BERKELEY LAB
Lawrence Berkeley National Laboratory

Energy Technologies Area   Lawrence Berkeley National Laboratory

U.S. Renewables Portfolio Standards

2016 Annual Status Report

Galen Barbose

Lawrence Berkeley National Laboratory

April 2016

For more information: rps.lbl.gov

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. LBNL-1005057

Highlights

- RPS policies collectively apply to 55% of total U.S. retail electricity sales
- Significant recent policy revisions include new or increased RPS targets in CA, HI, OR, VT, and NY (in development) while KS replaced its RPS with a voluntary goal
- More than half of all growth in renewable electricity (RE) generation (60%) and capacity (57%) since 2000 is associated with state RPS requirements
- Wind energy has been the primary form (64%) of all RPS-driven RE capacity growth to-date, but solar was the largest source (69%) of RPS builds in 2015
- Total RPS demand will double from 215 TWh in 2015 to 431 TWh in 2030; U.S. non-hydro RE generation would need to reach 12.1% of retail sales to keep pace
- RPS demand could require an additional 60 GW of RE capacity by 2030, roughly a 50% increase from current non-hydro RE capacity (114 GW through 2015)
- Achievement of RPS requirements has thus far been high, with states collectively meeting roughly 95% of their interim RPS targets in recent years
- RPS compliance costs totaled $2.6 billion in 2014, averaging $12/MWh-RE and equating to 1.3% of average retail electricity bills; though costs rose from 2013, future growth will be capped by RPS cost containment mechanisms in most states

Table of Contents

What is a Renewables Portfolio Standard?

Renewables Portfolio Standard (RPS)

- **A requirement on retail electric suppliers…**
- **To supply a minimum percentage or amount of their retail load…**
- **With eligible sources of renewable energy**

Typically	Backed with penalties of some form
Often	Accompanied by a tradable renewable energy certificate (REC) program to facilitate compliance
Never	Designed the same in any two states

This report covers U.S. state RPS policies. It does <u>not</u> cover:

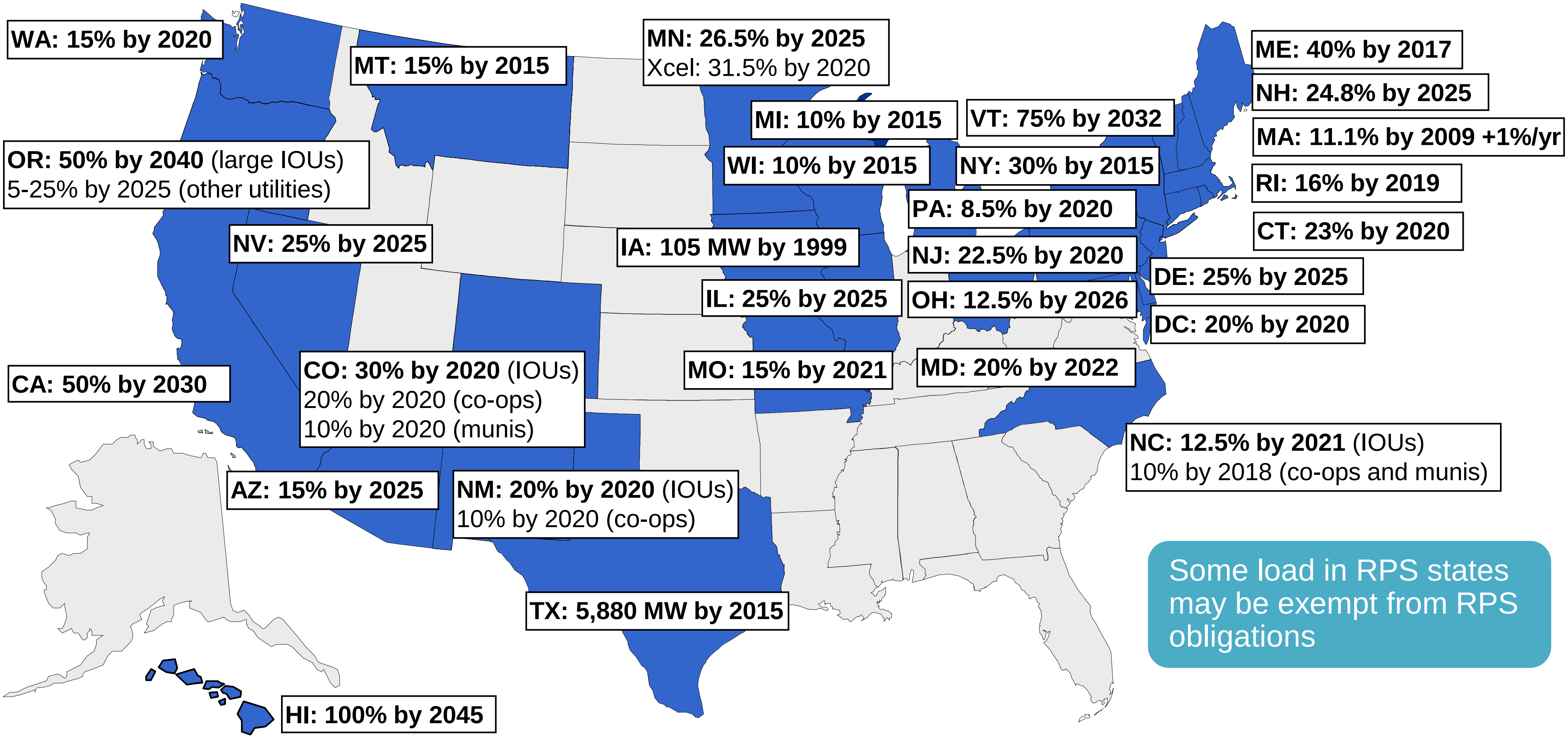
– Voluntary renewable electricity goals

– Broader clean energy requirements without a renewables-specific component

– RPS policies outside of the United States or in U.S. territories

RPS Policies Exist in 29 States and DC

Apply to 55% of Total U.S. Retail Electricity Sales



Some load in RPS states may be exempt from RPS obligations

Source: Berkeley Lab

Notes: Estimated retail sales subject to RPS obligations accounts for any applicable exemptions. 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).

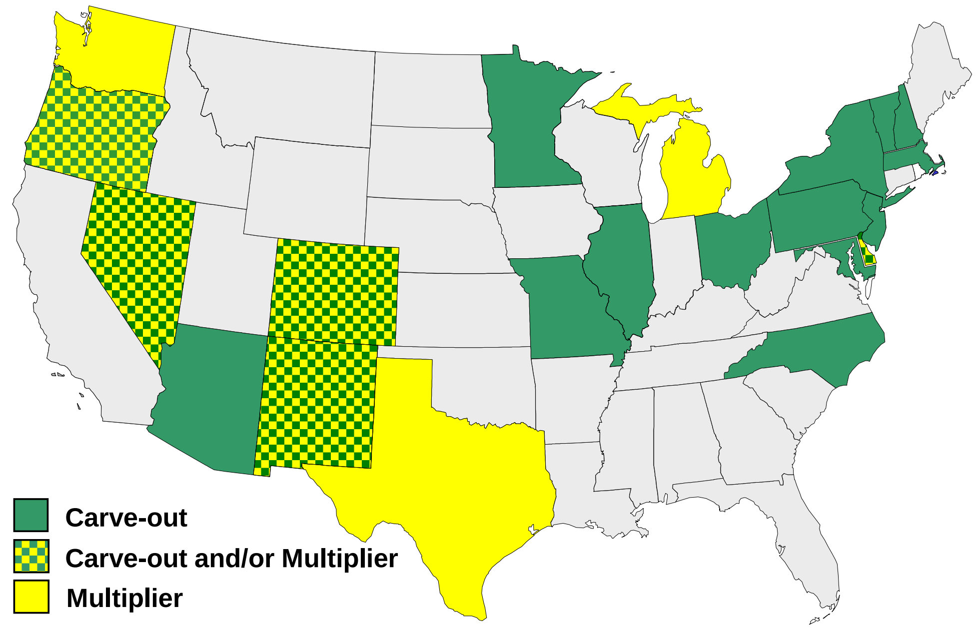
BERKELEY LAB

RPS Policies and Rules Are Not Uniform

Major Variations Across States

- Targets and timeframes
- Entities obligated and exemptions
- Eligibility rules related to technology, vintage, location, and deliverability
- Use of resource tiers, carve-outs, or multipliers (e.g., see map)
- REC definitions, limitations, and tracking systems
- Contracting requirements or programs
- RPS procurement planning/oversight
- Compliance enforcement methods, reporting, and flexibility rules
- Existence and design of cost caps, alternative compliance payment rates

Solar or Distributed Generation (DG) Carve-Outs and Credit Multipliers



Source: Berkeley Lab

18 states + D.C. have solar or DG carve-outs, sometimes combined with credit multipliers; 3 other states only have credit multipliers

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

Year	Enactment	Major Revisions
1983	IA	
1991		*IA*
1994	MN	
1996	AZ	
1997	MA, ME, NV	
1998	CT, PA, WI	
1999	NJ, TX	*MN, WI*
2000	NM	*AZ*
2001		*MN, NV*
2002	CA	*NM*
2003		*CT, MN, NV*
2004	CO, HI, MD, NY, RI	*NJ, NM, PA*
2005	DC, DE, MT	*CT, CO, NV, TX*
2006	WA	*AZ, CA, CT, HI, NJ, WI*
2007	IL, NH, NC, OR	*CA, CO, CT, DE, MD, ME, MN, NJ, NM, PA, TX*
2008	MI, MO, OH	*DC, DE, HI, MA, MD, NJ*
2009	KS	*HI, IL, ME, MN, NV, OR, RI*
2010		*CO, DE, IL, MA, MD, NJ, NY*
2011		*CA, CT, DC, DE, IL, MA, MD, NC, WI*
2012		*MA, MD, NJ, NH, NM, NY, OH*
2013		*CO, CT, MD, MN, MT, NM, NV*
2014		*IL, MA, OH, OR, WI*
2015	VT	*CA, CT, HI, KS, VT*
2016		*OR*

Source: Berkeley Lab
Current as of March 2016

General Trends in RPS Revisions

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

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

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, many bills have been proposed to repeal, reduce, or freeze RPS programs, though only two (OH, KS) have thus far been enacted

Recent Legislative Activity on RPS Policies

RPS-Related Bills Introduced (Enacted) in 2015 and 2016-to-date

	Strengthen	Weaken	Neutral	Total
2015	44 (5)	51 (2)	44 (7)	139 (14)
2016 (Jan-Feb)	22 (1)	4 (0)	19 (0)	45 (1)

Data Source: EQ Research

Notes: Companion bills introduced in both chambers are counted as a single bill. Numbers in parentheses refer to bills enacted.

Significant recent legislative actions include:

– **CA:** Increased RPS to 50% by 2030

– **CT:** Created residential solar program funded through RPS (300 MW by 2022)

– **HI:** Increased RPS to 100% by 2045

– **KS:** Repealed RPS and replaced with voluntary RE goal

– **OR:** Increased RPS to 50% by 2040 for large IOUs

– **VT:** Created a new RPS (75% by 2032) with a DG carve-out (10% by 2032)

***NY:** Though not a result of legislative action, the PSC is in the process of developing a 50% by 2030 clean energy standard, in response to the governor's directive*

Table of Contents

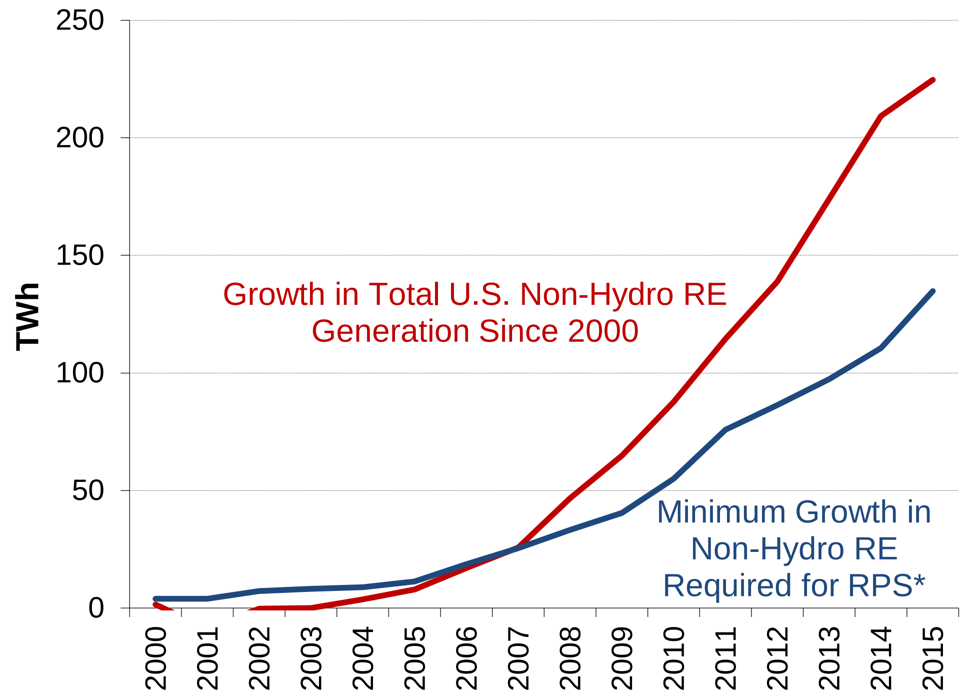
RPS Policies a Driver for RE Generation Growth

60% of all growth in RE generation since 2000 required by RPS

RE growth has been driven by multiple factors, but several benchmarks can help to gauge the impact of RPS programs

- RPS programs required 135 TWh growth in renewable electricity (RE) generation since 2000
- Represents 60% of growth in total U.S. non-hydro RE generation (though some of that growth may have occurred in the absence of RPS)
- Additional RE growth associated with voluntary green power markets, accelerated RPS procurement, and economic purchases

Growth in U.S. Non-Hydro Renewable Generation (TWh)

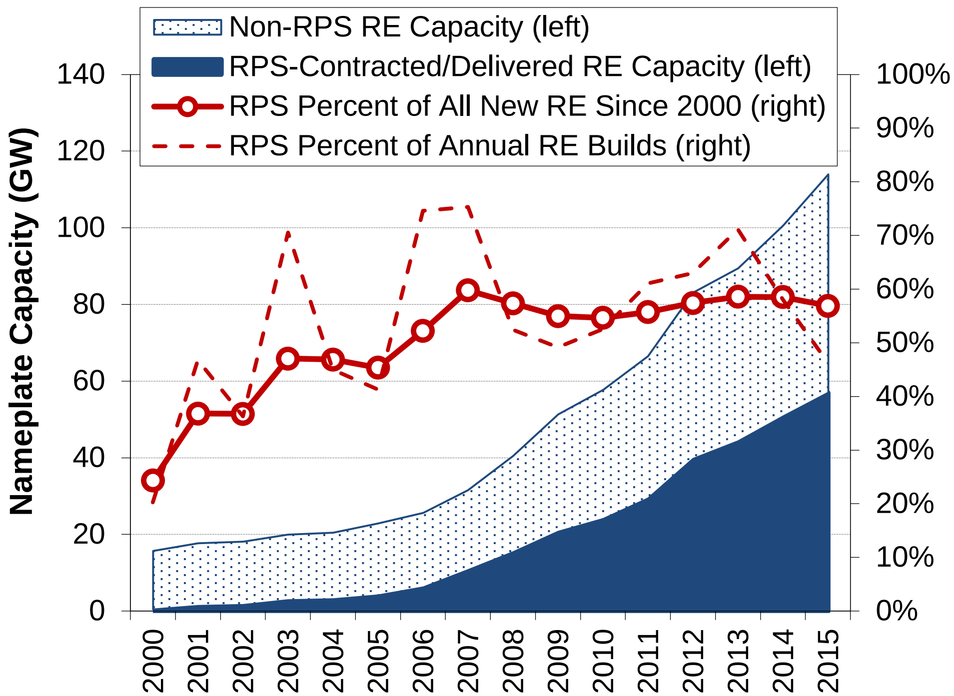


Notes: Minimum Growth in Non-Hydro RE Required for RPS excludes contributions to RPS compliance from pre-2000 vintage facilities, and from hydro, municipal solid waste, and non-RE technologies. This comparison focuses on non-hydro RE, because RPS rules typically allow only limited forms hydro for compliance.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

RPS Policies Also Driving Growth in RE Capacity

57% of all new RE capacity delivered to RPS-obligated load

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



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

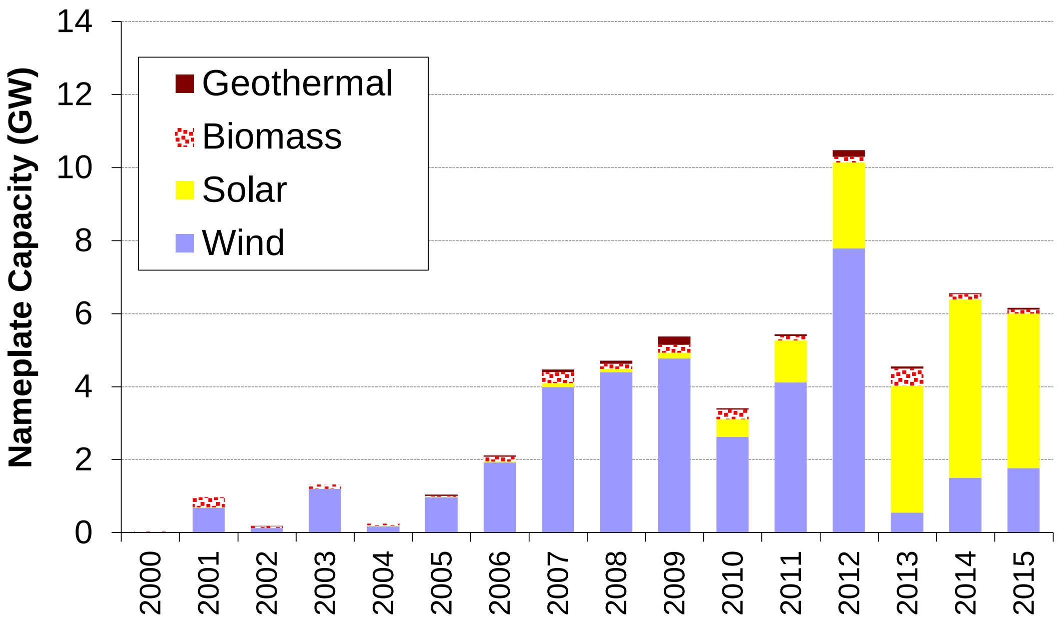
- Total U.S. non-hydro RE capacity additions equal 100 GW since 2000
- Of that, 57 GW is contracted to load-serving entities (LSEs) with active RPS obligations or is otherwise sold into RPS markets
- Non-RPS RE capacity growth is mostly wind in Texas and the Midwest (in excess of RPS requirements, much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

BERKELEY LAB

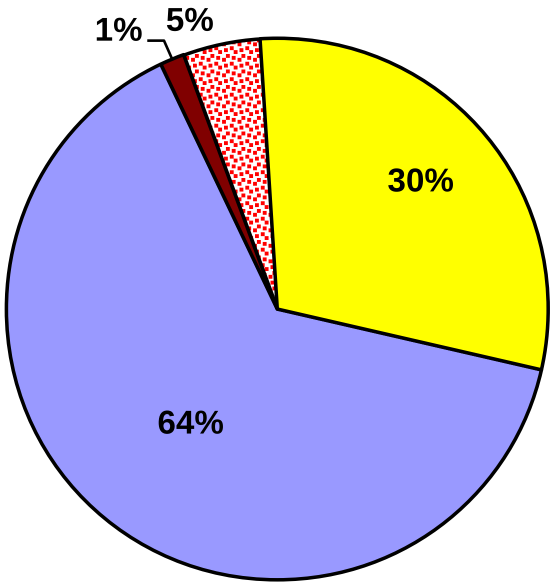
Wind Was Historically the Dominant New-Build for RPS, But Solar Has Come to the Fore

RPS Capacity Additions by Technology Type

Annual RPS Capacity Additions



Cumulative RPS Capacity Additions

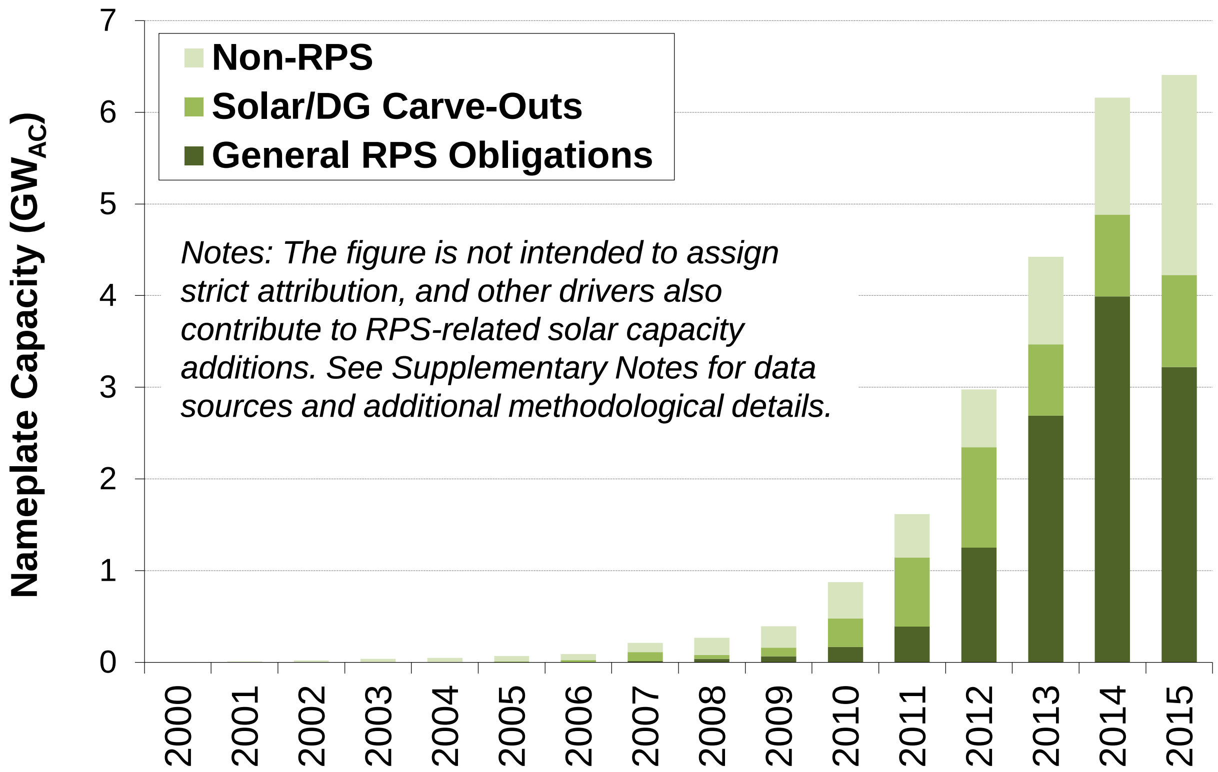


Notes: On an energy (as opposed to capacity) basis, wind represents approximately 68%, solar 16%, biomass 12%, and geothermal 4% of RPS-related renewable energy growth. See Supplementary Notes for data sources and methodological details.

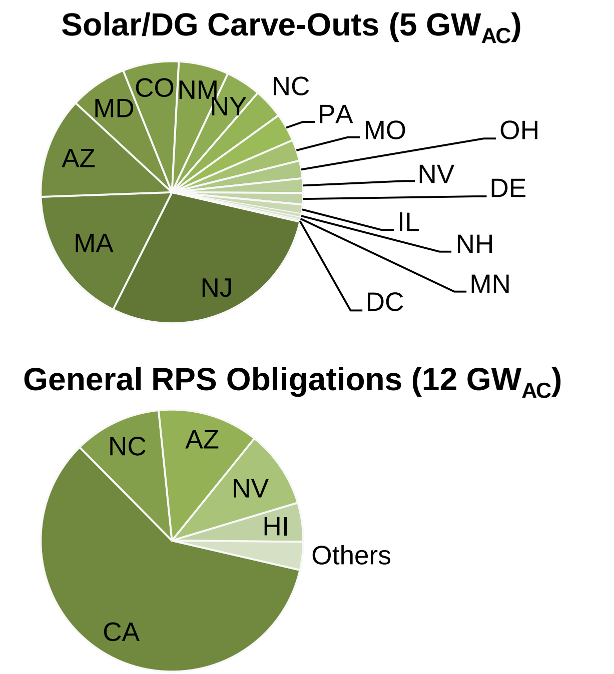
Trends partly reflect that recent wind additions have been built primarily outside of RPS requirements, while solar is relatively more-concentrated in RPS states

RPS Solar Additions Associated with Solar/DG Carve-Outs and General RPS Obligations

Annual U.S. Solar Capacity Additions



Cumulative RPS Solar Capacity Additions



Notes: A portion of the solar capacity shown for AZ and NV serves RPS obligations in CA

Growing share of non-RPS solar: primarily CA (net-metered PV); NY and AZ (utilities exempt from state RPS); and TX, GA, FL (mostly utility-scale)

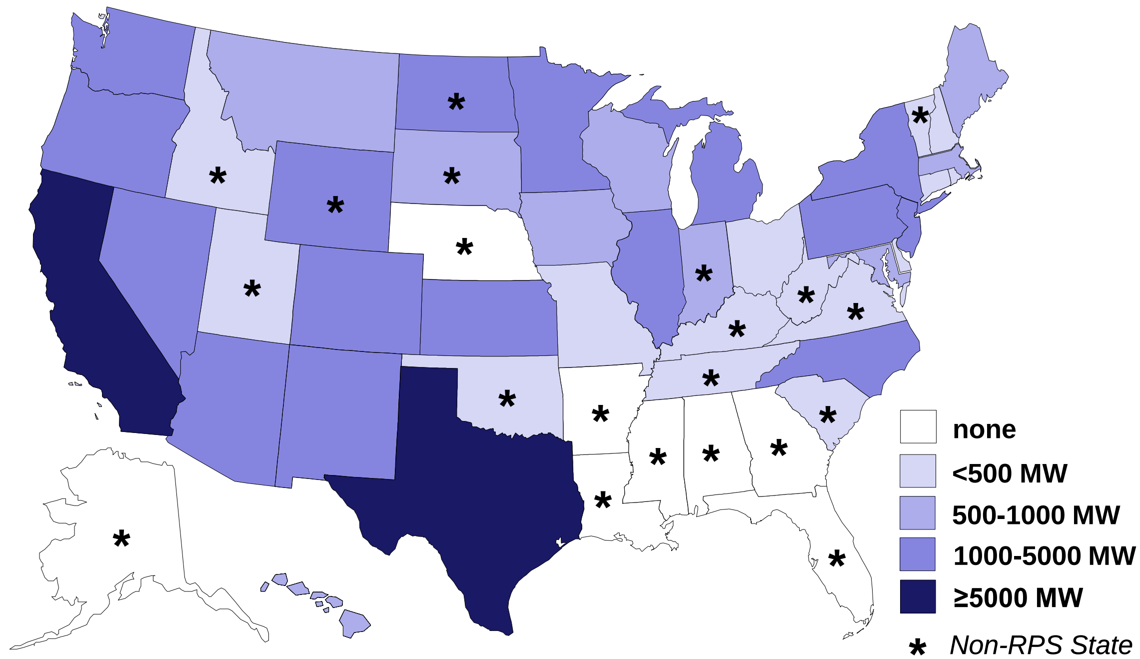
BERKELEY LAB

RPS Capacity Additions Span 43 States

More than 10% of RPS additions built in non-RPS states

- Largest state-level RPS capacity additions in CA and TX, reflecting large populations and correspondingly large RPS demand
- RPS capacity additions distributed across a large number of states
- Includes 13 non-RPS states with RE capacity serving RPS demand in the region (most notably: ND, WY, SD, IN)
- Illustrative of the role of cross-state RE transactions for RPS compliance

Location of RPS Capacity Additions
(2000-2015)



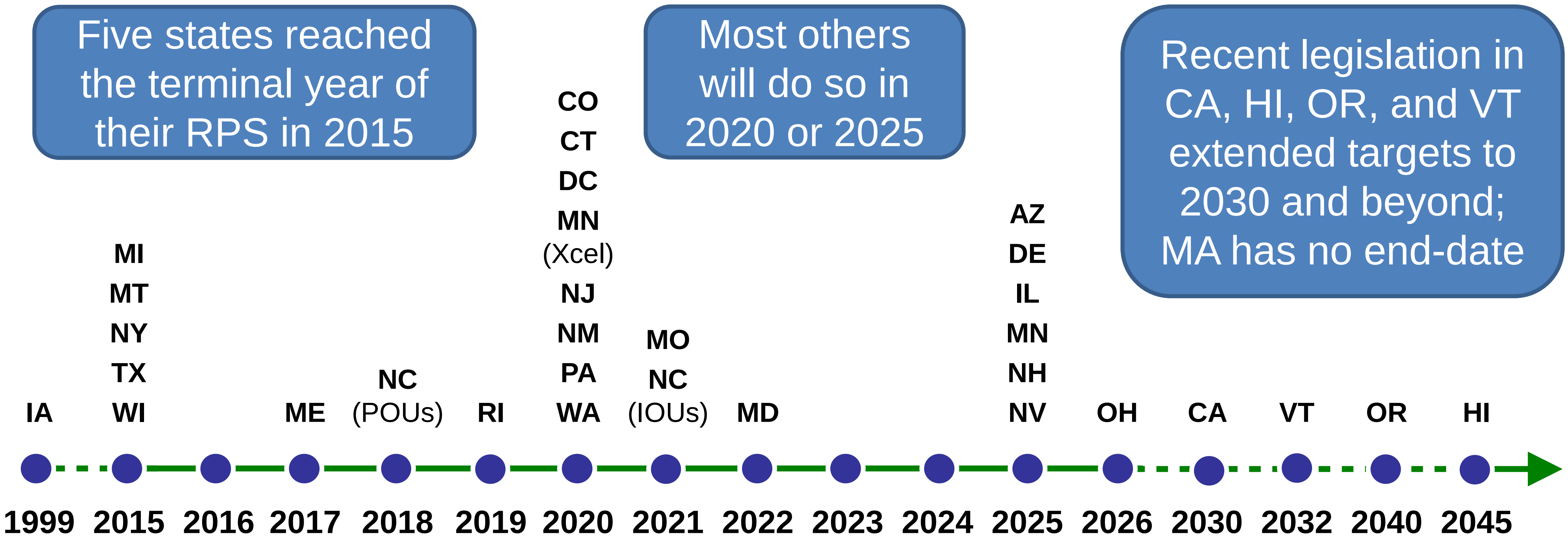
Source: Berkeley Lab
Notes: States are denoted "Non-RPS State" if an RPS did not exist at any point over the 2000-2015 period. RPS capacity additions are identified using the same data sources and methodology as in the figure on Slide 12.

Table of Contents

States Are Starting to Approach Final Targets

Though most still have 5-10 years

Year of Final RPS Target



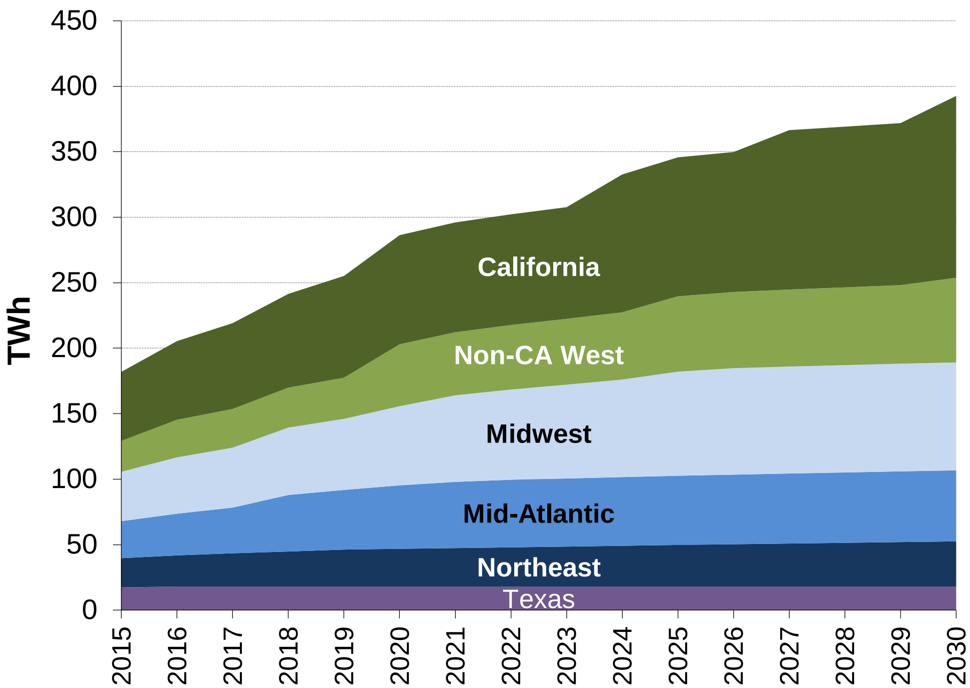
RPS demand will continue to grow slowly after final targets, due to load growth and RE retirements

BERKELEY LAB

Substantial Growth in RPS Demand Remains

Total U.S. RPS demand doubles to 431 TWh by 2030

Projected RPS Demand for RE
Excluding hydro, MSW, and non-RE



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

- Under current state targets, total U.S. RPS demand will increase from 215 TWh in 2015 to 431 TWh in 2030 (though RE-portion in figure is slightly lower: 393 TWh in 2030)
- California represents roughly 40% of that growth; most of the remainder associated with relatively large states
- Some utilities and regions are ahead of schedule, with RE purchases in excess of current requirements; increased demand does not equate to required increase in supply

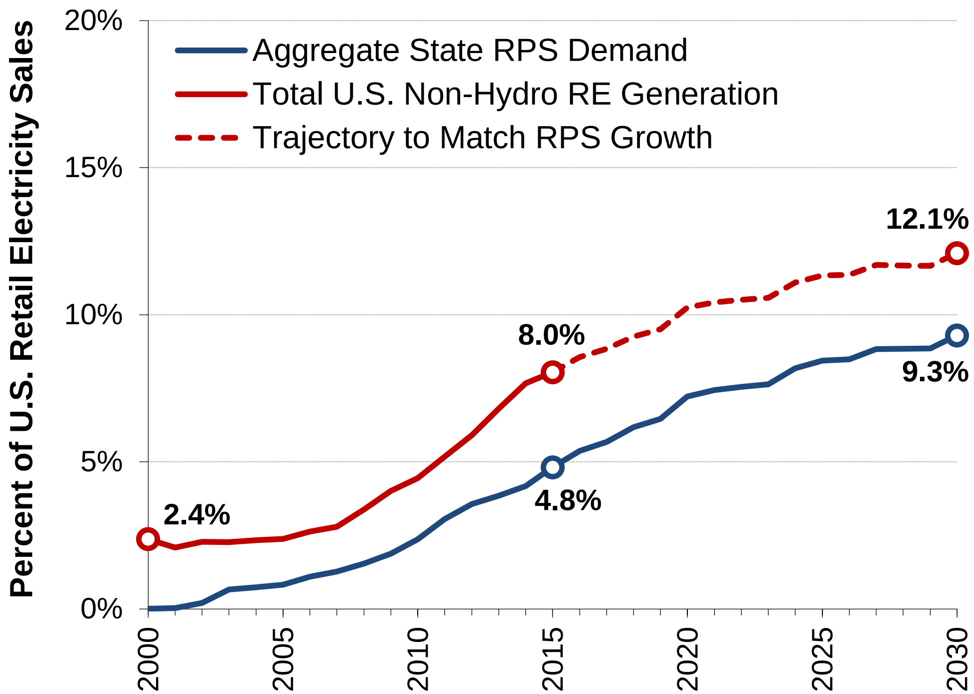
State-level RPS demand projections available for download at: rps.lbl.gov

BERKELEY LAB

U.S. RE Generation Must Increase to Keep Pace

Would reach 12.1% of retail sales to match RPS growth

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



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, and Total U.S. Non-Hydro RE Generation is based on EIA Electric Power Annual.

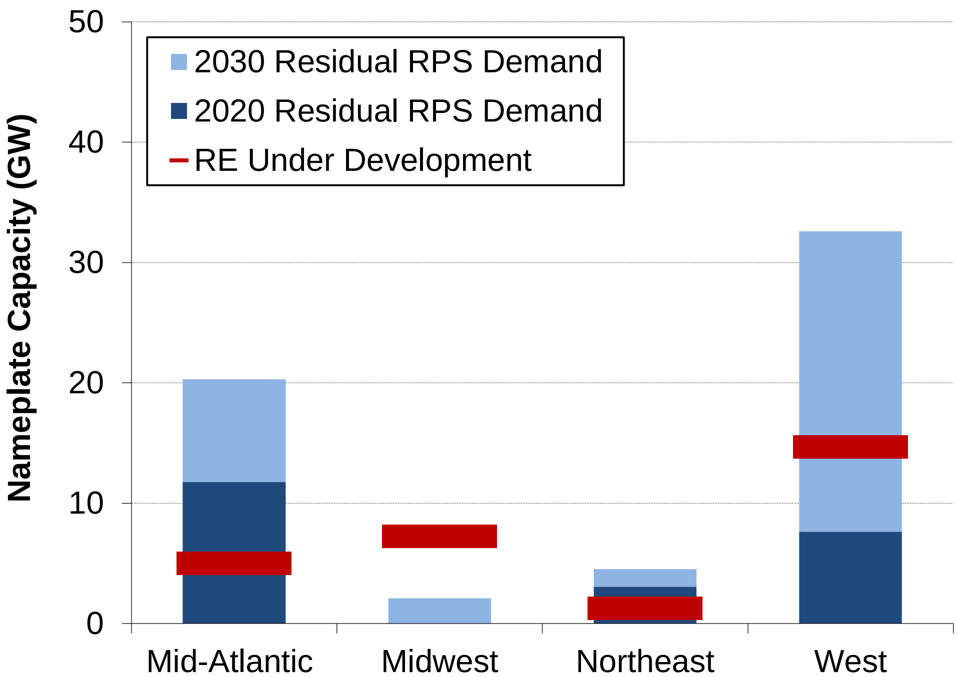
- Under current targets, total U.S. RPS demand will increase from 4.8% of U.S. retail electricity sales in 2015 to 9.3% in 2030
- Total U.S. RE supply would need to grow to 12.1% of retail sales in 2030 to keep pace with RPS demand growth
- Actual growth in U.S. RE supply may by less or greater than this amount
  - Current RE supplies exceed RPS demand; some of that surplus may be used to meet RPS demand growth
  - Other policy and economic drivers may spur RE growth, beyond minimum RPS requirements

BERKELEY LAB

RE Capacity Needed for RPS Demand Growth

60 GW of additional RE capacity needed by 2030

Residual RPS Demand Relative to Available RPS Supply



Notes: Residual RPS demand is measured relative to RPS-Contracted/Delivered capacity through 2015, as shown on slide 12. See Supplemental Notes for additional details and for information on how this approach could over- or under-estimate residual RPS capacity needs. RE Under Development consists of plants permitted or under construction as of Jan. 2016, based on data from ABB-Ventyx Velocity Database.

Given existing RE capacity available for RPS compliance, RPS demand growth will require an additional 22 GW of RE capacity by 2020 and 60 GW by 2030

– Represents roughly a doubling of total RPS-builds to-date (56 GW)

– More than a 50% increase from current non-hydro RE capacity (114 GW)

– Current build-rates are on pace to meet residual needs (6 GW of RPS capacity added in 2015, per slide 15)

Much of the near-term residual RPS demand may be met with RE capacity under development (28 GW currently)

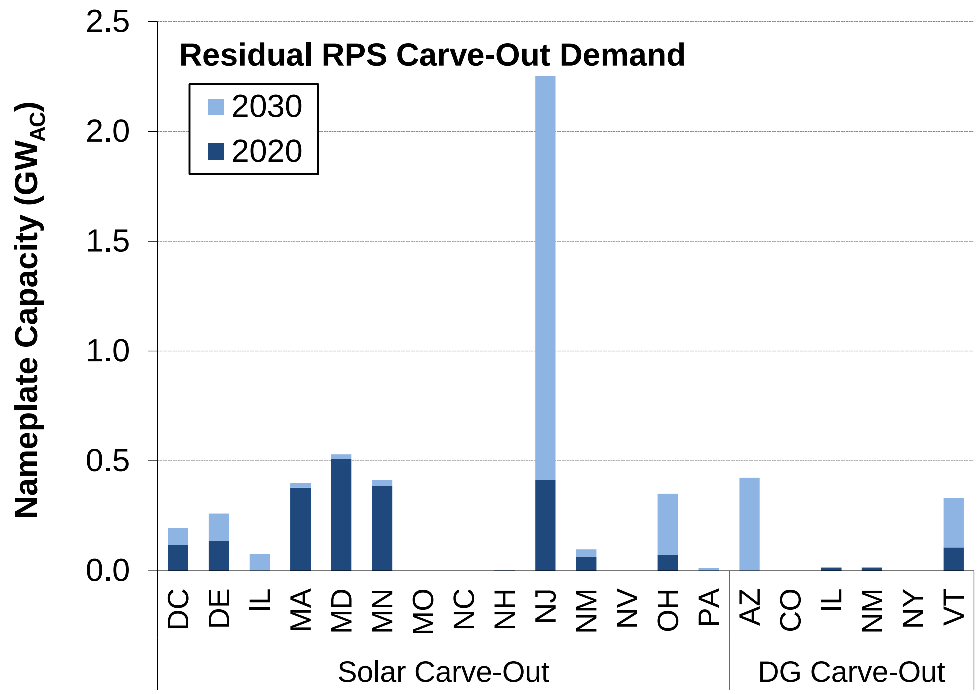
– Though not all will be built, and not all will be available for RPS compliance or fungible within regions

BERKELEY LAB

Residual Solar/DG Carve-Out Demand Remains, Despite Over-Supply in Some Markets

- Total solar/DG carve-out demand rises from 4 GW in 2015 to 8 GW in 2020 and 11 GW in 2030
- Many states are over-supplied relative to current targets, and some have already met their final targets
- Nevertheless, residual demand remains: **additional 2 GW of capacity needed by 2020 and 5 GW by 2030**, relative to current solar/DG capacity
- Greatest near-term (2020) residual demand in MA, MD, MN, and NJ
- Large 2030 residual demand in NJ associated with 15-year limit on solar project eligibility, need for "replacement capacity" in later years

Residual Solar/DG Carve-Out Demand Relative to Supply



Notes: The methods and data sources for estimating Residual RPS Carve-Out Demand vary by state. See Supplemental Notes for additional details and for information on how this approach could over- or under-estimate residual RPS capacity needs.

BERKELEY LAB

Table of Contents

Summarizing RPS Target Achievement: Methods and Data

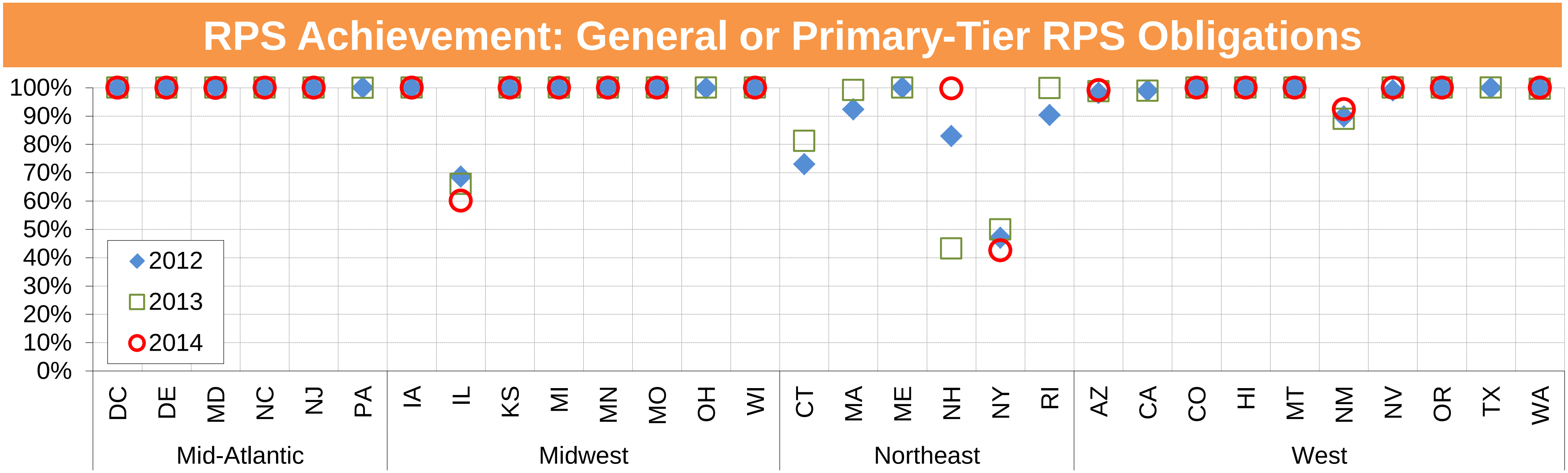
- We estimate each state's ***RPS Achievement*** as the quantity of renewable energy certificates (RECs) retired for RPS obligations each year, as a percentage of that year's interim RPS target
  - Accounts for actual use of available credit multipliers
  - Includes banked RECs from prior years that are then retired for compliance
  - Does not include alternative compliance payments (ACPs)
  - Does not include surplus RECs procured in a compliance year but not retired
- These values ***should not*** be equated to the available RE supply, nor should they be equated to "compliance", which is defined formally and differently by each state
- Underlying data are sourced primarily from utility and PUC annual compliance filings, often issued a year or more after the end of a compliance period
  - **Compliance data are therefore lagged; available for most states thru 2014**

Data on historical RPS obligations and RPS Achievement are available in tabular form here: rps.lbl.gov

BERKELEY LAB

Most States Have Fully Met Recent RPS Targets

RPS Achievement averaged 95% in 2014 and 94% in 2013



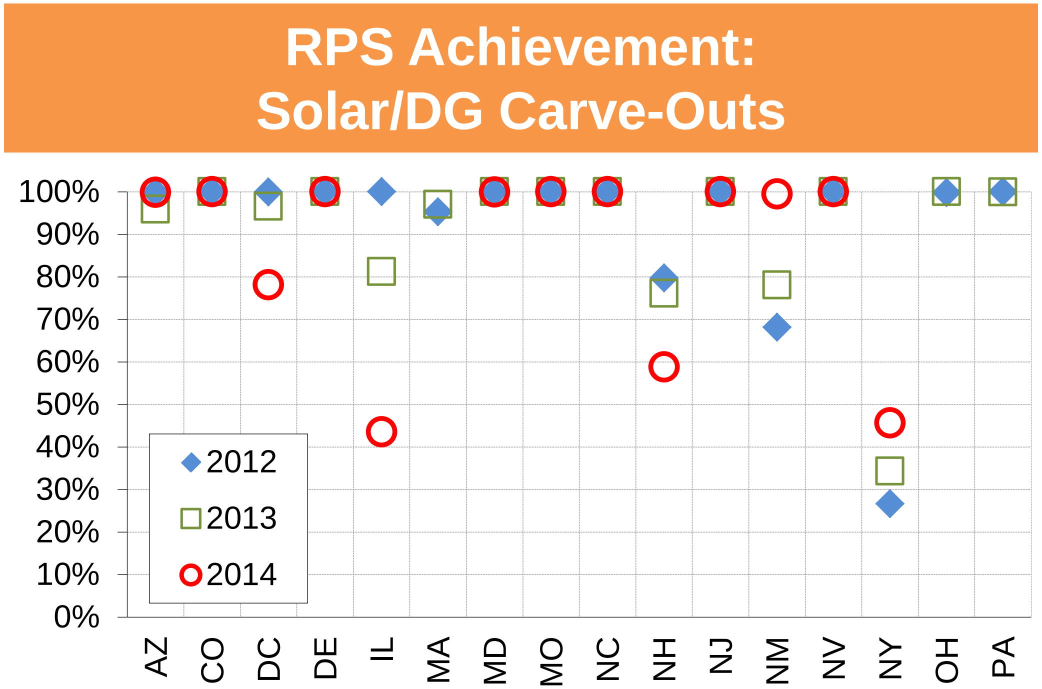
Notes: The values represent the percentage of annual RPS targets met with RE or RECs retired for RPS compliance each year, focusing on general or primary-tier (new, Class I, or Tier I) RPS obligations—i.e., excluding technology carve-outs or secondary (existing, Class II or Tier II) resource tiers. For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

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

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

Interim Carve-Out Targets Also Mostly Met

RPS Achievement averaged 87% in 2014 and 91% in 2013



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.

Most states with 100% RPS Achievement are well ahead of their solar/DG targets

Although most states fully achieved their solar/DG targets over the 2012-2014 period, some exceptions exist:

- **DC:** Inherent challenges of an exclusively urban market
- **IL:** Rules for alternative retail suppliers incentivize them to use ACPs for 100% of solar requirements
- **NH:** Competition from more-lucrative neighboring markets for NH SRECs
- **NM:** RPS cost caps forced reduced procurement for one utility
- **NY:** Performance of procurement measured based on resources under contract (rather than delivered RECs)

Table of Contents

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

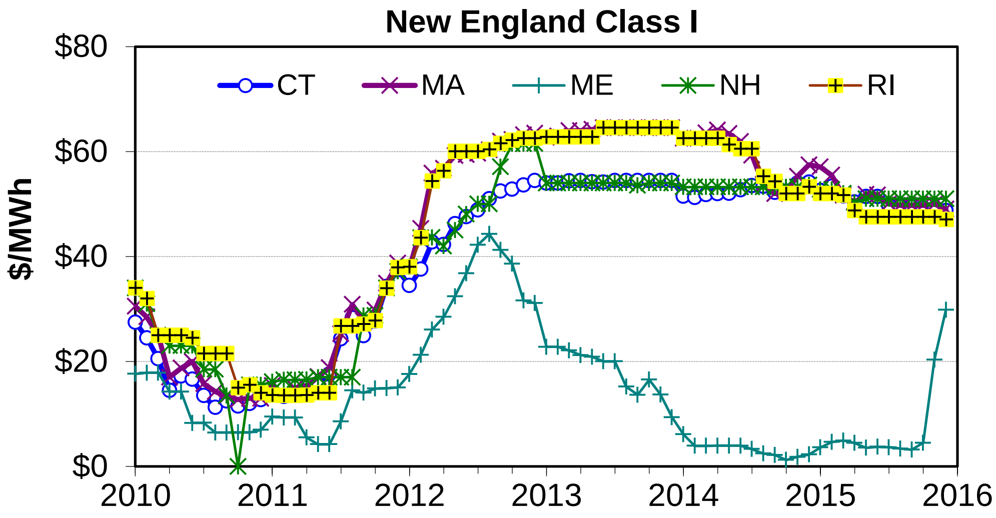
REC Pricing in Restructured RPS Markets: The Basics

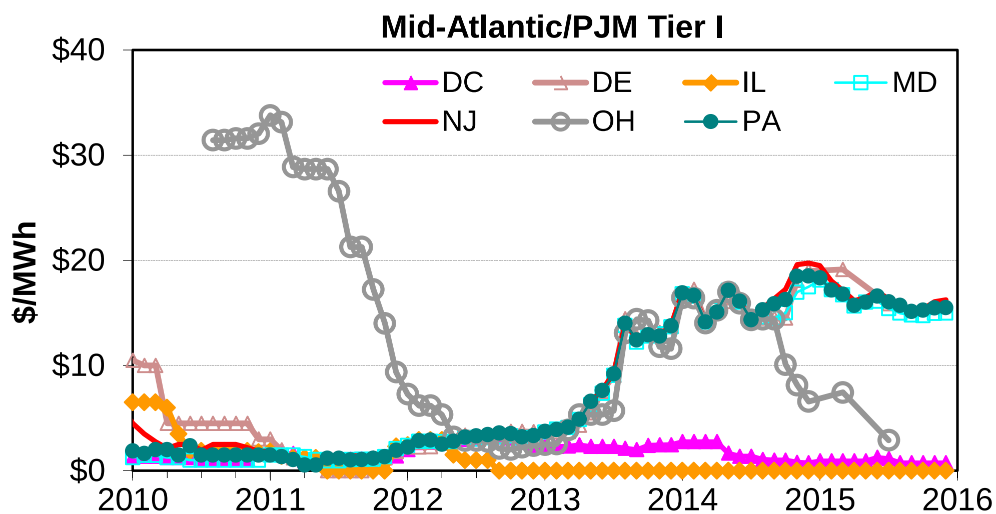
- RPS compliance in restructured (i.e., competitive retail) markets typically occurs through "unbundled" RECs sold separately from the underlying electricity, often via spot market transactions or relatively short-term contracts
  - Long-term contracting programs in many restructured states have migrated some REC volume into longer-term, bundled PPAs (similar to regulated states)
- REC pricing varies by state RPS market and by resource tier or carve-out
- ACP rates serve as a cap on REC prices
- REC pricing can be viewed from several perspectives
  - A potentially important source of revenues for RE generators
  - The direct cost of compliance to entities with RPS obligations
  - Signals whether REC supply and demand are in balance

The following two slides focus on **spot market REC pricing** trends for RPS states with active REC trading, recognizing that spot market transactions may represent only a portion of total compliance obligations

Primary-Tier REC Pricing Trends

New England remained the highest-priced market in 2015





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

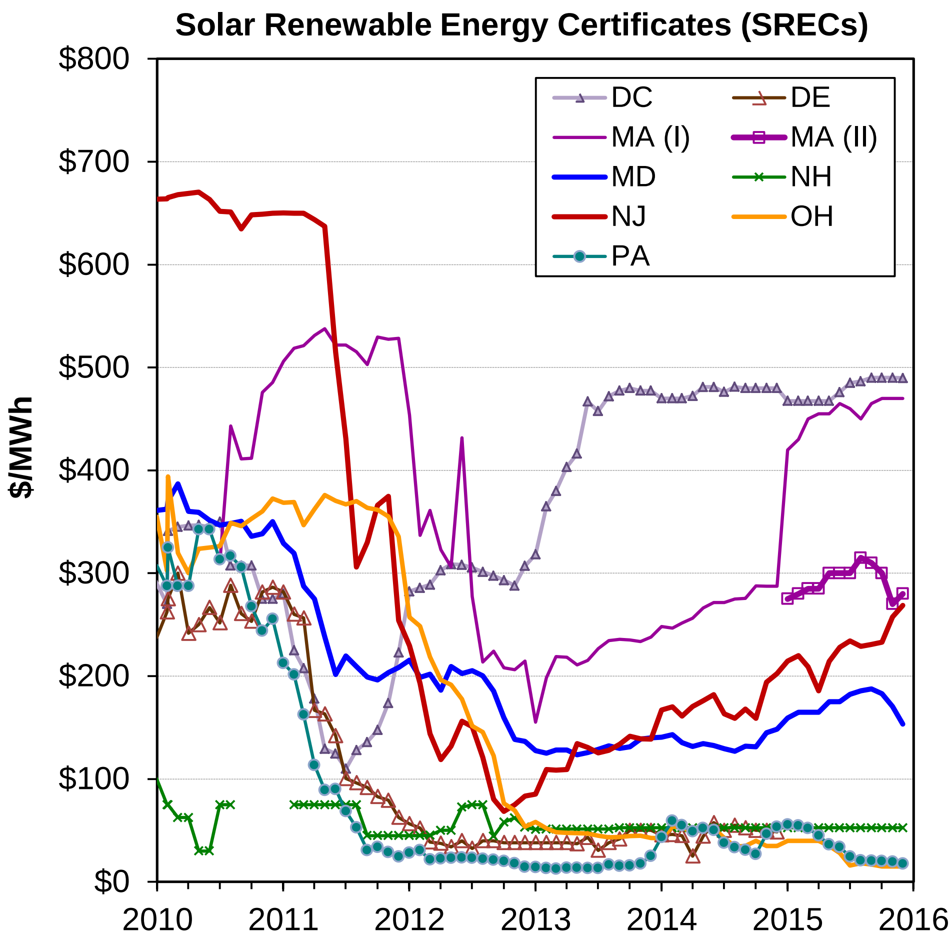
Trends reflect regional supply-demand balance and differences in state eligibility rules and ACPs

- **New England:** Tight supplies, with 2015 spot prices near CT/NH ACP levels ($55); lower prices in ME because of biomass resources ineligible for other states
- **Mid-Atlantic/PJM:** Spot pricing in NJ-MD-PA markets remained above historical lows, but still well below ACPs ($40-50); low pricing in other states with access to add'l RE supply
- **Elsewhere:** NYSERDA 2015 RFP for long-term REC contracts averaged $23/MWh; TX prices remain low (≤$1/MWh) reflecting acute surplus

BERKELEY LAB

Solar Carve-Out REC Pricing Trends

SREC prices vary widely, from $20-500/MWh in 2015



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—reflecting in-state supply-demand balance, SACPs, spot market volume, and other factors:

- **NJ:** Coming back into balance from large historical over-supply
- **MD:** Modest but persistent over-supply
- **MA:** SREC II program is oversupplied, but clearinghouse provides soft floor
- **PA** and **OH** heavily oversupplied, in part due to eligibility of out-of-state projects
- **DC** and **NH**: Both undersupplied, but vastly differing SACP ($500 v. $55/MWh)
- **DE:** Large portion of solar carve-out met through long-term contracts

BERKELEY LAB

Table of Contents

RPS Compliance Costs

Definitions, Methods, and Metrics

RPS Compliance Costs: Net cost to the compliance entity, 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
- We synthesize available utility and PUC compliance cost estimates
- Limitations: Varying methods across states; incomplete or sporadic reporting (no data for IA, MT, NV, KS)

Compliance cost data are lagged; available for most states through 2014

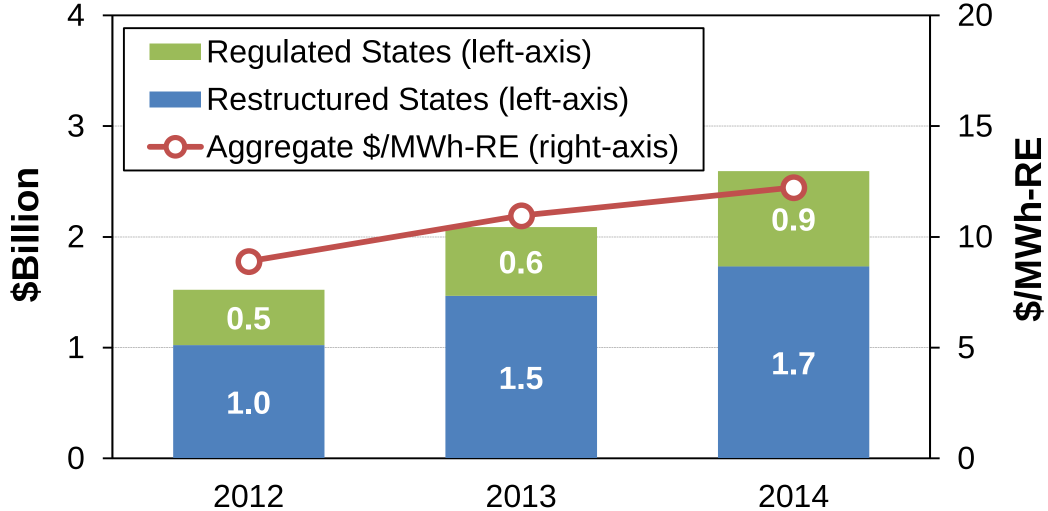
RPS Compliance Cost Metrics

1. Absolute dollars ($)
2. Dollars per MWh of renewable electricity ($/MWh-RE) used for RPS
3. Costs as a percentage of average retail electricity bill

Aggregate U.S. RPS Compliance Costs

Totaled roughly $2.6B in 2014, up from $2.1B in 2013

Total RPS Compliance Costs



Notes: Compliance costs for restructured states represent REC plus ACP expenditures. Compliance costs for regulated states are based on utility- or PUC-reported estimates in annual RPS compliance filings and legislative reports. 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 the diverse methods used to estimate compliance costs across states

Cost growth year-over-year associated with increasing targets, shift toward somewhat higher-cost RPS resources, and increasing REC prices in some states

Weighted avg. cost of $12/MWh-RE (across all tiers, including carve-outs) in 2014, up from $11/MWh-RE in 2013

Aggregate U.S. RPS compliance costs highly sensitive to California:

- We use CA PUC estimates, which rely on the all-in cost of a CCGT as the basis for avoided costs
- IOU avoided cost estimates yield RPS compliance costs roughly $2.3B higher in 2014

BERKELEY LAB

Compliance Costs as a Percent of Customer Bills

Weighted average of 1.3% of retail electricity bills in 2014

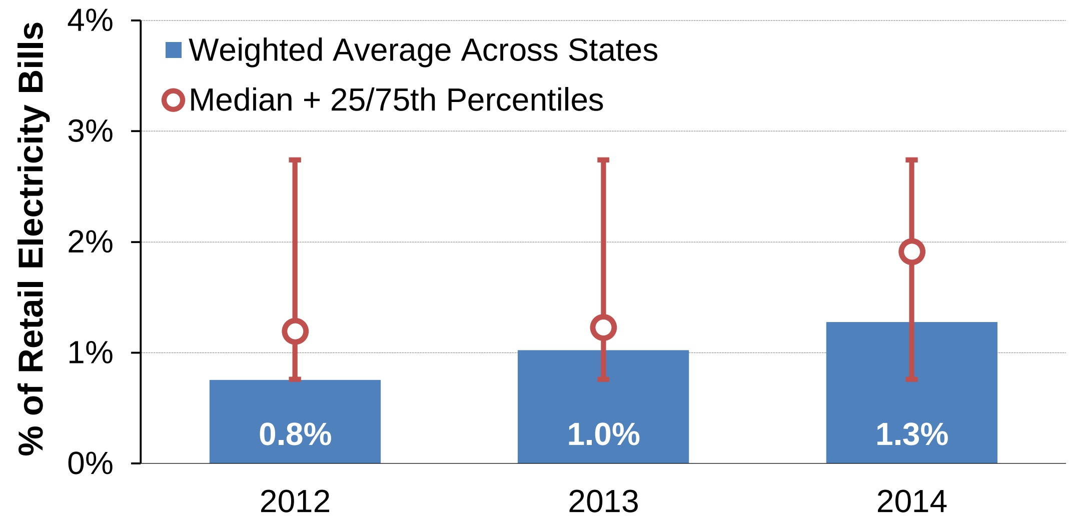
Rose from average of 1.0% of retail electricity bills in 2013, consistent with increase in aggregate dollar costs discussed on previous slide

Compliance costs in most states were equivalent to less than 2% of retail bills in 2014 (median value)

Wide variability across states also evident in percentile bands; more details on state-specific compliance costs included in the following slides

RPS Compliance Costs

Percentage of Average Retail Electricity Bill



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.

This metric can be considered a proxy for "rate impact", albeit a rough one:

– Some impacts (merit order effect, integration costs) may not be fully captured

– Costs borne by LSE are not always fully or immediately passed through

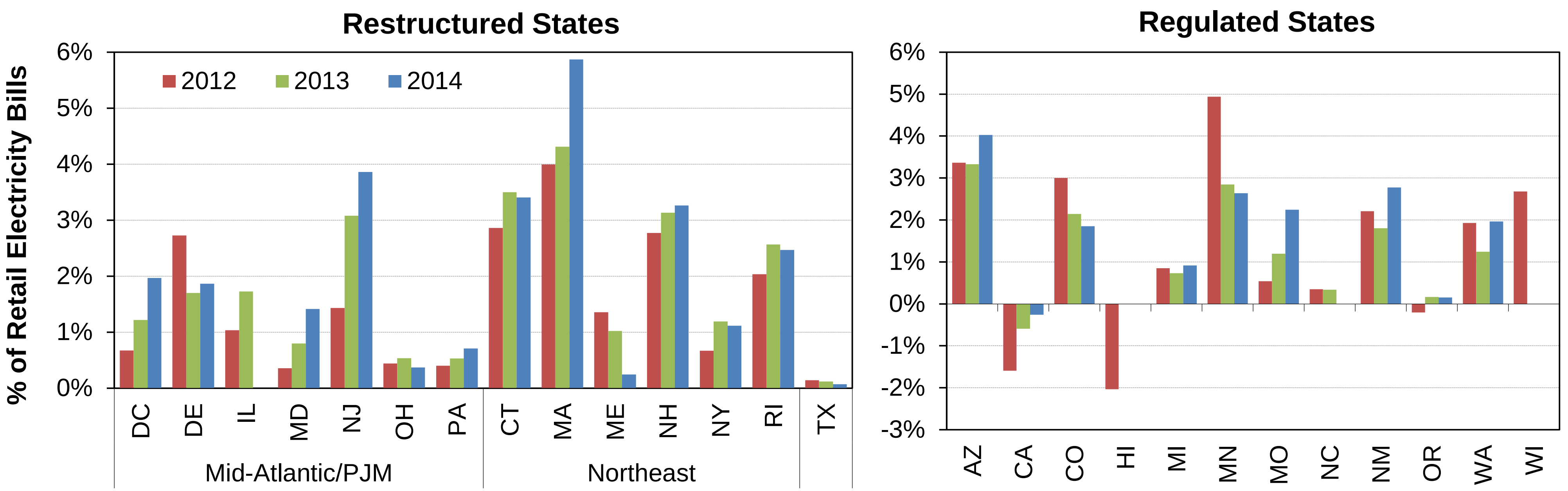
– ACPs may be credited to ratepayers or recycled through incentive programs

BERKELEY LAB

RPS Compliance Cost Variation Across States

Ranged from -0.3% to 5.9% of retail electricity bills in 2014

Total RPS Compliance Costs (all resource tiers)



See Supplementary Notes for data sources and key methodological details.

Variation across states reflects a multitude of factors: RPS target levels, resource tiers/mix, REC prices, wholesale electricity prices, reliance on pre-existing resources, and cost calculation methods (among other differences)

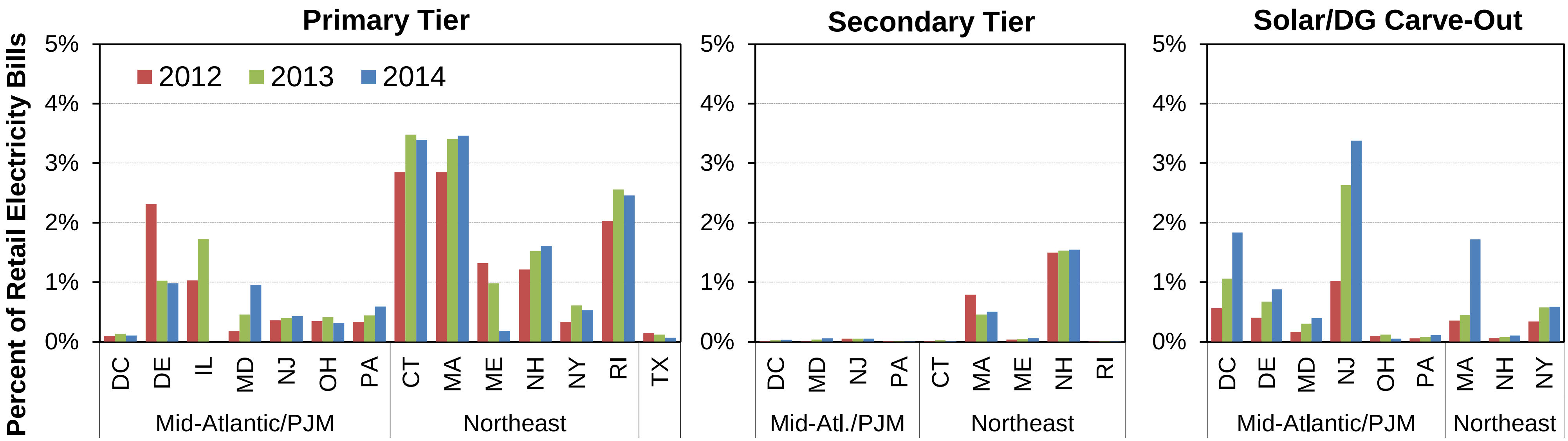
Though not shown, compliance costs can also vary among LSEs within an individual state (e.g., between IOUs and municipal utilities)

BERKELEY LAB

Cost Contributions by Resource Tiers

Primary tiers the largest absolute share, but solar costs growing fastest

RPS Compliance Costs by Resource Tier (Restructured States Only)



See Supplementary Notes for data sources and key methodological details.

Primary-tiers: $1000M in REC+ACP expenditures in 2014, or 0.8% of average bills across all restructured states; generally small changes year-over-year

Solar/DG carve-outs: $700M in 2014 or 0.9% of average retail bills among states with carve-outs; driving total RPS cost growth in several states (DC, MA, NJ)

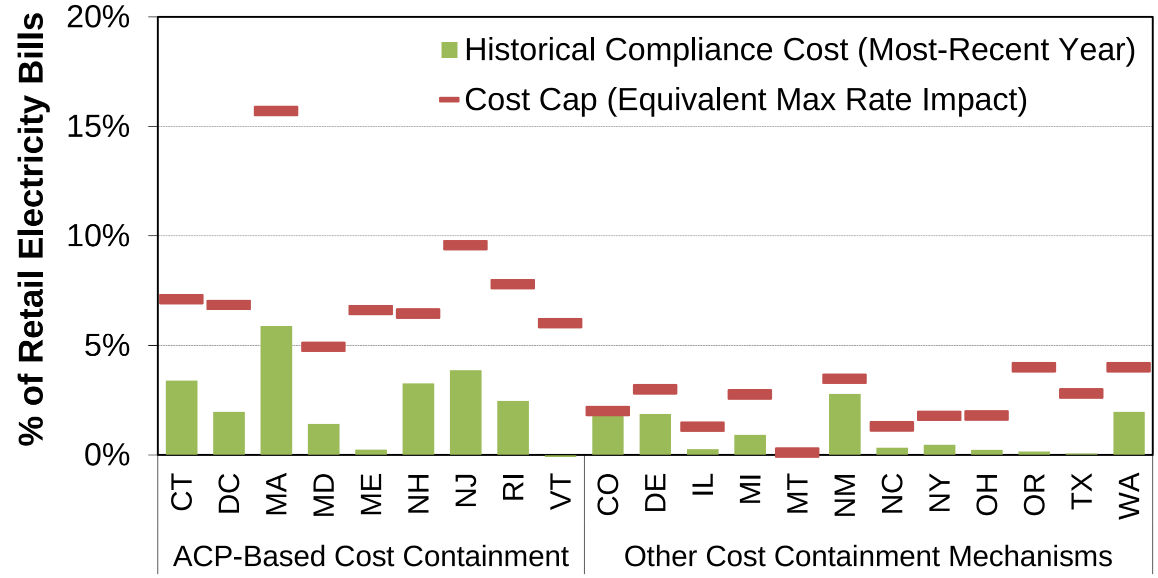
Secondary tiers: $100M in 2014; rate impact is generally minimal, with most notable exception in NH where vintage threshold is misaligned with other states

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

RPS policies include various cost containment mechanisms

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

Recent Costs Compared to Cost Caps



See Supplementary Notes for key methodological details.

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

Table of Contents

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

Endogenous Factors

- RPS compliance costs and ACPs/cost caps
- Legislative and legal challenges to state RPS programs
- Whether states extend RPS targets as they approach final year
- Ongoing refinement to RPS policies and rules in response to experience and to changing market and policy conditions

Exogenous Factors

- Clean Power Plan legal challenges, compliance plans, implementation
- The many related issues affecting RE deployment (integration, siting, net metering, etc.)

For Further Information

LBNL RPS reports, presentations, data files, resources

rps.lbl.gov

LBNL renewable energy publications

emp.lbl.gov/reports/re

Contact information:

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

Acknowledgements

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. For reviewing and providing comments on earlier versions of this material, we thank Warren Leon (Clean Energy Group), Ed Holt (Ed Holt & Associates), Jenny Heeter (National Renewable Energy Laboratory), and Jeff Deyette (Union of Concerned Scientists). We also thank the many state RPS administrators that graciously offered their time and assistance in providing and clarifying information contained in this annual report.

Acronyms

ACP: Alternative compliance payment

DG: Distributed generation

EIA: Energy Information Administration

IOU: Investor-owned utility

GW: Gigawatt

GWh: Gigawatt-hour

LSE: Load-serving entity

MSW: Municipal solid waste

MW: Megawatt

MWh: Megawatt-hour

NYSERDA: New York State Energy Research and Development Authority

PSC: Public service commission

PUC: Public utilities commission

RE: Renewable electricity

REC: Renewable electricity certificate

RPS: Renewables portfolio standard

SACP: Solar alternative compliance payment

TWh: Terawatt-hour

Supplementary Notes

RPS impacts on renewables development to-date

Slide 11: "Minimum Growth in Non-Hydro RE Required for RPS" is estimated by first calculating total RPS compliance demand for each state, based on historical retail electricity sales and accounting for exempt load, use of RPS credit multipliers, offsets, and other state-specific provisions. Minimum Growth is then calculated by deducting contributions to RPS compliance from pre-2000 vintage facilities and from hydro, municipal solid waste, and non-RE technologies, based on data from state and utility RPS compliance reports. That minimum growth can be considered to have been a floor on growth in RE generation; however, some portion of that minimum growth would likely have occurred in the absence of RPS policies. "Growth in Total U.S. Non-Hydro RE Generation" is based on data from EIA's Electric Power Annual.

Slide 12: The figure is derived by parsing annual RE capacity additions into RPS-Contracted/Delivered and Non-RPS additions. Total annual RE capacity additions are based primarily on data from AWEA (wind), GTM Research (solar), EPA's Landfill Methane Outreach Program (LFG), and ABB-Ventyx Velocity Database (biomass and geothermal). Projects are counted as RPS-Contracted/Delivered only if the contract off-taker is subject to an RPS or if the energy is sold on a merchant basis into regional power markets with active RPS obligations. In the latter case, the assumption is that unbundled RECs from merchant projects are generally used for RPS compliance in the same regional power market into which the energy is sold. In addition, projects are counted as RPS-Contracted/Delivered only if they commenced commercial operation after enactment of the off-taker or regional power market's earliest RPS requirement, and before the final RPS target was reached. Thus, only a portion of RE capacity additions in Texas and Iowa that are counted as RPS-Contracted/Delivered, given that those states have already far surpassed their final RPS targets. To be sure, this analysis is not intended to attribute causality to state RPS programs, and some of the RPS-Contracted/Delivered capacity may have occurred in the absence of RPS programs. Moreover, this analysis does not precisely account for the flow of RECs, and as a result, could over-state the portion of RE capacity being used for RPS compliance in some cases (e.g., RE capacity used for utility-sponsored voluntary green power programs) and under-state it in other cases (e.g., RE capacity where the energy is sold to utilities without RPS obligations but RECs are sold separately into RPS compliance markets).

Slide 13: The data shown in this figure consist of the RPS-Contracted/Delivered RE capacity additions from Slide 12. See notes above for underlying data sources and methodological details.

Slide 14: The figure is derived by parsing annual solar capacity additions into the three categories shown. Solar capacity additions are counted as "Solar/DG Carve-Outs" if installed in a state with an active solar or DG carve-out, subject to several constraints. First, for states where only subset of utilities are subject to the carve-out (AZ, CO, NY), associated capacity additions are based on data from utility RPS compliance reports, rather than on statewide solar capacity additions. Second, for states that have fully met their final carve-out targets (NC, NV), solar capacity additions above and beyond the carve-out are counted as "General RPS Obligations". For states with an RPS but no solar or DG carve-out, solar capacity additions are counted as "General RPS Obligations" using the same criteria as in Figure 12.

Supplementary Notes
Future RPS demand and incremental needs

Slide 20: Total RE capacity required to meet each state's RPS is estimated by applying technology and capacity factor assumptions to its projected total RPS demand, based in part on historical, state RPS compliance data. Residual RPS capacity needs are then calculated as total RE capacity required to meet future RPS demand, minus RPS-Contracted/Delivered Capacity (see slide 12 notes), minus pre-existing RE capacity contracted prior to RPS enactment. This is estimated on a regional basis, based on the sum of the aforementioned quantities for all RPS states in the region. Importantly, this approach does not account for several additional complexities that could result in either higher or lower estimates. In particular, retirement of RPS capacity would result in greater residual capacity needs. Additionally, we assume that all existing RPS capacity is liquid within a region–e.g., that surplus RE capacity currently contracted to a utility in Colorado with RPS obligations could be sold to a utility in California for its residual RPS needs. In reality, constraints to intra-regional liquidity exist, which would also result in greater residual capacity needs. Conversely, we assume that all current "non-RPS capacity"–e.g., RE capacity currently being sold into voluntary green power markets or to utilities without RPS obligations–is unavailable for meeting future RPS demand. In reality, some of this RE capacity could be "re-purposed" for RPS obligations, particularly for states with relatively flexible rules related to the use of unbundled RECs. This factor would result in lower residual RPS needs than shown here.

Slide 21: Total capacity required to meet each state's solar/DG carve-out is estimated by applying state-specific capacity factor assumptions to its projected total carve-out demand. Each state's residual RPS Carve-Out Demand is then measured relative to its available supply; however, the particular approach to estimating available supply varies by state. For states with active SREC markets and that effectively restrict carve-out eligibility to in-state resources (DC, DE, MA, MD, NJ, NH), available supply is equal to total in-state solar capacity installed through 2015, based on data from GTM Research and SEIA. This approach could over-state available supply (and thus under-state residual demand) to the extent that the RECs associated with some portion of installed solar capacity in these states have been retained by the site host for environmental claims or designated for other non-RPS purposes. For IL, PA, and OH—which allow out-of-state resources for their solar carve-outs—available supply is based on PJM-GATS data for facilities certified as eligible for at least one of those states' carve-outs. Projects certified for more than one of those three states are allocated according to each state's 2020 carve-out demand. For AZ, CO, NM, and NV, available supply is based on data from utilities' RPS compliance plans. For NY, available supply is based on installed carve-out capacity reported in NYSERDA's most recent RPS annual report. For MN and VT, available supply are equal to in-state solar capacity additions installed after the threshold eligibility date (May 2013 for MN and June 2015 for VT). For MO, no residual demand is assumed to exist, given unrestricted use of out-of-state solar. Similarly, no residual demand is assumed for NC, given that currently installed solar capacity in the state far outstrips the final carve-out targets. We do not account for retirement of solar/DG capacity, which may lead to an under-estimate of residual needs. However, for NJ, we do account for the fact that solar projects become ineligible for the carve-out after 15 years of operation, and our projection of future demand includes "replacement" capacity as existing projects lose their eligibility.

Supplementary Notes
RPS compliance costs and cost caps

Slide 32: For restructured states, costs calculated from REC and ACP prices and volumes for each compliance year. REC prices are based on data from the following sources: **CT/MA/NH/RI/TX** (broker price sheets supplemented with available data on long-term contract prices), **DC** (PSC annual compliance reports), **DE** (Delmarva IRPs), **MD** (data provided by PSC staff), **NJ** (BPU annual compliance reports), **NY** (NYSERDA annual RPS status reports), **IL** (IPA's annual RE cost and benefits reports, and data provided by ICC staff), **ME** (PUC annual compliance reports), **OH** (PUC annual compliance reports), **PA** (data published on PUC website). REC and ACP volumes are based on utility or PUC annual RPS compliance reports. For regulated states, costs are based on utility- or PUC-reported estimates in annual RPS compliance filings and legislative reports, and typically reflect the total quantity of RPS resources procured in each year, which may exceed the minimum amount required. Data for CA are CPUC-reported estimates based on comparison to the estimated all-in cost of a combined cycle gas turbine (CCGT); the CA IOUs submitted higher compliance cost estimates based on comparison to day-ahead CAISO energy market prices. Data for some states (AZ, CA, CO, MN, and NC) reflect only a subset of RPS-obligated LSEs. States omitted if data are unavailable (IA, KS, MT, NV).

Slide 33: Values in this chart are calculated by dividing the dollar value of RPS compliance costs (derived as described above) by the aggregate retail electricity bills for RPS-obligated load. Retail electricity bills are calculated from EIA data on annual average retail electricity rates for each state, applied to portion of statewide retail sales subject to RPS requirements.

Slide 34: See notes for Slides 32 and 33 for relevant details.

Slide 35: See notes for Slides 32 and 33 for relevant details.

Slide 36: Each state's cost containment mechanism was translated into the equivalent maximum possible rate impact for the final year in the RPS. For states with an ACP, the maximum possible rate impact corresponds to the scenario in which the entire RPS obligation in the final RPS year is achieved with RECs priced at the ACP. 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 explicit 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.