2015 or completed in 2015 (Source: Ventyx/ABB Velocity Database).

- Meeting future RPS demand will require an add'l 32 GW of RE by 2020 and 67 GW by 2030
- To put that into context:
  - RPS-builds to-date = 50 GW
  - Total U.S. RE in 2014 = 100 GW
- Much of the incremental RPS demand through 2020 may be met with the ~30 GW of capacity already under development (esp. in West)
  - Though not all of that capacity will be built
  - And not all will be available for RPS compliance (or fungible within each region)

RPS Impacts on CPP Compliance Depend on Rate vs. Mass-Based Approach and Vary by State

RPS Demand as Percentage of Retail Electricity Sales





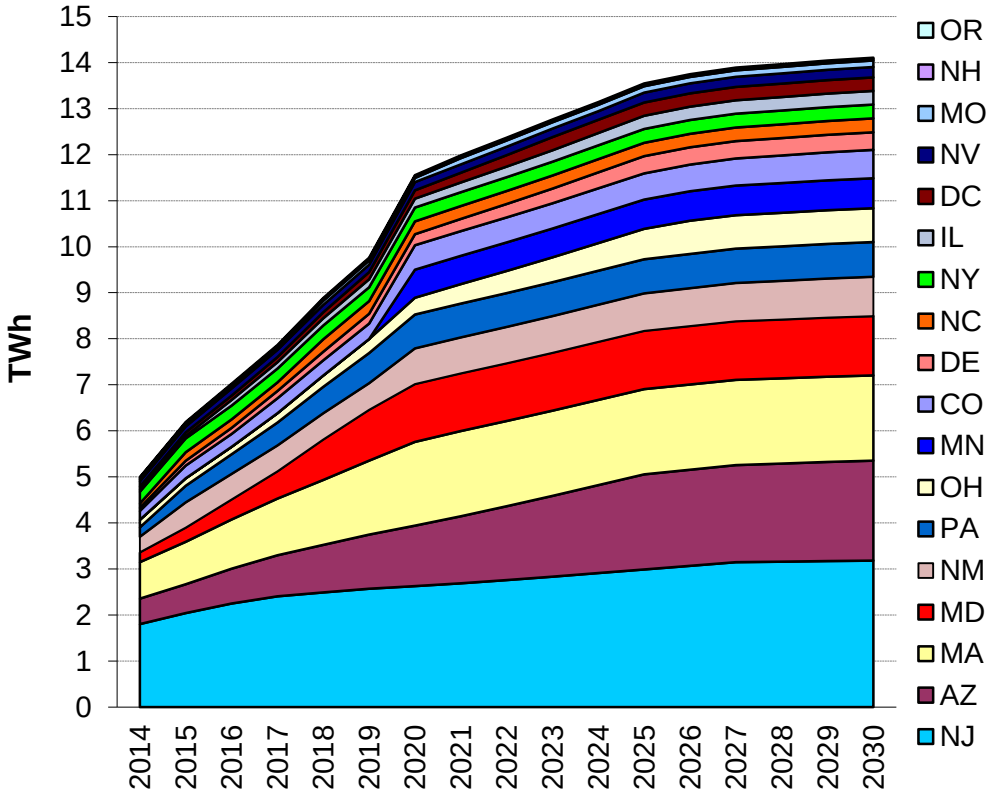
Under rate-based approach, only RE capacity built after 2012 is eligible for credit

- State-levels RPS impacts on CPP naturally depend on RPS target levels (relative to 2012, if rate-based), among potentially *many* other factors
- Nationally, CPP-eligible RPS demand represents 6-10% of U.S. electricity sales in 2030, depending on prevalence of mass- vs. rate-based approaches

BERKELEY LAB

Remaining Growth in RPS Solar/DG Set-Aside Demand is Sizeable But Mostly Front-Loaded

Projected RPS Solar/DG Set-Aside Demand



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.

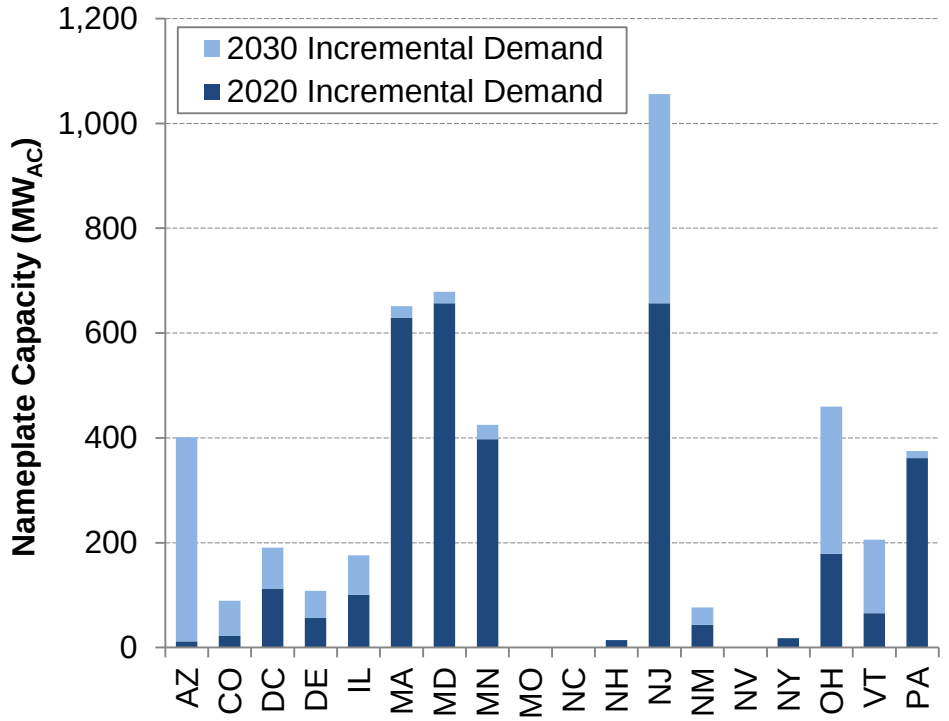
- RPS policies in 17 states and D.C. include either a solar or DG set-asides (aka, carve-outs)
- Under current targets, total solar/DG set-aside demand increases from **6 TWh in 2015** to 12 TWh in 2020 **and 14 TWh in 2030**
- Most of that growth centered in four states: AZ, NJ, MA, MD

As with general RPS obligations, some states are currently oversupplied, limiting near-term residual needs

Notwithstanding Current Surpluses, Significant Residual Solar Set-Aside Demand Remains

- Meeting future demand will require add'l 3 GW by 2020, 5 GW by 2030
  - Beyond the 5 GW of solar/DG set-aside capacity additions to-date
- Greatest residual set-aside demand thru 2020 in MA, MD, MN, NJ
- AZ incremental demand materializes post-2020
- PA & OH: out-of-state solar eligible, so potentially little new build needed

Incremental Solar/DG Set-Aside Demand Relative to Eligible In-State Supply in 2014



Notes: Incremental demand is measured relative to 2014 supply under contract to RPS-obligated entities only. Capacity under development includes plants permitted or under construction as of Sept. 2015 or completed in 2015 (Source: Ventyx/ABB Velocity Database).

Outline

- RPS impacts on renewables development to-date
- Future RPS demand and incremental needs
- **RPS compliance costs**
- Summary and outlook

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

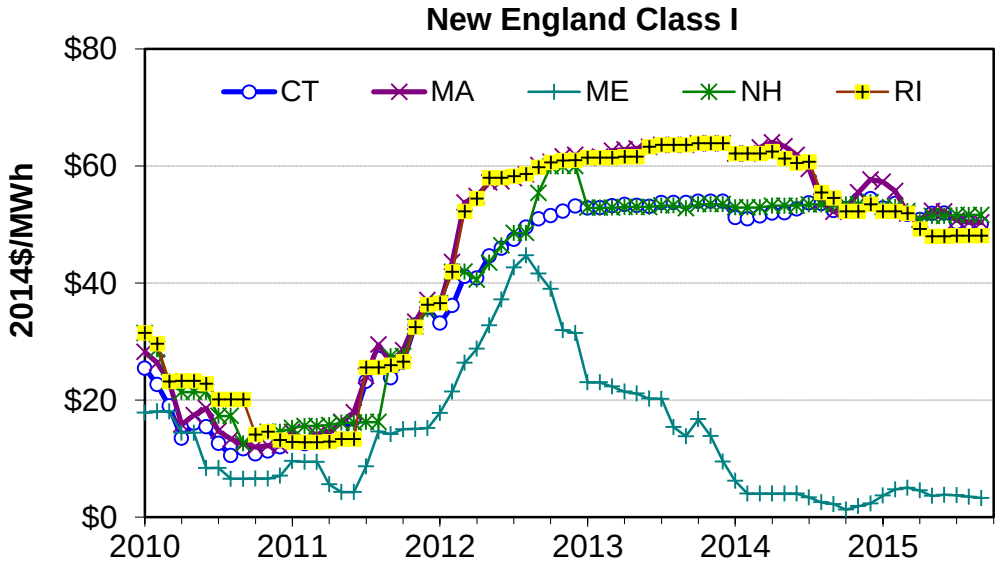
- Compliance typically occurs through retirement of unbundled RECs, historically dominated by short-term purchases
- We estimate RPS compliance costs based on REC plus ACP expenditures
- Limitations: Growing use of long-term/bundled PPAs; ignores "socialized" transmission and integration costs not paid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

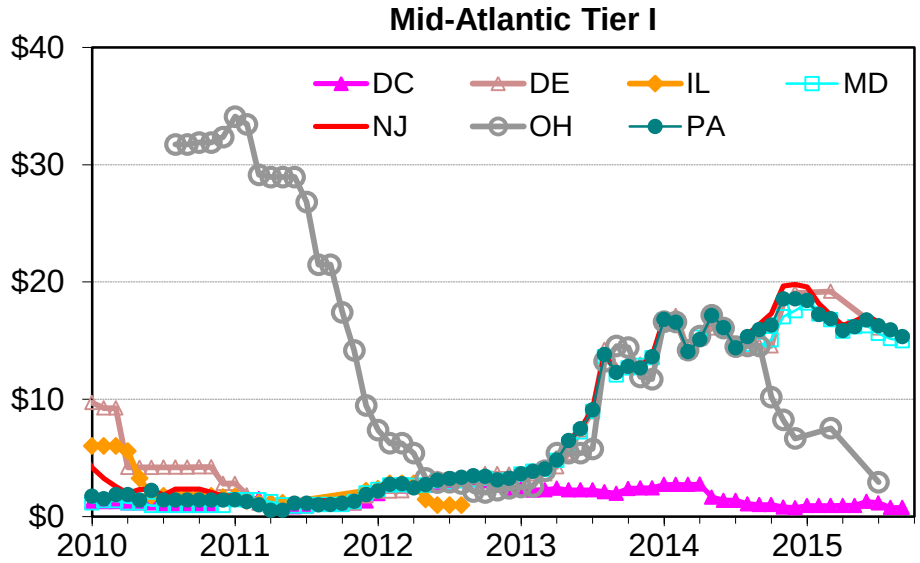
Regulated Markets

- 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 State-Specific RPS Rules

Spot Market Pricing: Class I/Tier I RECs





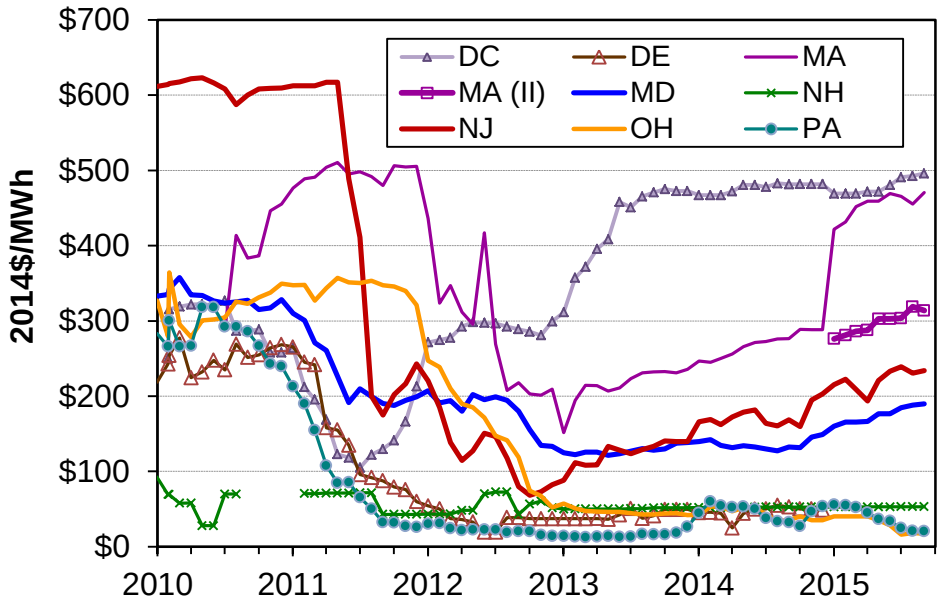
Source: Marex Spectron. Plotted values are the average monthly closing price for the current or nearest future compliance year traded in each month.

- **New England:** Tight supplies, with pricing just below CT/NH ACP levels; lower prices in ME reflect biomass resources that are ineligible for other states
- **Mid-Atlantic:** Pricing well below ACPs, but above historical lows, reflecting anticipation of potential 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.

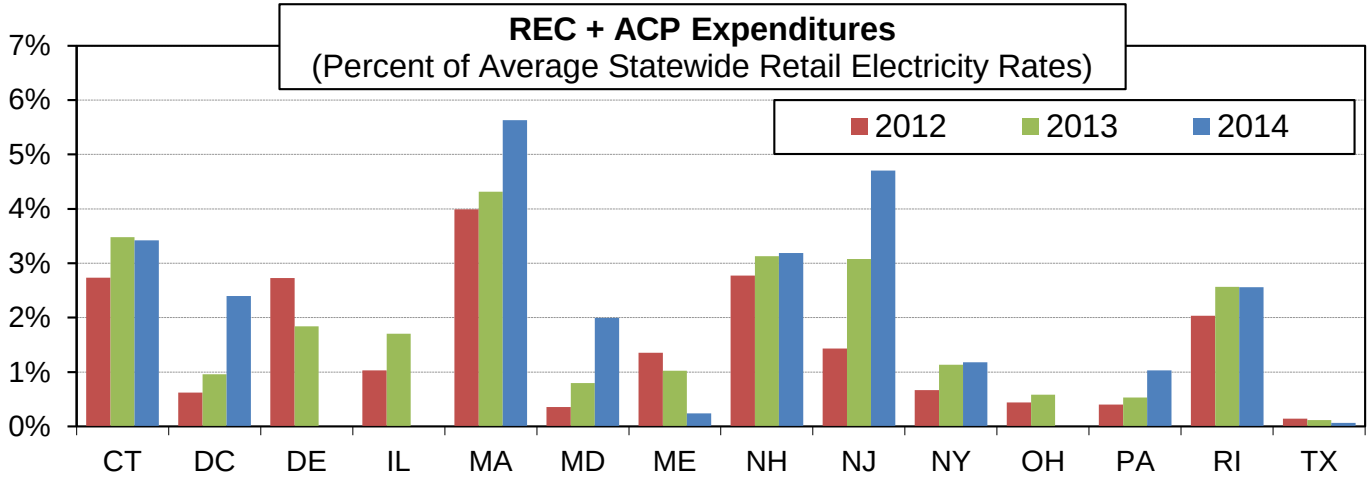
Spot prices reflect supply-demand balance, SACPs, contracting trends, and other factors:

- **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

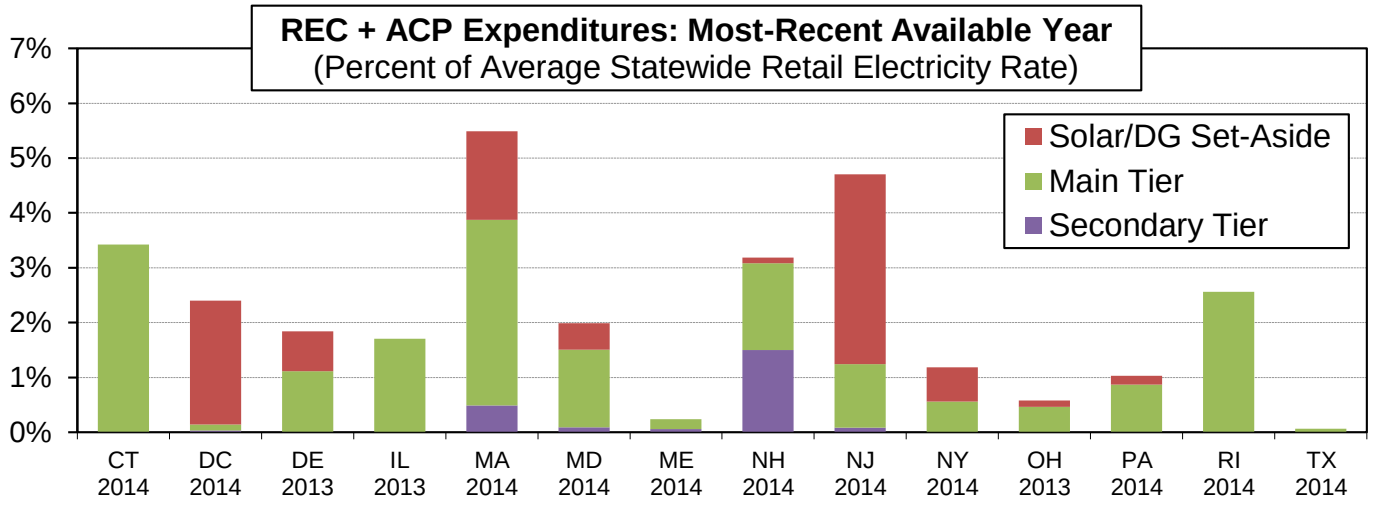
Rising costs in some states due to:

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

BERKELEY LAB

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

Compliance Costs Disaggregated by Resource Tier

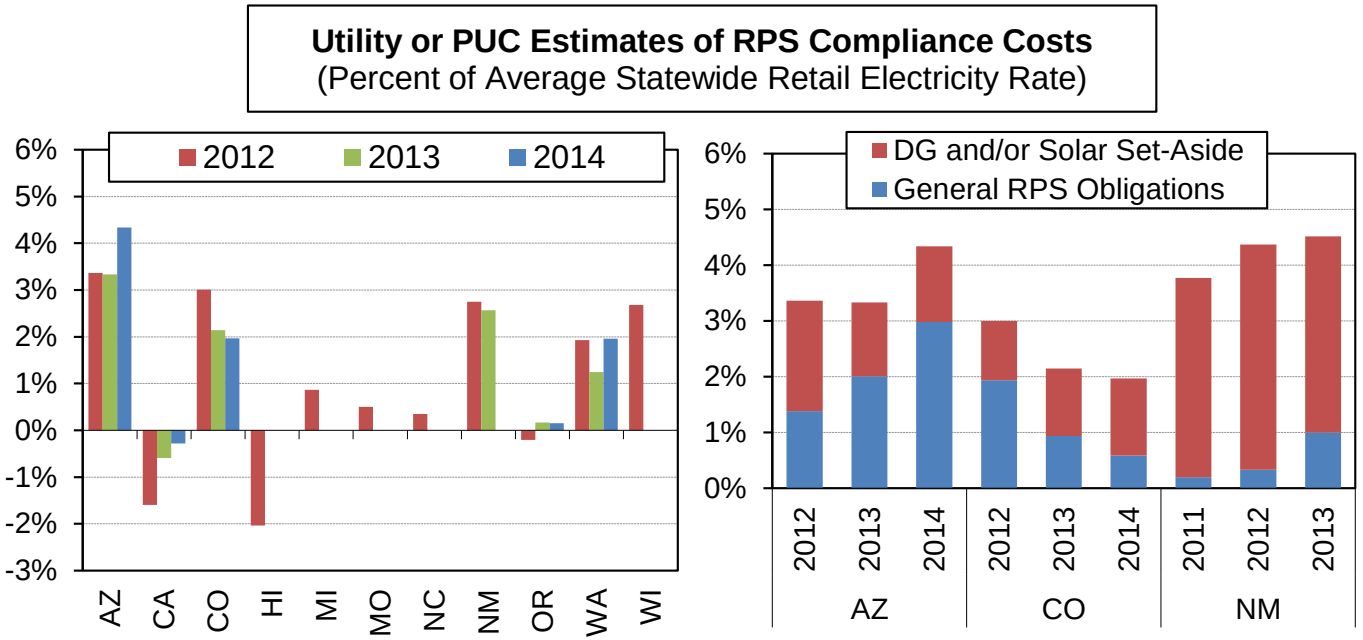


** Notes: Values calculated from REC and ACP prices and volumes for each compliance year, and from EIA data on avg. statewide retail electricity rates. REC prices are based on annual avg. prices reported by the PUC or utilities, if available; otherwise they are based on published spot market prices,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

- 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

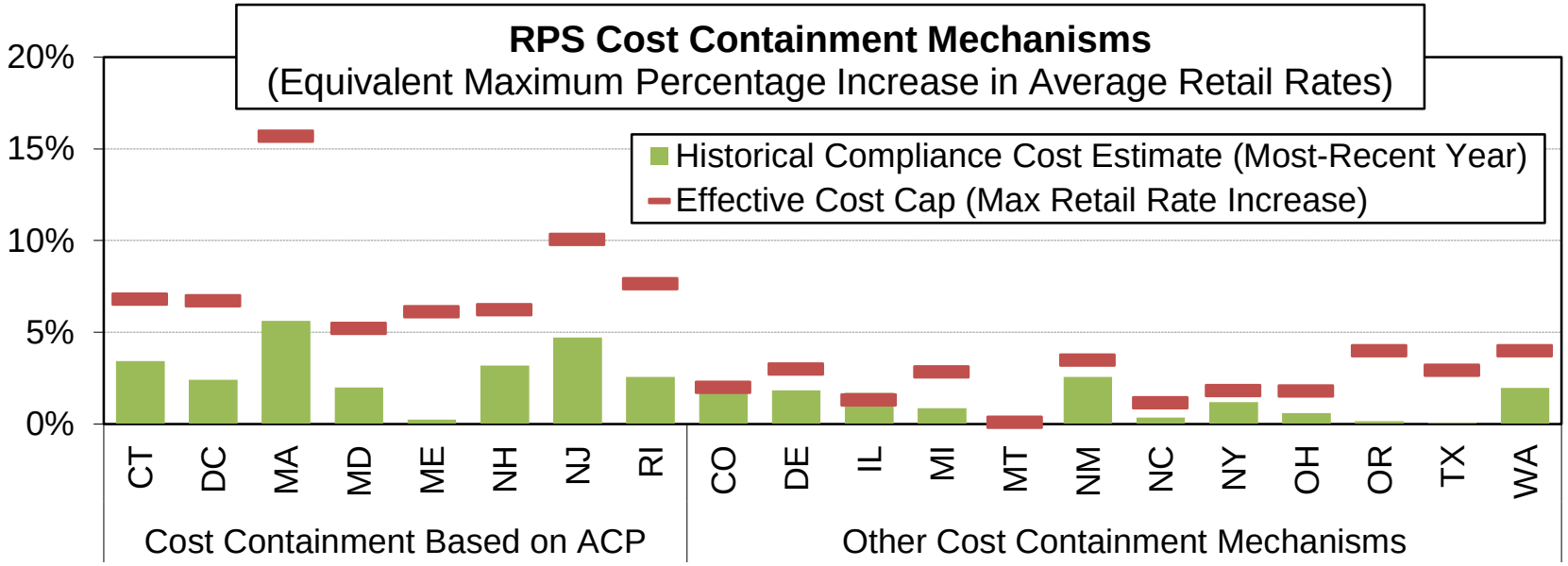


Data represent utility- or PUC-reported estimates and reflect either total RPS resources procured or only those RPS resources applied to the target each year. Data for CA are CPUC-reported estimates based on comparison to the Market Price Referent. Data for CO are for Xcel only. Data for NM include SPS 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

Outline

- RPS impacts on renewables development to-date
- Future RPS demand and incremental needs
- RPS compliance costs
- **Summary and outlook**

Re-Cap of Key Take Aways

- RPS policies have been a significant source of U.S. RE demand
  - 62% of growth in all U.S. non-hydro renewable generation and 58% 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
  - 67 GW of new RE capacity needed to meet RPS demand by 2030, relative to 2014 supply
  - Much of the near-term incremental demand through 2020 may be met with the ~30 GW of RE capacity already under development
- 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
  - Cost growth possible going forward, given rising targets, but will be 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:

Galen Barbose, *glbarbose@lbl.gov*, 510-495-2593