U.S. State Renewables Portfolio & Clean Electricity Standards: 2023 Status Update

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Advancing Towards 100% Clean Energy: A State-Federal Summit

May 17, 2023

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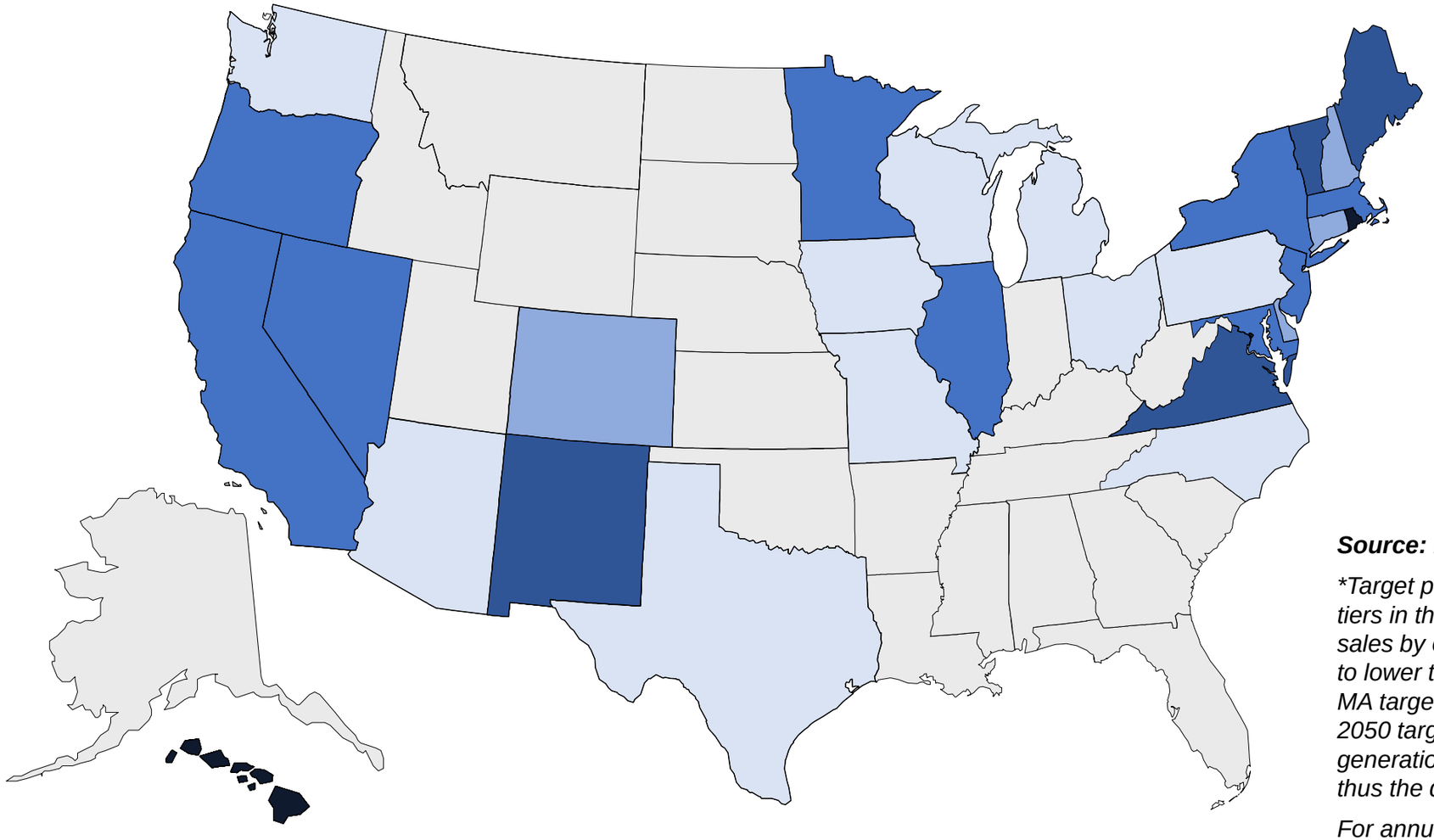
RPS Policies Exist in 29 States and DC

Apply to 58% of total U.S. retail electricity sales



Source: Berkeley Lab *(April 2023)*

**Target percentages represent the sum total of all RPS resource tiers in the final target year, expressed as a percentage of retail sales by obligated LSEs. Some LSEs in each state may be subject to lower target percentages or exempt from the RPS altogether. The MA target escalates at 1% per year; the shading shown reflects the 2050 target level. The HI RPS is denominated as a percent of generation, and will ultimately rise to above 100% of retail sales; thus the darkest shade refers to 100%+.*

For annual RPS targets by state, see http://rps.lbl.gov

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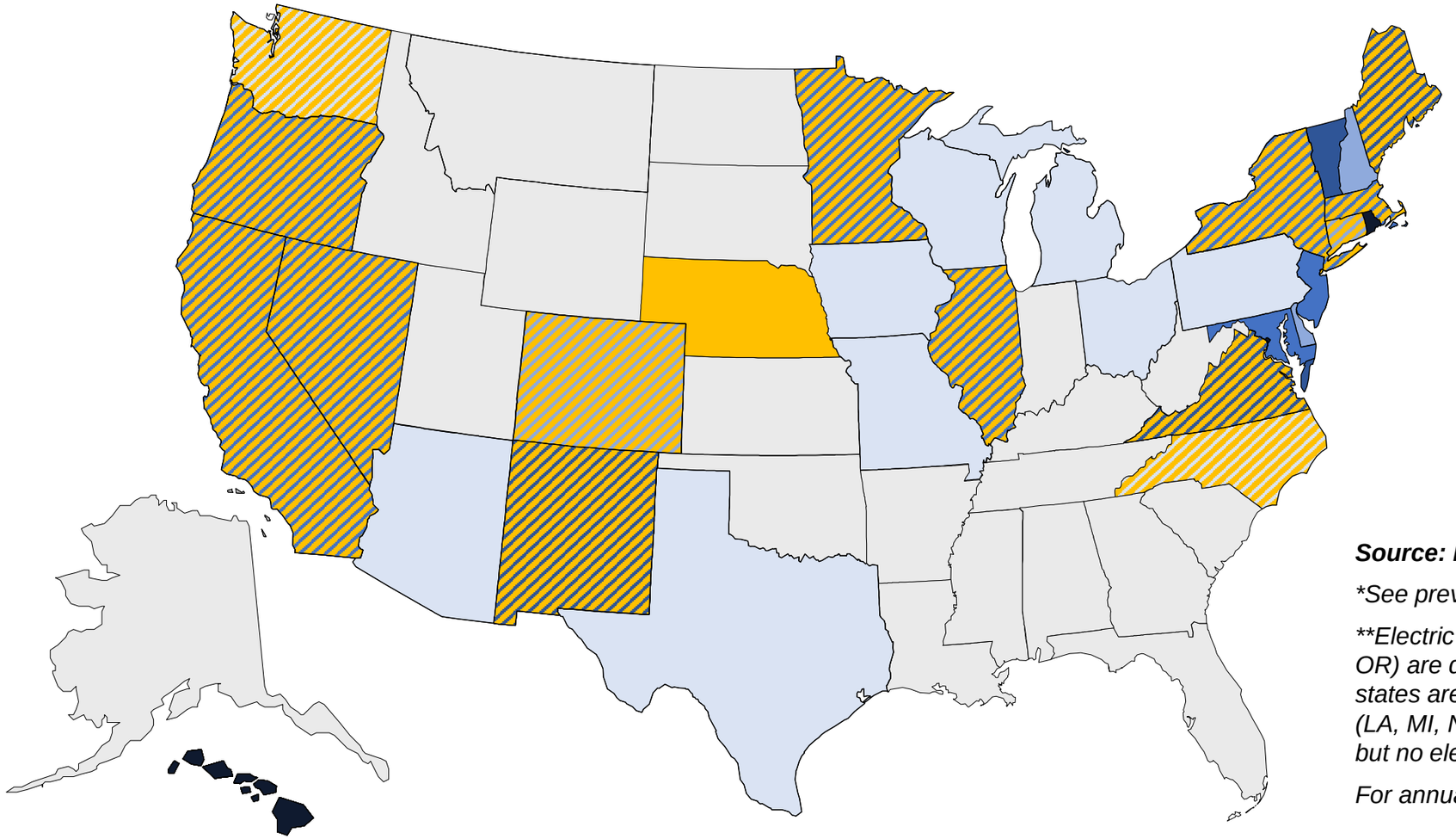
15 States Have Established a Broader 100% CES **

Typically in combination with an RPS



Source: Berkeley Lab *(April 2023)*

**See previous slide for notes on RPS targets*

***Electric sector emission standards in several states (CO, NC, NV, OR) are depicted here as a CES. Not included among the CES states are those that established a target only via executive order (LA, MI, NJ, WI) or with economy-wide emission reduction targets but no electric sector-specific targets (MD).*

For annual RPS & CES targets by state, see http://rps.lbl.gov

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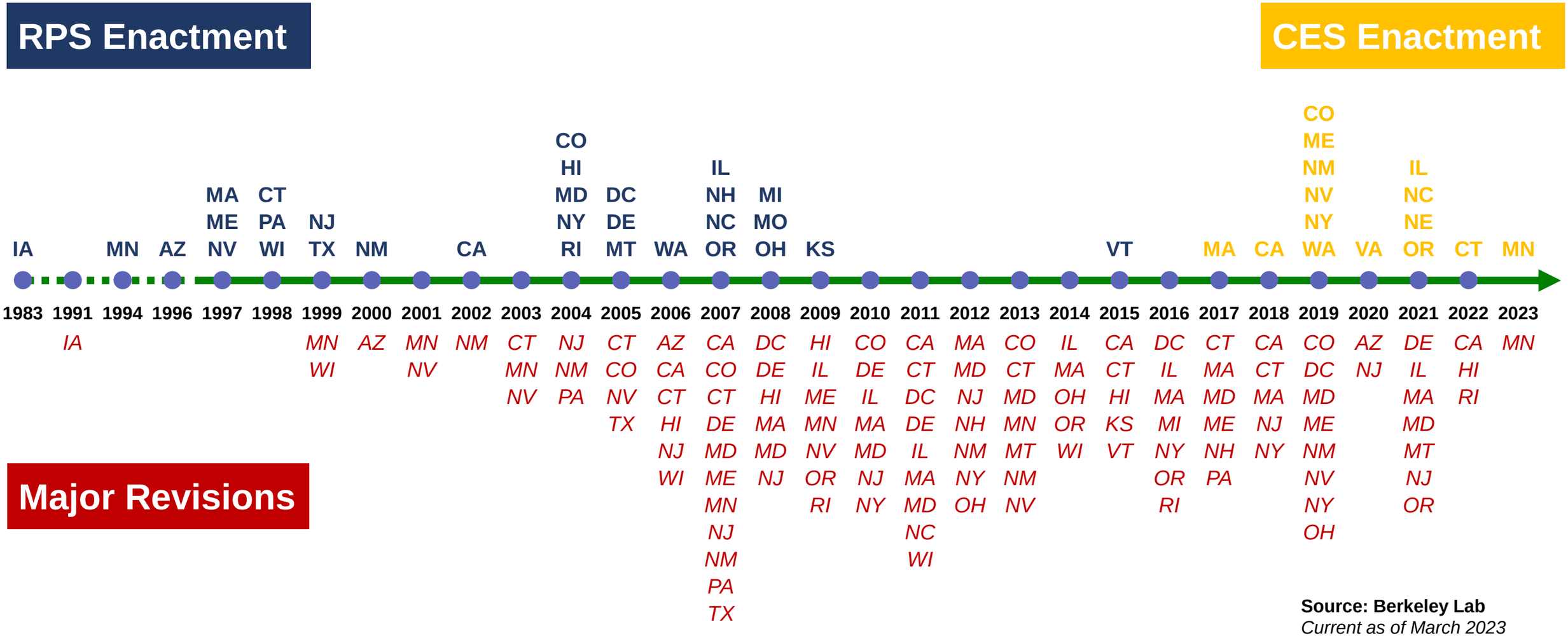
Most RPS Policies Have Been on the Books for More Than a Decade

But states continue to make significant revisions & adopt new CES'

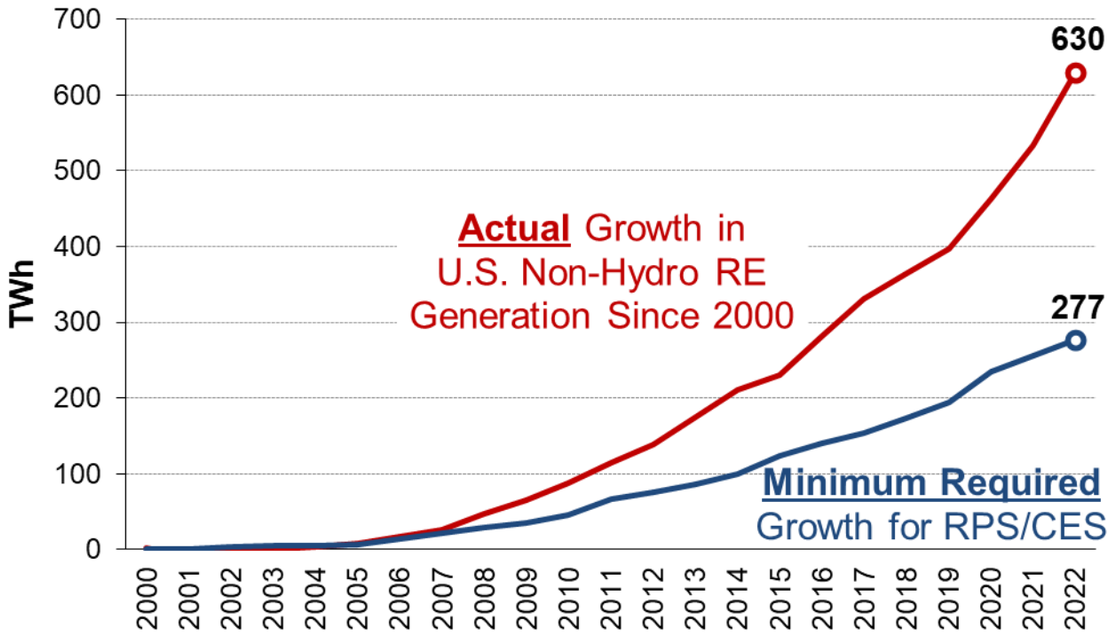


Source: Berkeley Lab
Current as of March 2023

Historical Impacts of State RPS and CES Policies on Renewables Development

RPS' & CES' Have Been One Key Driver for RE Generation Growth

Growth in Non-Hydro Renewable Generation: 2000-2022



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

- Total non-hydro RE generation in the U.S. has grown by 630 TWh since 2000
- RPS+CES policies required a 277 TWh increase over the same period (44% of total RE growth)
- Not strict attribution
  - Some of that growth would have occurred without RPS+CES requirements
  - Conversely, RPS+CES policies may have also contributed to more RE growth than what is strictly required (e.g., progress toward distant CES targets, spillover effects)

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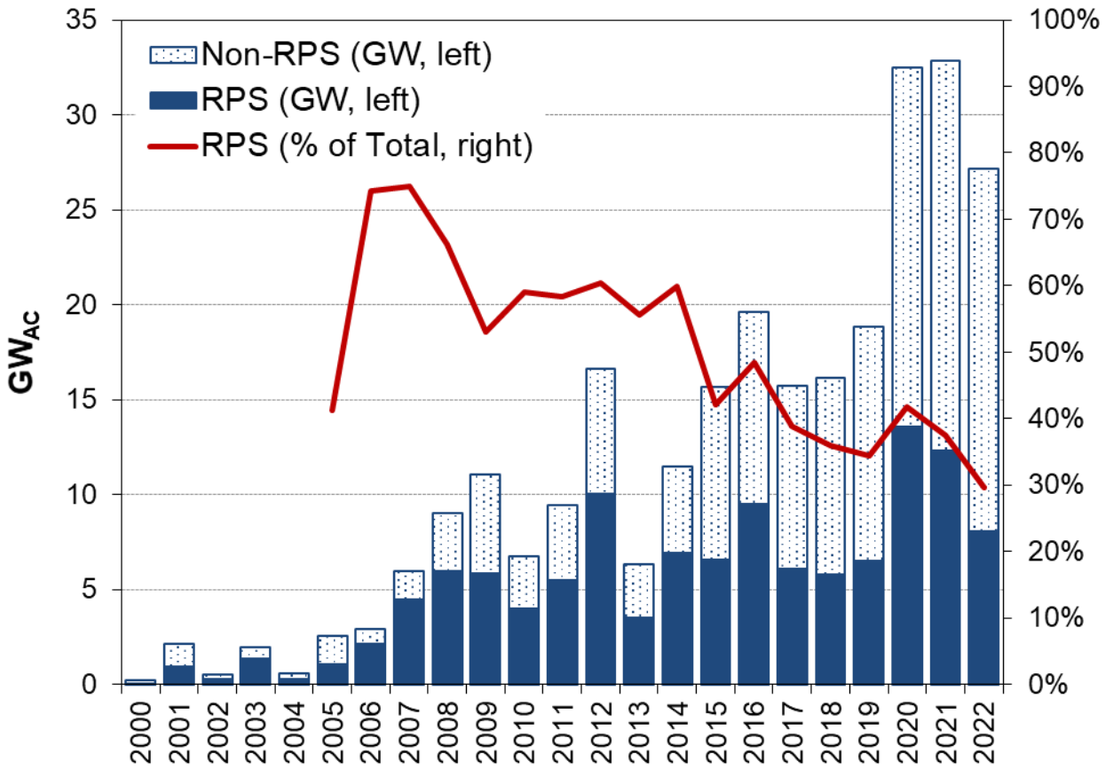
RPS' Have Provided a Stable Source of Demand for RE New-Builds

Even if RPS *portion* of annual RE capacity additions has declined over time

Annual Renewable Capacity Additions



Notes: The criteria for assessing whether a project may be used for RPS compliance depend on the off-taker type and region. See previous slide for further details.

- Cumulatively, 45% of all RE capacity additions since 2000 are in some form "RPS-related" (120 GW out of 265 GW)
- That share has declined over time, dropping to 30% of RE additions in 2022, compared to 60-70% in earlier years
- Despite the shrinking share, the absolute quantity of RPS-related RE capacity additions has grown over time
- However, RE capacity growth outside of RPS programs has simply been more rapid, consisting of:
  - Utility/power marketer procurement in non-RPS states (7 GW in 2022; mostly TX, Midwest, Southeast)
  - Onsite solar not used for RPS (6 GW in 2022; half from CA, FL, TX)
  - Corporate PPAs and community solar not certified for RPS eligibility (5 GW)

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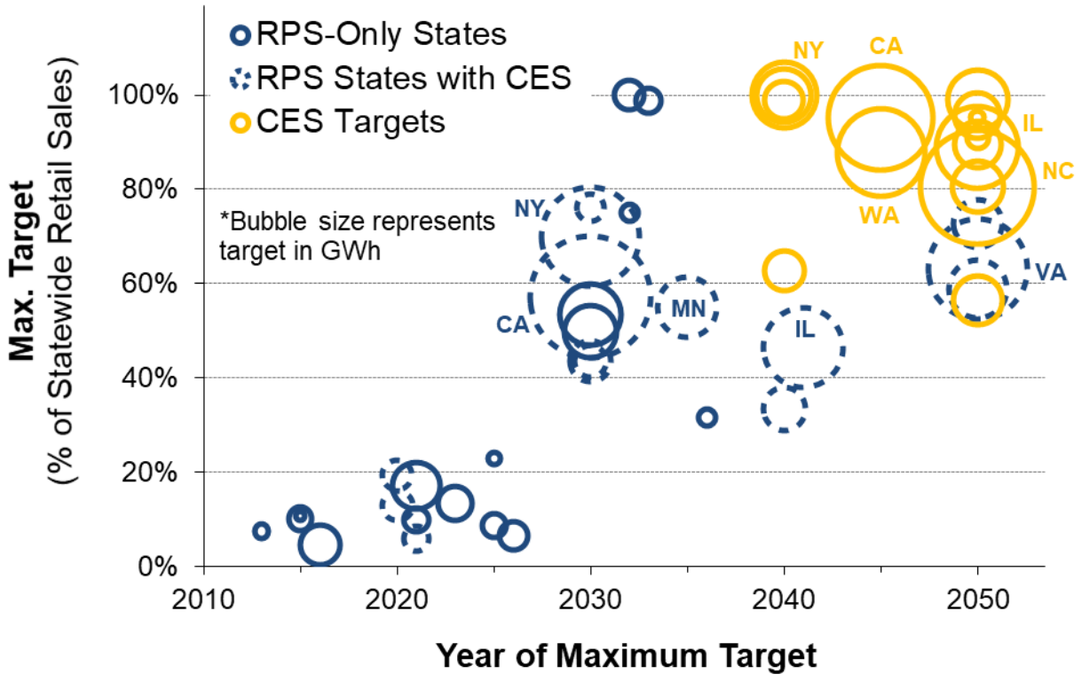
Projected RPS & CES Demand and New Supply Needs

Target Levels and Timeframes Vary Widely

Max. RPS & CES Targets and Target Years



Notes: Figure shows each state's maximum RPS and CES percentage target and the associated year when that target must be reached. To facilitate comparison across states, targets are calculated as the percentage of total statewide retail sales, which may differ from nominal targets if those apply to only a subset of LSEs in a state. The bubble represents the target in GWh terms; in the case of the CES targets, the size reflects only the incremental GWh above and beyond the RPS.

- Targets translated into a percentage of *statewide* retail sales (to provide comparability)
- RPS states can be grouped into three sets
  - Legacy RPS programs with final targets of roughly 15-25% by 2015-2025
  - A sizeable contingent of states with higher RPS targets (≥50%) in the 2030 timeframe
  - States with similarly high targets but longer timeframes (2040-2050)
- Most of the states in the latter two groups, with relatively high RPS targets, have also adopted even higher, longer-term CES targets

Annual RPS & CES percentage targets by state available for download at: rps.lbl.gov

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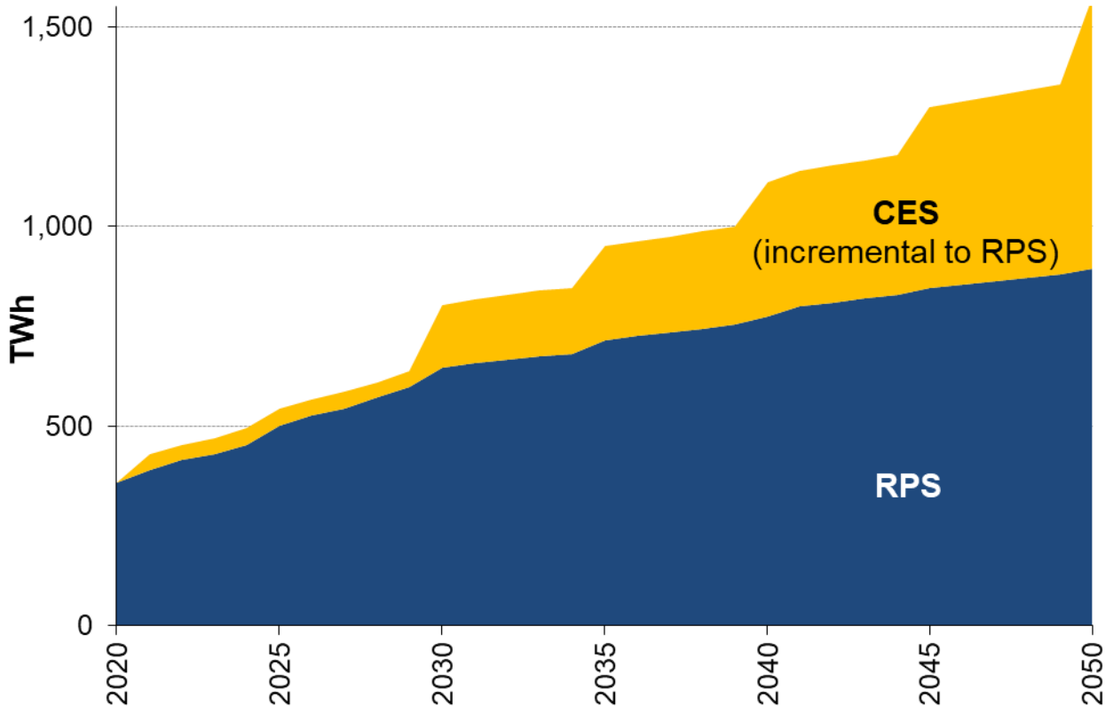
Aggregate U.S. RPS and CES Requirements

Grows over time with rising targets and load growth

Projected RPS + CES Demand



Notes: Projected RPS+CES demand is 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 regional growth rates from the most-recent EIA Annual Energy Outlook reference case.

- Aggregate RPS demand more than doubles from 400 TWh in 2023 to 900 TWh in 2050
- RPS demand growth tapers off after 2030, as most states reach their maximum target
- CES targets pick up that slack, adding more than 700 TWh of additional demand for clean electricity by 2050
  - Lumpy growth, reflecting staggered targets; corresponding supply growth likely smoother
  - A sizeable portion of CES demand may be met by existing nuclear and large hydro (see next slide)

State-level RPS & CES demand projections through 2050 available for download at: rps.lbl.gov

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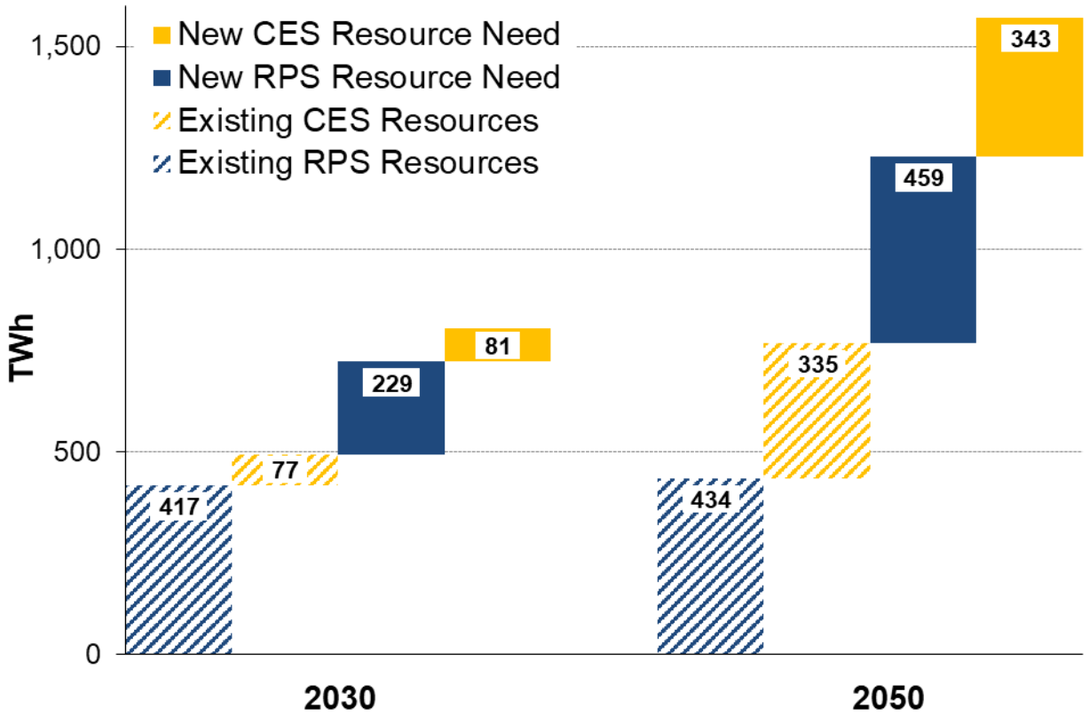
New Resources Needed to Meet RPS+CES Demand Growth

Existing vs. New Resource Contributions to RPS and CES Demand in 2030 and 2050



Notes: Existing Resources represent the potential contribution to future RPS and CES demand from resources in operation as of 2022, and include potential contribution from banked RECs. Existing CES resources consist almost entirely of existing nuclear and large hydro.

- RPS targets require roughly a 50% increase in RPS supply by 2030 and a doubling by 2050
- Roughly half of 2050 CES demand (incremental to RPS) can be met with existing nuclear and hydro
  - Actual long-term contribution will depend on re-licensing
- Two important factors not captured here:
  - Retirements of existing RPS and CES resources would increase new resource needs
  - New inter-regional transmission may reduce new resource needs for both RPS and CES

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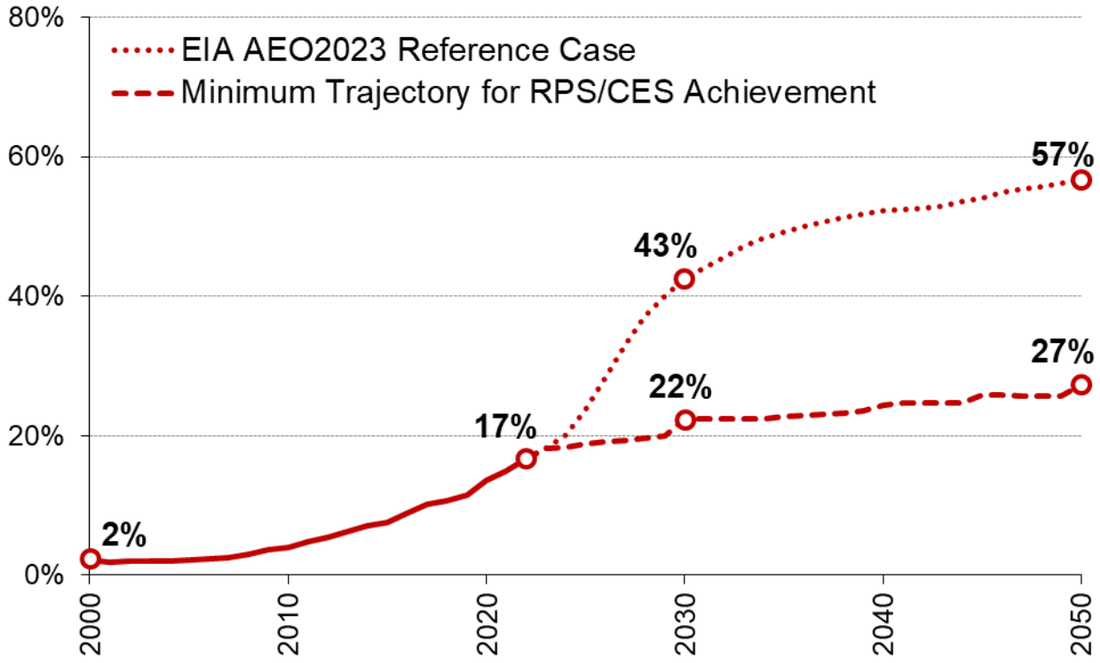
Growth in Non-Hydro RE for RPS and CES Targets

Compared to EIA-forecasted growth with IRA

Non-Hydro Renewable Generation
(% of U.S. Generation Mix)



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

- To meet future state RPS and CES targets, U.S. non-hydro renewables will need to reach 22% of the U.S. generation mix by 2030, 27% by 2050
  - Assumes all new RPS and CES supply consists of non-hydro RE
- Represents roughly one-quarter of EIA's total forecasted growth in non-hydro RE
  - EIA reference case includes IRA and BIL
  - Rapid growth during ITC/PTC availability through 2032, followed by slower growth out to 2050
- Suggests a somewhat diminished role for state RPS/CES policies relative to historical trends
  - Though in some parts of the country, RPS and CES targets will continue to play a larger role

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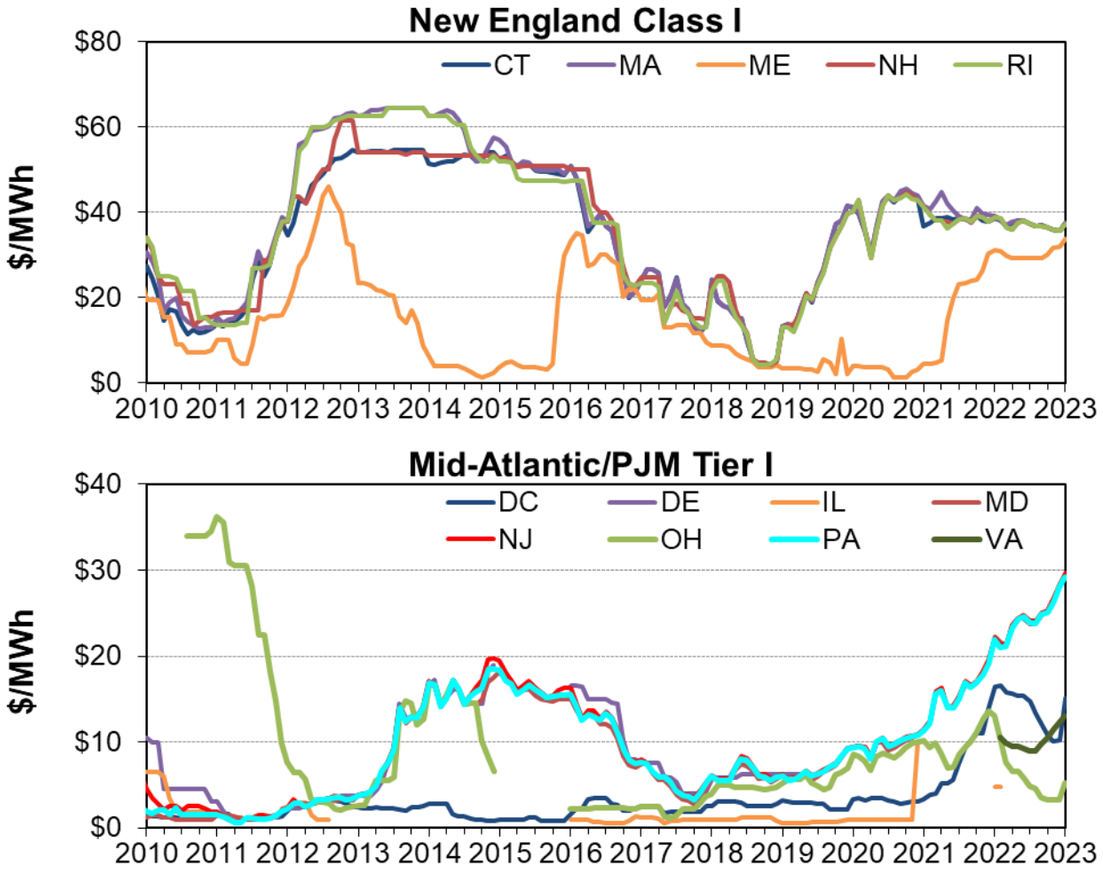
REC Pricing and RPS Compliance Costs

REC Pricing Trends for Primary Tier RPS Obligations

Prices in 2022 have remained high in New England, continued rising in PJM



Source: Marex Spectron. Plotted values are the mid-point of monthly average bid and offer prices for the current or nearest future compliance year traded in each month.

New England:

- Pricing relatively stable over the past few years, below ACPs
- Maine prices were historically lower, due to broader biomass eligibility, but rising as new RE tier (Class IA) ramps up

Mid-Atlantic/PJM:

- Bifurcated market based on geographic eligibility rules (more restrictive rules & higher prices in NJ-PA-MD-DE)
- Prices rising steadily as regional RPS targets grow faster than new supply

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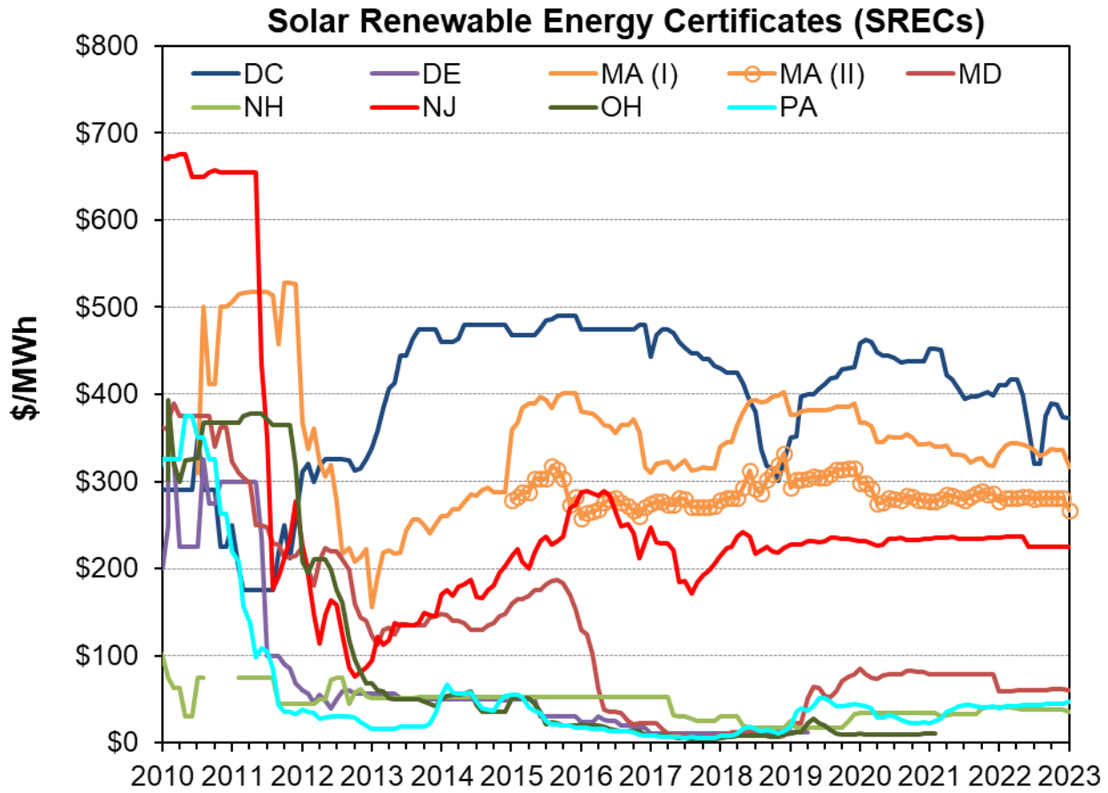
SREC Pricing Trends for RPS Solar Carve-Outs

Prices in most states remained flat through 2022



Source: Marex Spectron. Plotted values are the mid-point of monthly average bid and offer prices for the current or nearest future compliance year traded in each month.

- DC: Prices gradually falling as supply finally catches up with demand, though still quite high
- MA: Price movements in legacy SREC I and II programs bounded by clearinghouse floor and SACP
- NJ: Pricing for legacy carve-out remained stable as state transitioned to successor program
- MD: Prices rose in 2019 after higher targets enacted, but have since remained stable
- DE and PA heavily oversupplied, in part due to eligibility of out-of-state projects
- NH: Low solar ACP (~$60/MWh)

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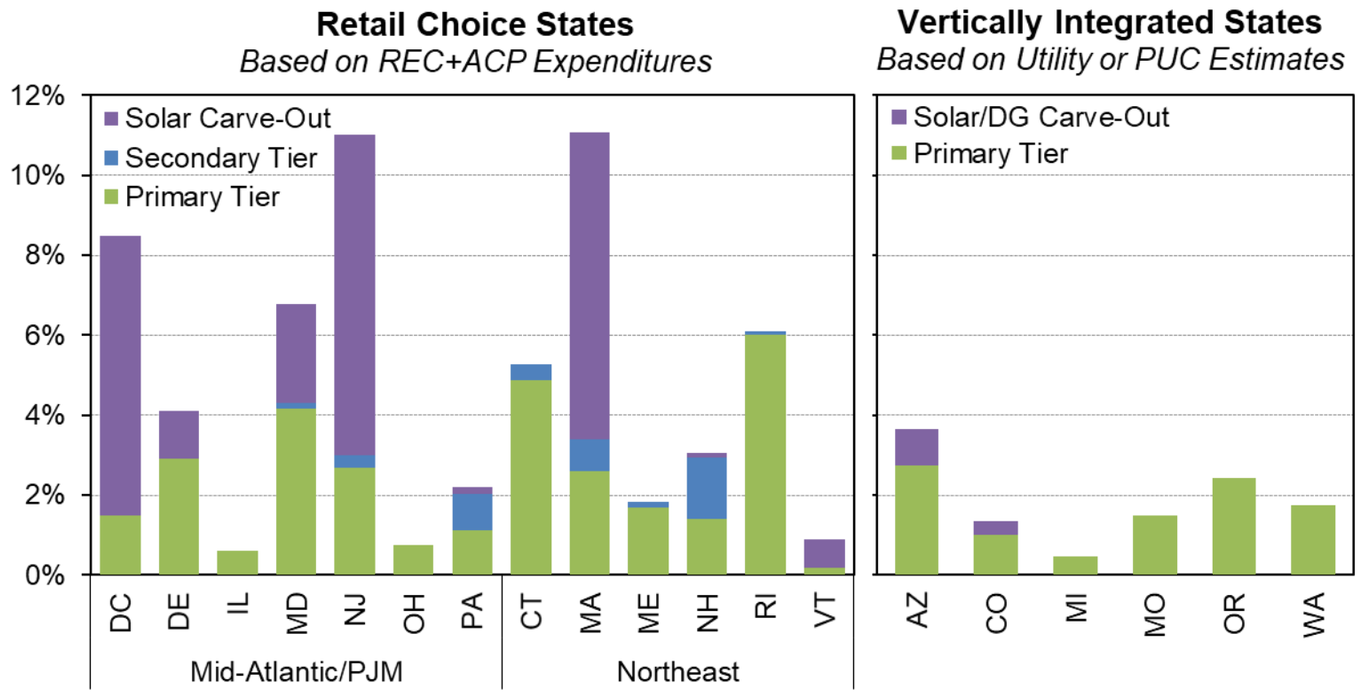
RPS Compliance Costs Average ~4% of Customer Bills but Vary Widely

RPS Compliance Costs for Most-Recent Available Year
(Percentage of Average Retail Electricity Bill)



Notes: Data for most states are based on either the 2021 or 2022 compliance year. For retail choice states, RPS compliance cost estimates are based, whenever possible, on the average cost of all RECs retired for compliance, including both spot market purchases and long-term contracts. For MA, the solar carve-out includes SREC I and SREC II, and the Primary Tier includes the residual Class I requirement plus the CES. Solar carve-out costs for IL, MO and OR are included in the Primary Tier costs.

- Highest compliance costs are driven by solar carve-outs in states with high SREC prices
- Primary-tier costs generally rising as a result of increasing targets and, in Mid-Atlantic, rising REC prices
- Secondary-tier costs are generally a marginal contributor, due to low REC prices, though several states are seeing costs on the order of 1% of customer bills
- Compliance costs in vertically integrated states are generally lower than in retail choice states, reflecting reliance on bundled PPAs
- Cost difference in retail choice states also reflect varying degrees of reliance on long-term PPAs and procurement program structures

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Outlook

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

- Whether additional states decide to increase and extend RPS targets and/or adopt broader “clean electricity” mandates
- What kinds of implementation and enforcement mechanisms are ultimately established to meet longer-term CES targets
- Efficacy of IRA and BIL in stimulating new clean electricity supplies and transmission
- Complementary efforts to address RE integration and interconnection issues
- Other ongoing RPS policy refinements (e.g., long-term contracting programs, ACP rates, REC banking rules, eligibility rules, etc.)
- RE cost and REC price trajectories, and the attendant impacts on RPS compliance costs

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For more information

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Acknowledgements

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RPS and CES Legislation in 2022 and Q1 2023

RPS & CES Related Bills since Jan. 2022

	Strengthen	Weaken	Neutral	Total
Introduced	**63**	**32**	**55**	**150**
Enacted	**4**	**0**	**13**	**17**

Data Source: *EQ Research (March 22, 2023) and Berkeley Lab*
Notes: *Companion bills counted as a single bill*

- Most proposals sought to strengthen or make neutral/technical changes to existing programs, a small fraction of which were ultimately enacted
- Among those bills signed into law are 3 states that either raised their RPS to 100% or created a new 100% CES (see text box to the right)
- Other enacted revisions were all relatively minor or only peripherally related to RPS/CES

Major revisions enacted:

- **CT:** Created a new CES targeting 100% zero-carbon electricity by 2040
- **HI:** Revised RPS to be based on a percentage of total generation, rather than a percentage of retail sales (thus effectively raising the target)
- **MN:** Established new 100% CES by 2040 and increased RPS to 55% by 2035
- **RI:** Increased RPS to 100% by 2033

* *Focus here is on legislation involving RPS and CES; other types of policy revisions not included*

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General Trends in RPS Revisions

Increasing and extending RPS targets: More than half of all RPS states have raised their overall RPS target or carve-out one or more times since initial RPS adoption; many in recent years

Embedding RPS within broader clean electricity standards: Several states have created 100% zero-carbon electricity targets or targets for other zero-emission resources, in concert with the RPS

Addressing valuation and integration issues: Several states have created separate energy storage targets or "clean peak" standards in tandem with an RPS, in order to address RE integration issues

Developing carve-outs to support specific technologies/applications: Emphasis initially on solar and DG, but some states have phased those out; recent focus on offshore wind, storage, low-income

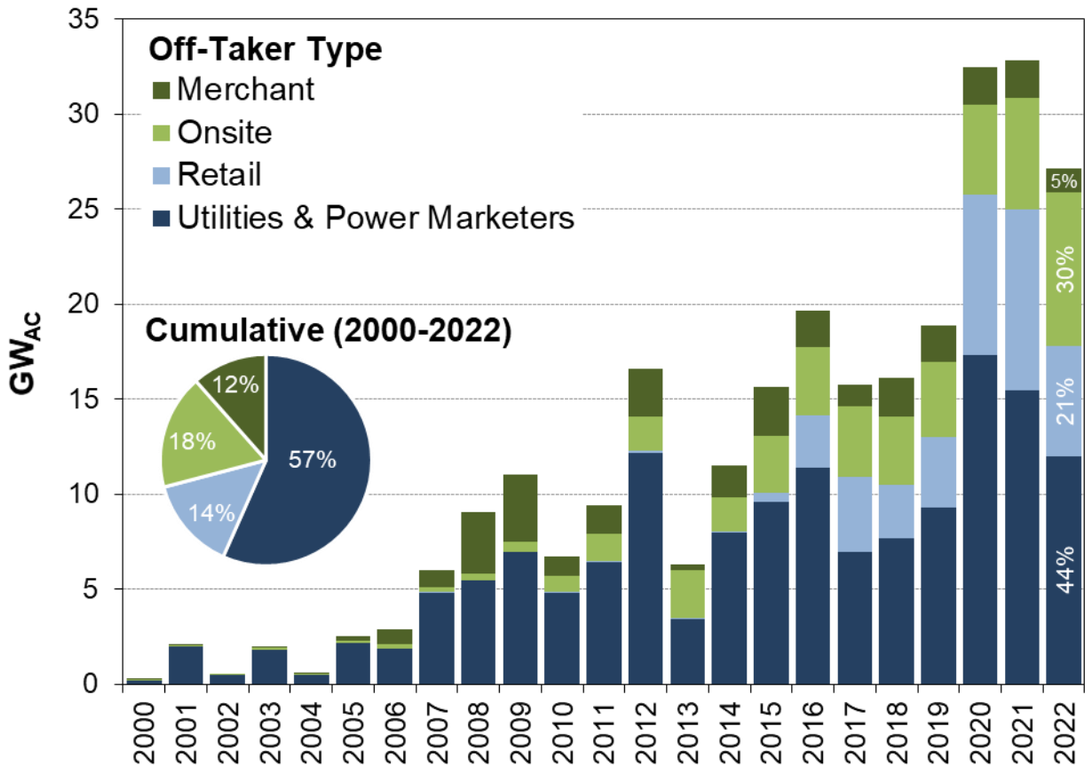
Long-term contracting programs: Often aimed at regulated distribution utilities in competitive retail markets; have sometimes targeted specific types of resources (solar/DG, offshore wind)

Adjusting alternative compliance payment (ACP) rates and cost caps: Both increases and decreases, as states seek to achieve compliance at least-cost

Refining resource eligibility rules: Most recently for energy storage, and also for hydro and biomass (e.g., related to project size, vintage, eligible feedstock, repowered facilities)

Most Renewable Capacity is Sold to Utilities & Power Marketers, but Retail & Onsite Projects Are a Growing Share

Annual Renewable Capacity Additions



Sources: LBNL, ABB Ventyx, EIA, American Clean Power Association

- Utilities and power marketers (load-serving entities) continue to represent the largest class of off-takers for new renewable capacity (44% in 2022, 57% cumulatively)
- Retail off-takers (corporate PPAs and community solar), have become more prominent in recent years, though their share dipped in 2022 to 21% of capacity additions
- Onsite projects have seen slow but steady growth in recent years, but surged to 30% of RE adds in 2022 (the only category that grew last year)
- Merchant sales have a long history but are presently a small share of new RE additions (5% in 2022)

Definitions: **Utilities & Power Marketer** projects are those where the power is sold to or owned by utilities or competitive retail electricity suppliers. **Retail** projects are those where the power is sold to specific end-use customers through either corporate PPAs or community solar arrangements. **Onsite** projects are those installed at customer facilities and used to directly serve onsite load (i.e., behind-the-meter). **Merchant** projects are those where the power is sold into wholesale spot markets.

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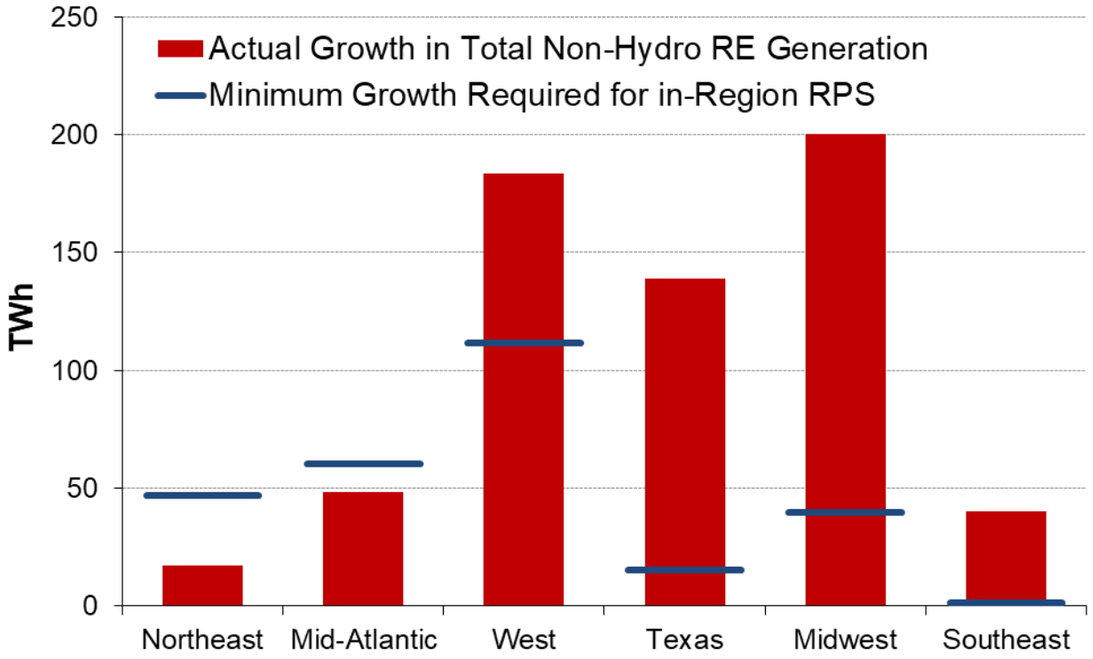
RPS & CES Role in Driving RE Growth Varies by Region

Most critical in the Northeast and Mid-Atlantic; less so in other regions

Growth in Non-Hydro Renewable Generation: 2000-2022



Notes: Northeast consists of New England states plus New York. Mid-Atlantic consists of states that are primarily within PJM, in terms of load served. The comparisons shown here should be not interpreted as indicative of compliance levels; see later sections of the report for data on historical compliance levels by state.

Northeast and Mid-Atlantic: RPS needs have outpaced actual in-region RE growth (deficit partly met by imports), suggesting that RPS demand has been a key driver of non-hydro RE growth

West: Actual RE growth has exceeded RPS requirements, partly due to net metered PV (33 TWh, most of which is not used for RPS)

Texas and the Midwest: RE growth has far outpaced RPS needs, driven by attractive wind energy economics

Southeast: Negligible regional RPS demand (NC), though some RE growth serves RPS demand in PJM

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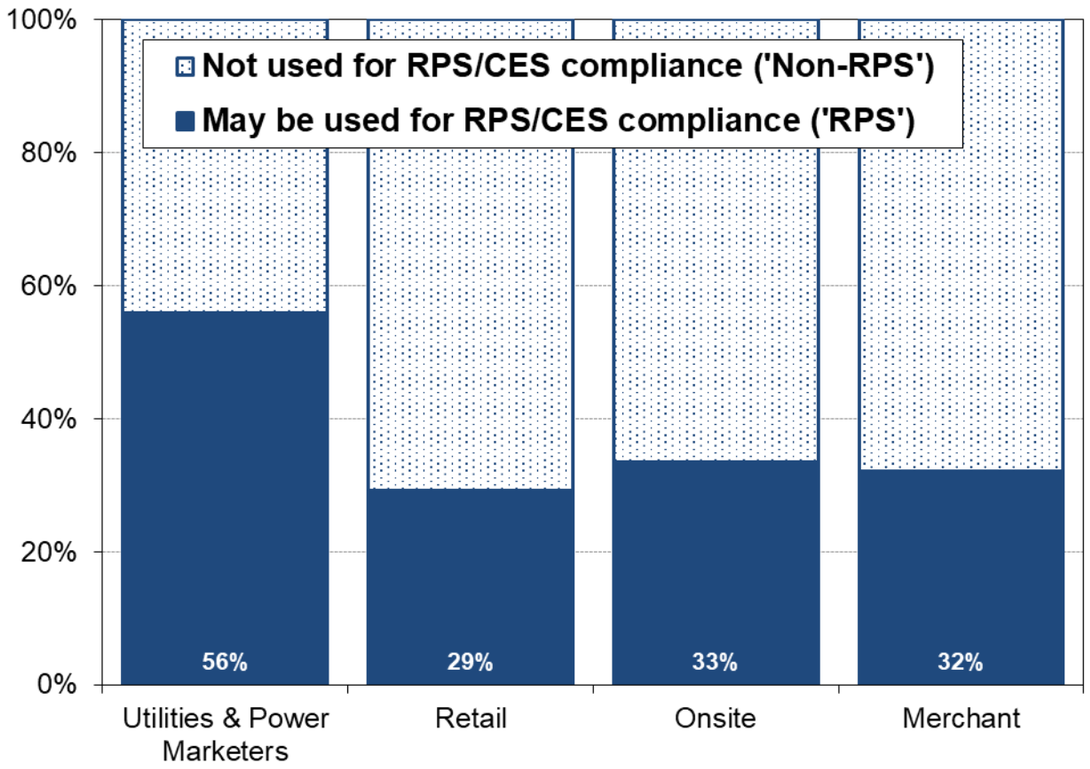
Within Each Class of Off-takers, a Portion of RE Capacity Additions Is—or May Be—Used for RPS/CES Compliance

Percent of Cumulative Renewable Capacity Additions by Off-Taker (2000-2022)



Notes: Going forward, we use the shorthand "RPS" and "Non-RPS" to refer to the categorization shown here, based on the decision-rules explained to the right.

The criteria for assessing whether a project may be used for RPS compliance depend on the off-taker type and region:

- **Utilities & Power Marketers:** Roughly **56%** of RE capacity additions since 2000 is owned by or contracted to load serving entities with active RPS or CES compliance obligations
- **Retail:** Roughly **29%** of capacity additions has been certified for RPS eligibility in one or more state, meaning that the RECs *could* be re-sold for RPS compliance (and potentially "swapped out" with cheaper voluntary-market RECs)
- **Onsite:** Roughly **33%** of capacity adds (almost all DG PV) is either being claimed by a utility for RPS compliance (typically through an incentive program) or is RPS-certified in one or more state and thus potentially selling its SRECs for RPS needs
- **Merchant:** Roughly **32%** of capacity additions has been certified for RPS compliance in PJM or ISO-NE, or was developed in Texas during the period when the state's RPS was binding

These percentages represent upper bounds on the portion of new RE capacity actually being applied toward RPS compliance

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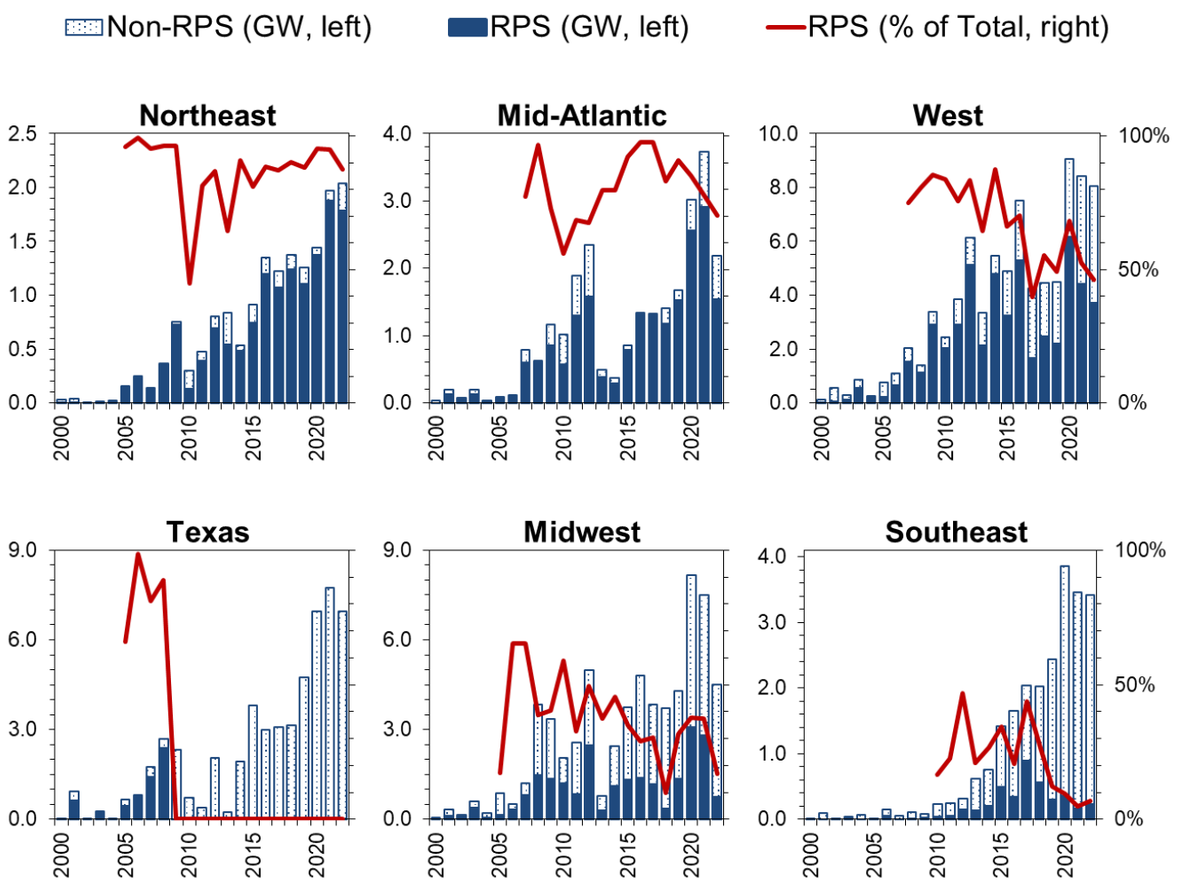
RPS Policies Remain Central to RE Growth in Particular Regions

Recent RE additions in Northeast and Mid-Atlantic primarily serve RPS demand



Notes: See previous slide for regional definitions and further details on the criteria for sorting RE capacity additions into RPS and Non-RPS categories.

RPS policies have been a ***larger*** driver in…

- **Northeast:** Relatively small market, but almost all RE capacity additions serving RPS demand, consisting mostly of onsite and community solar in recent years
- **Mid-Atlantic:** Mostly solar carve-out capacity and corporate PPAs with RPS-certified projects potentially selling RECs into compliance markets
- **West:** RPS additions driven by aggressive long-term RPS and CES targets throughout the region; non-RPS additions are mostly onsite solar

But have been a ***smaller*** driver in…

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

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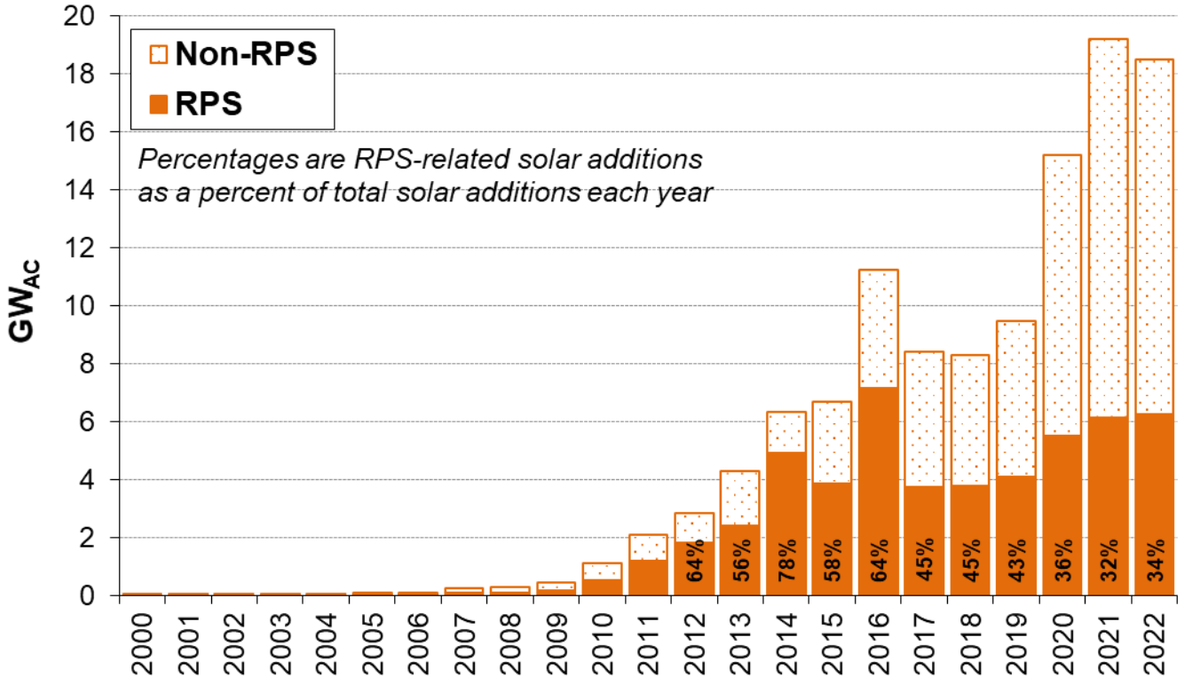
RPS' Have Had Greater Role in Driving Growth of Solar than Wind

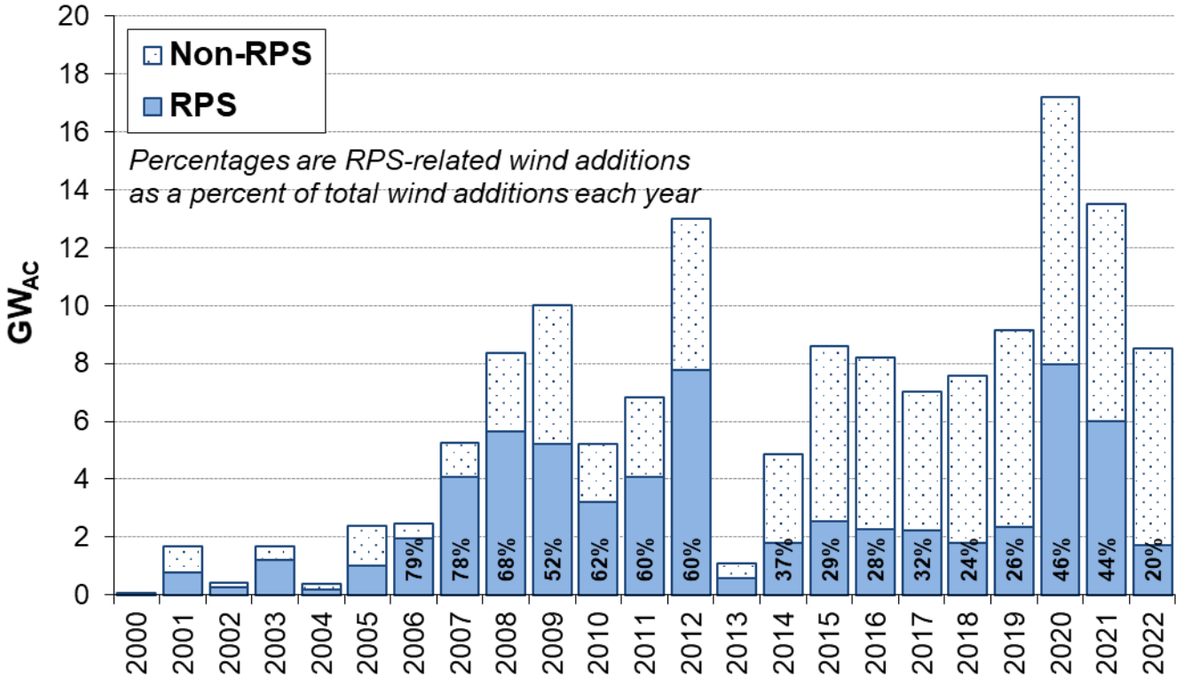
Though recent growth for both technologies has mostly occurred outside of RPS'

- RPS policies have historically been a larger driver for solar, compared to wind, due to solar's higher cost and the existence of RPS solar carve-outs, as well as the geographical distribution of RPS policies, which coincide well with solar-rich regions
- This trend inverted in 2020/2021, partly due to a large influx of wind capacity additions in the West serving utilities with expanded RPS or CES requirements

Solar Capacity Additions



Wind Capacity Additions



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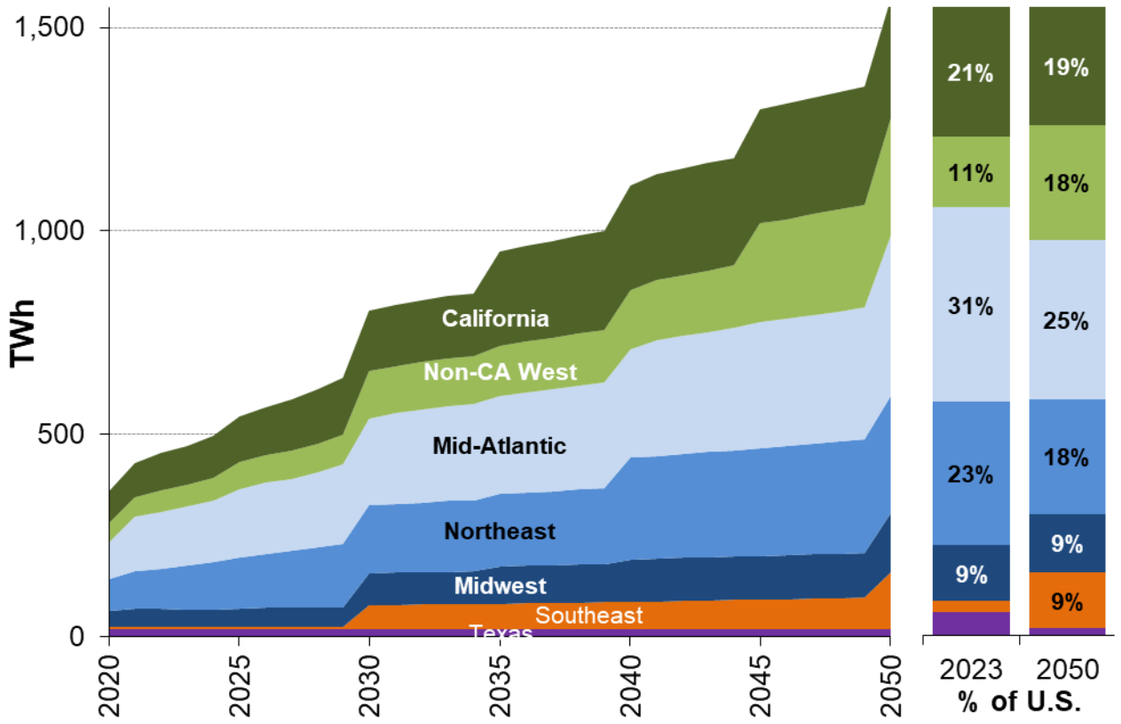
RPS + CES Demand by Region

Projected RPS + CES Demand



Notes: See notes on figure construction from previous slide. Northeast consists of New England states plus New York. Mid-Atlantic consists of states that are primarily within PJM, in terms of load served.

- RPS + CES demand growth occurs across virtually all regions
- Regional distribution in 2050 demand resembles today, with a few notable exceptions:
  - A shift towards the West (38% of total U.S. RPS+CES demand in 2050 vs. 29% today), as 100% CES targets come into force throughout the region
  - The Southeast emerges as a more significant share of the national total, as a result of NC's 100% CES
- Five states (CA, NY, NC, IL, VA) make up more than half of U.S. RPS+CES demand in 2050

How much new clean energy supply is needed to meet RPS and CES demand growth?

Requires that we account for:

- Quantity of RPS and CES supplies
- The eligibility and availability of existing supplies for meeting state RPS and CES demand
- REC banking, per each state's rules
- Extent of REC trading, especially in regulated states

For regulated states: estimated on a utility-specific basis, based on each utility's RPS procurement and REC bank as of year-end 2022

For restructured states: estimated regionally, based on the pool of RPS-certified resources registered in the regional REC tracking system, considering state-level differences in resource eligibility rules

REC Pricing Fundamentals

- Spot-market prices a function of current and expected future supply-demand balance and ACP rates
  - Can be volatile and sensitive to changes in eligibility rules
- Regional markets (e.g., in New England and Mid-Atlantic) form based on common pools of eligible REC supplies
  - States in those regions with looser eligibility rules have lower prices
- Solar REC (SREC) pricing is highly state-specific due to *de facto* in-state requirements in most states
- The key driver for RPS compliance costs in states that rely heavily on unbundled RECs

RPS Compliance Costs

Definition, data sources, and limitations

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

Can be measured in terms of different metrics; we summarize costs primarily in terms of a percentage of average retail electricity bills in each RPS state

Retail Choice States

- RPS compliance primarily via unbundled RECs
- We estimate RPS compliance costs based on REC plus ACP expenditures
- Rely wherever possible on PUC-published data on actual REC costs; otherwise use broker spot market prices

Vertically Integrated States

- RPS compliance primarily via bundled PPAs
- We synthesize available utility and PUC compliance cost estimates, which rely on varying methods
- PUCs/utilities impute compliance costs by comparing gross RPS procurement costs to a counterfactual (e.g., market prices or avoided cost projection)

***Key Limitation:** The underlying data and methods used here represent only a partial accounting of the full suite of costs and benefits associated with RPS policies, and are available for only a limited subset of vertically integrated states