# Innovative US energy policy: a review of states' policy experiences

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Since the early 1990s, US energy policy has been driven by state governments. States have adopted a variety of innovative policy instruments to diversify, decarbonize, and decentralize their electricity markets. Because states are still active energy policy leaders, and are continually adopting new or revising existing policies, there is great need for continual evaluation of the effects, effectiveness, challenges, and opportunities associated with these different policy instruments. This analysis synthesizes the findings in the literature to date and provides a summary of both the policy landscapes and the effects associated with some of the leading energy policies, including the renewable portfolio standard, the energy efficiency resource standard, net metering, and interconnection standards. © 2012 John Wiley & Sons, Ltd.

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## INTRODUCTION

The US electricity sector relies predominately upon large-scale, centralized fossil fuel power plants, with limited generation from smaller-scale or lower-carbon energy sources. Because of this electricity mix, the sector produces a significant amount of greenhouse gas (GHG) emissions—30% of all US GHG emissions are attributable to the sector[1]—and, thus, is a major contributor to anthropogenic climate change. The sector also contributes to local and regional air pollution[2] and energy insecurity,[3,4] among other environmental, economic, and social problems.

In recent years, concerns about these and related issues have caused energy policy to rise in perceived importance in the public policy domain. Despite the national prominence of the issue, US energy policy and, specifically, policy focused on the electricity sector, has developed predominantly at the state level.[5–7] In the absence of any comprehensive national legislation over the past two decades focused on electricity sector generation or emissions, state governments have assumed strong leadership roles in energy policy. During this era of state energy policy innovation, state governments have adopted a variety of different policies aimed at diversifying the mix of generation sources with a greater percentage of renewable energy, reducing the carbon intensity of the sector, and increasing the use of smaller and more localized generation units. These three objectives—diversification, decarbonization, and decentralization—have increasingly guided state energy policy since the mid-1990s.

Policy instruments designed to achieve one or more of these objectives include but are not limited to the renewable portfolio standard (RPS), net metering and interconnection standards, various tax incentives, the energy efficiency resource standard (EERS), and energy public benefit funds (PBFs). RPSs mandate that a state's utilities must provide a specific amount or percentage of total energy from alternative energy sources by a specific year (e.g., 20% renewable energy by 2025). Net metering and interconnection standards provide electricity customers that own their own generation units access to the electric grid and outline rules and procedures for connecting these distributed systems to the grid. Tax incentives provide financial support for renewable energy or energy efficiency systems, generally as a percentage of total upfront costs. EERSs require that utilities improve the operating efficiencies of their infrastructure and also promote programs that help electricity customers reduce consumption; these standards are translated as specific energy savings mandates over time. PBFs, also referred to as system benefit charges, are collected via

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small surcharges on end-users' electricity bills, and used to support investments in energy efficiency, renewable energy, or research and development.

The adoption of these different policies among US states is becoming increasingly common, although the current landscape exhibits a diverse patchwork of different policies across space. Currently, 29 states and the District of Columbia have some form of RPS and an additional 8 states have voluntary RPS policies. A total of 47 states and District of Columbia have either net metering or interconnection standards, or both; and 20 states have an EERS with an additional 6 that have a voluntary standard.[8] The designs of these policy instruments also demonstrate significant variation across states. States choose among a vast menu of different policy design features to tailor specific policy goals and standards to their own circumstances. Table 1 presents a detailed state inventory of policy portfolios and instrument design features, and demonstrates this immense variation in policy adoption and design across states.

Throughout the era of state energy policy innovation, the energy policy literature has developed along with states' experiences with these policies. Early evaluations focused on the effects of more basic forms of these various policy instruments; as states have developed more sophisticated policy variations and as the number of these policies has increased, so too has the literature evolved toward increasing sophistication of analysis and prevalence of studies.

Particularly given that states are still active energy policy leaders, and are continually adopting new or revising existing policies, there is great need for evaluation of the effects, effectiveness, challenges, and opportunities associated with these different policy instruments. This analysis therefore seeks to synthesize major findings in the literature and to provide a summary of both the policy landscapes and the effects associated with some of the leading energy policies, both in their elementary and more nuanced forms. This study evaluates in depth four state-level energy policies that are representative of the larger suite of state energy policies highlighted above: the RPS, the EERS, net metering, and the interconnection standard. The disproportionate share of attention, however, is focused on the RPS policy, as this policy instrument is more extensively studied than other policies due to the popularity and prevalence of the policy among states, and the availability of data that allow analysts to measure policy outcomes. Each of the following sections outlines the current understanding about these policies, with an overview of the policy landscape, effectiveness, and other important policy effect considerations revealed in the associated literature to date. Following this discussion, we also provide a brief overview of other policy actions most commonly pursued by states, including tax incentives, PBFs, and institutional reforms. The review concludes with a brief summary of general trends and opportunities for further research.

## RENEWABLE PORTFOLIO STANDARDS

### Policy Landscape

The RPS was initially introduced in Iowa in 1983 but gained popularity especially within the last 15 years.[8] As of 2011, over half of all US retail electricity sales are affected by state RPS programs.[9] Figure 1 displays the RPS policy landscape in the United States as of early 2012, where states in red have a mandatory policy standard and states in yellow have a voluntary policy goal. As this map reveals, the majority of states have an RPS with the exception of most southeastern states.

The RPS mandates that a state's energy portfolio include a minimum level of electricity generated from renewable sources by a particular date; however, individual RPS policies have many different design features. Targets are designated either by portfolio percentage or level of energy or power output, and are generally designed to achieve desired environmental benefits with minimal effect on electricity prices.[10] Most states allow utilities to comply at least partially with their RPS mandates through the purchase and exchange of renewable energy credits (RECs) or certificates, which represent 1 MWh of renewable generation. Some states only allow for in-state REC transactions, whereas others allow utilities to buy RECs from independent power producers located out of state. Electricity retailers, therefore, can meet their RPS obligations by generating their own renewable energy, by purchasing RECs from other power generators either in or out of state, or through a combination of both.[11]

Some states allow for extra or multiplied credits from solar and distributed generation (DG) systems (e.g., one REC of solar energy is equivalent to two RECs from wind energy) and others include explicit 'carve-outs' or 'set-asides' for technologies that are less favored by a traditional, technology-neutral RPS. A carve-out is a mandate for a specific technology. For example, Arizona requires that 4.5% of its electricity comes from DG units and Delaware mandates that 3.5% of its electricity is sourced by solar energy.[8]

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**TABLE 1** | Policy Instruments Adopted by State (as of March 2012)

| State | RPS | RPS Nuances | EERS | EERS Nuances | Net Metering | Net Metering Nuances | Interconnection Standards | Interconnection Standard Nuances |
|---|---|---|---|---|---|---|---|---|
| Alabama | | | | | | | | |
| Alaska | | | | | P | Σ | IPG | Φ |
| Arizona | RPS | * | ES | | P | Σ,∞ | | |
| Arkansas | | | EG | ψ | P | | IPG | Φ |
| California | RPS | | ES | ψ | P | Σ | IPS | ∞ |
| Colorado | RPS | *,☼,† | ES | ψ | P | ∞,β | IPS | |
| Connecticut | RPS | | ES | | P | Σ | IPS | |
| Delaware | RPS | *,☼ | ES | ψ | P | β | IPG | Φ |
| Florida | | | ES | | P | | IPS | Φ |
| Georgia | | | | | P | | IPG | |
| Hawaii | RPS | | ES | ψ | P | Σ | IPS | ∞ |
| Idaho | | | | | V | | | |
| Illinois | RPS | * | ES | ψ | P | Σ | IPS | ∞ |
| Indiana | G | # | ES | | P | Σ | IPS | ∞ |
| Iowa | Q | | ES | ψ | P | Σ | IPS | |
| Kansas | RPS | | | | P | Σ | IPG | ∞ |
| Kentucky | | | | | P | Σ | IPS | Φ |
| Louisiana | | | | | P | | IPG | Φ |
| Maine | RPS | ‡ | EG | ψ | P | β | IPS | ∞ |
| Maryland | RPS | * | ES | | P | | IPS | |
| Massachusetts | RPS | *,‡ | ES | ψ | P | Σ | IPS | ∞ |
| Michigan | RPS, Q | ☼ | ES | ψ | P | Σ | IPS | ∞ |
| Minnesota | RPS | † | ES | ψ | P | | IPS | |
| Mississippi | | | | | | | | |
| Missouri | RPS | * | | | P | | IPG | Φ |
| Montana | RPS | | | | P | Σ | IPG | Φ |
| Nebraska | | | | | P | | IPG | Φ |
| Nevada | RPS | *,☼ | | | P | Σ | IPS | |
| New Hampshire | RPS | * | | | P | | IPS | Φ |
| New Jersey | RPS | * | | | P | Σ,∞ | IPS | ∞ |
| New Mexico | RPS | *,† | ES | | P | Σ | IPS | |
| New York | RPS | * | ES | ψ | P | Σ | IPS | |
| North Carolina | RPS | *,† | | | P | Σ | IPS | ∞ |
| North Dakota | G | | | | P | Σ | | |
| Ohio | RPS | *,# | ES | | P | Σ,∞ | IPS | |
| Oklahoma | G | | | | P | Σ | | |
| Oregon | RPS | *,☼,† | | | P | Σ,β | IPS | |
| Pennsylvania | RPS | *, # | ES | | P | Σ | IPS | Φ |
| Rhode Island | RPS | | ES | ψ | P | Σ | IPS | ∞ |
| South Carolina | | | | | V | | IPG | |
| South Dakota | G | | | | | | IPS | |
| Tennessee | | | | | | | | |
| Texas | Q | ☼ | EG | | V | | IPS | |
| Utah | G | ☼ | | | P | Σ | IPS | |
| Vermont | G | | EG | | P | | IPS | ∞ |
| Virginia | G | ☼ | EG | | P | Σ | IPS | |
| Washington | RPS | ☼ | ES | | P | | IPS | |
| West Virginia | G | ☼, # | | | P | | IPS | |
| Wisconsin | RPS | † | ES | ψ | P | Σ | IPS | |
| Wyoming | | | | | P | Σ | IPG | Φ |
| District of Columbia | RPS | * | | | P | | IPS | |

*Source*: North Carolina Solar Center (2012).

Renewable portfolio standard (RPS) indicates RPS% standard; Q, RPS quantity standard; G, RPS% goal; *, RPS solar or distributed generation carve-out; ☼, RPS solar, nonwind, or renewable distributed generation credit multiplier; #, RPS allows for nonrenewable alternative sources; †, RPS includes variation in standard or goal among utilities; ‡, RPS includes separate provision for new renewable sources; ES, energy efficiency resource standard (EERS) standard; EG, EERS goal; ψ, EERS includes natural gas savings requirement or goal; P, net metering state policy; V, net metering voluntary utility programs; Σ, net metering state policy only applies to certain utility types (e.g., investor-owned utilities); β, net metering state policy includes different capacity limits for co-ops and municipalities; ∞, net metering or interconnection state policy does *not* include individual system capacity limit; IPS, interconnection policy is a state standard; IPG, interconnection policy is a state guideline; Φ, interconnection standard or guideline only applies to net-metered systems.

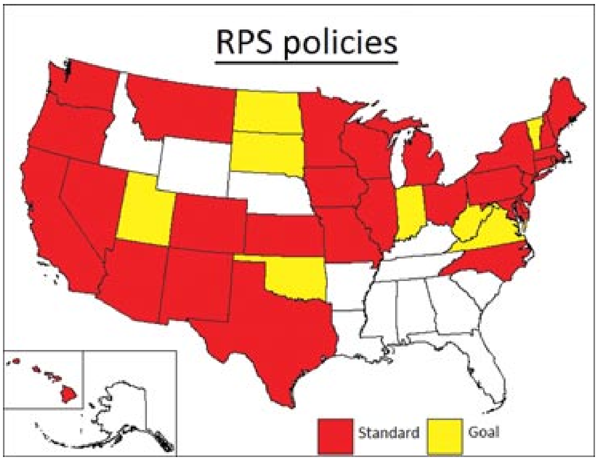


**FIGURE 1** | Renewable portfolio standard policy adoption among US states. Twenty-nine states, plus Washington D.C. and Puerto Rico, have adopted some type of renewable portfolio standard. Eight states have enacted renewable portfolio goals. (Created using data from the North Carolina Solar Center.)

A growing number of state RPS programs have specific provisions for solar and DG. More than half of the 29 binding-state RPS policies require a prescribed portion of credited renewable energy to come from either solar or DG. Other less common carve-outs have been developed for combined heat and power, waste energy, biomass, geothermal, and animal waste products.[8] Table 2 outlines RPS targets, technology carve-outs, and credit multipliers for states with binding and voluntary RPS policies, and demonstrates the significant variation in the design of this policy across states.

There are several other design features that vary across states, including but not limited to which resources are eligible, or whether states apply penalties for noncompliance, offer alternative compliance payments, or cap costs. State programs identify explicitly energy sources that satisfy RPS mandates, such as wind, solar, biomass, and other sources. Most states only include renewable energy sources in this eligibility list but others also include energy efficiency. Ohio, Pennsylvania, and West Virginia also give credit to alternative energy sources that are not renewable, such as natural gas or clean coal. As shown in Table 2, however, these three states mandate either a minimum percentage of renewable energy or a maximum percentage of natural gas in addition to an overall alternative energy requirement. Some states require that utilities pay penalty fees if they do not achieve their annual RPS benchmarks; some states also allow utilities to pay an alternative compliance payment, which is generally set above the market value of RECs, to satisfy RPS benchmarks. To contain compliance costs and electricity rates, some states include as a part of their RPS instrument a cost-capping mechanism. In some cases, these mechanisms protect customers directly, dictating that utilities are no longer responsible for increasing renewable generation once prescribed electricity rate limits are reached.[12,13] Berry and Jaccard[10] note that some states cap individual REC prices (e.g., at 1.5 cents per kWh). In other states, regulated utilities are only required to spend a certain percentage of their annual retail revenue requirement in meeting RPS compliance standards; utilities in these states are in compliance if they meet revenue percentage targets even if annual RPS targets remain out of reach.[13]

Before assessing RPS effectiveness, it is important to understand why states adopt this policy. In fact, some scholars have argued that any evaluation of efficacy must first take into account the policymaking context, economic and social conditions, and natural resource endowments that inform the initial adoption of these policies.[14] Although evaluating these contexts for each state is beyond the scope of this analysis, it is useful to identify some common factors that influence RPS development.

There are many explanations as to why RPS polices have been so widely adopted. There are arguments for both intra- and interstate factors that influence RPS adoption but some have found that policy diffusion between states is less significant than internal state policy drivers.[15] For example, intrastate environmental features influence energy policy development and help to explain, at least in part, RPS adoption. Some researchers have noted the important role of local air pollution.[15,16] In addition, as wind generation is currently the least costly renewable option, wind power potential may have some influence on whether states adopt an RPS,[15–17] especially when the state also faces significant electricity demand growth.[18,19] Delmas and Montes-Sancho[14] note more generally that a state's natural resource endowment positively explains RPS adoption. In some cases, producers, supporters, and beneficiaries of local renewable energy have influenced the policy process through formal representation in state legislatures.[6,16]

Empirical analyses have identified several other local influences as well. Economic and political factors such as gross state product per capita,[16,20,21] state legislature partisanship and ideology,[16,22,23] and state-level citizenship ideology[15,21,22,24] all affect RPS adoption. Government ideology affects the adoption of more stringent RPS policies, whereas citizen ideology affects the adoption of less stringent and voluntary policies.[22] The RPS policy is also a popular

**TABLE 2** | Renewable Portfolio Standards Targets, Carve-outs, and Credit Multipliers by State

| State | Portfolio Target | Portfolio Target Date | Carve-Outs | Credit Multipliers |
|---|---|---|---|---|
| Arizona | 15% | 2025 | 4.5% from DG | – |
| California | 33% | 2020 | – | – |
| Colorado | 30% (IOUs); 10% (Co-ops, municipalities) | 2020 | 3.0% from DG (IOUs) | 300% solar (Co-ops, municipalities) |
| Connecticut | 27% | 2020 | 4% CHP by 2010 | |
| Delaware | 25% | 2025 | 3.5% solar | 300% solar (before 2015); 150% wind (before 2013); 350% offshore wind (before 2018) |
| Hawaii | 40% | 2030 | – | – |
| Illinois | 25% | 2025 | 1.5% solar; 18.75% wind; 0.25% DG | – |
| Indiana[1] | 10% | 2025 | – | – |
| Iowa | 105 MW | 2025 | – | – |
| Kansas | 20% | 2020 | – | – |
| Maine | 40% | 2017 | 10% new sources | – |
| Maryland | 20% | 2022 | 2% solar | – |
| Massachusetts | 15% (new sources); 7.1% (existing sources) | 2020 (new); 2009 (existing) | 400 MW solar; 3.5% waste energy by 2009 | – |
| Michigan | 10%; 1100 MW | 2015 | – | 300% solar |
| Minnesota | 25%; 30% (Xcel Energy) | 2025; 2020 (Xcel Energy) | 25% wind (Xcel Energy) | – |
| Missouri | 15% | 2021 | 0.3% solar | – |
| Montana | 15% | 2015 | – | – |
| Nevada | 25% | 2025 | 1.5% solar | 240% solar; 105% DG |
| New Hampshire | 23.80% | 2025 | 16% new sources; 0.3% solar by 2014 | – |
| New Jersey | 22.50% | 2021 | 2518 GWh solar; 5316 GWh solar by 2026 | – |
| New Mexico | 20% (IOUs); 10% (Co-ops) | 2020 | 4% wind; 4% solar; 2% geothermal, biomass, hydro; 0.6% DG | – |
| New York | 29% | 2015 | 0.41% DG | – |
| North Carolina | 12.5% (IOUs); 10% (Co-ops, municipalities) | 2021 (IOUs); 2018 (Co-ops, municipalities) | 0.2% solar by 2018; 0.2% swine waste by 2018; 900K MWh poultry waste by 2014 | – |
| North Dakota[1] | 10% | 2015 | – | – |
| Ohio | 25% all alternatives (12.5% renewables) | 2025 | 0.5% solar | – |
| Oklahoma[1] | 15% | 2015 | – | – |
| Oregon | 25% (utilities with >3% total sales) | 2025 | 20 MW solar by 2020; 8% DG (<20 MW) by 2025 (goal) | – |
| Pennsylvania | 18% all alternatives (8% renewables) | 2021 | 0.5% solar | – |
| Rhode Island | 16% | 2019 | – | – |
| South Dakota[1] | 10% | 2015 | – | – |

(*Continued*)

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**TABLE 2** | Continued

| State | Portfolio Target | Portfolio Target Date | Carve-Outs | Credit Multipliers |
|---|---|---|---|---|
| South Dakota[1] | 10% | 2015 | – | – |
| Texas | 5880 MW | 2015 | 500 MW nonwind (goal) | 200% nonwind renewables |
| Utah[1] | 20% | 2025 | – | 240% solar |
| Vermont[1] | 20% | 2017 | – | – |
| Virginia[1] | 15% of 2007 sales | 2025 | – | 200% wind, solar; 300% offshore wind |
| Washington | 15% | 2020 | – | 200% DG |
| West Virginia[1] | 25% alternatives | 2025 | 22.5% not from natural gas | 200–300% renewables; 200% DG renewables |
| Wisconsin | 10% | 2015 | – | Formula for small (<60 MW) hydro |
| District of Columbia | 20% | 2020 | 2.5% solar by 2023 | – |

*Source*: North Carolina Solar Center (2012).
IOU, investor-owned utility; co-op, electricity cooperative; DG, distributed generation; CHP, combined heat and power.
[1] Renewable portfolio goal.

policy instrument because it is more politically palatable than alternative policies, especially when particular aspects are customized to fit the needs and wants of a given state.[6] Furthermore, RPS adoption can serve as an important symbolic policy commitment for state legislatures; even if the renewable energy mandate or goal is small, this policy can still indicate that states are in favor of renewable energy development.[25]

## RPS Effectiveness

Because RPS policies are intended to increase electricity generation from renewable energy sources, a review of the policy's effectiveness should begin with the discussion of how well the policy increases development activity and rates of renewable energy deployment. Several case studies have found that the RPS policy is effective at increasing renewable electricity generation in specific locations.[6,17] Some case studies have also found that RPS policies facilitate competition between renewable energy producers, such as in Texas, where Langniss and Wiser[17] found that the RPS policy encourages competition between wind power producers. Some note, however, that RPS case studies that focus only on positive policy results are misleading because some states, such as Massachusetts and Nevada, remain noncompliant with their RPS targets and others, such as California, have not experienced any measurable increase in nonhydro renewable electricity generation.[26] Yet many empirical studies that take into account the diverse experiences of all states conclude convincingly that the RPS policy on average effectively increases the amount of electricity generated from renewable sources of energy,[20,27–30] thus validating the findings from various case studies.

One could claim that the objective of the RPS policy is not solely to increase renewable energy development and deployment, but additionally to diversify a state's electricity portfolio mix with a greater proportion of electricity sourced from alternative energy resources. Several researchers have either directly or indirectly addressed the policy's ability to achieve such objectives. In a national energy modeling analysis, Palmer and Burtraw[11] found that the RPS has the potential to offset carbon-intensive generation, particularly from natural gas as it typically competes with renewables for a share of new capacity and at similar load requirements. In a similar energy modeling exercise, Kydes[31] found that a national 20% RPS has the potential to reduce statewide emissions of nitrogen oxides, carbon dioxide, and mercury due to the replacement of renewable energy for fossil fuel resources. Other studies have found that the RPS-induced renewable energy primarily serves as new capacity, not as a replacement for other generation.[32] An RPS policy in absence of energy efficiency mandates also does not affect demand. These two trends suggest, and as is also confirmed by other studies, that RPS policies may fail to significantly increase the percentage share of renewables in a state's total energy mix.[5,12,33]

Similarly, some analysts have found that many states are not on pace to meet their eventual renewable energy target levels or percentages[7,33]; some states are also not on track to meet their carve-out mandates.[9] Michaels[26] found that most states are not achieving

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their RPS intermediate benchmarks due to noncompliance from participating utilities. He argues that noncompliance, particularly in California, is due to low financial penalties as well as transmission capacity and other procurement limitations. Besides mere noncompliance, the literature has revealed several RPS limitations that help explain some of these trends. Compliance is particularly difficult, one author notes, because renewable sources of energy are often intermittent and, therefore, added renewable capacity must be three to four times greater than displaced fossil fuel capacity to avoid disruptions in supply.[34] Many renewable energy projects require transmission line development, which is susceptible to localized opposition and siting delays.[6] Unanticipated siting difficulties for both renewable energy generation systems as well as additions to the transmission grid have served as a barrier to state RPS compliance.[35] On the basis of a cluster analysis of over 200 firms from around the United States, Schmidt et al.[36] found that firms interpret and respond to state-level RPS policies differently: some choose to divert resources toward research and development of renewable energy technology and others choose to either pay noncompliance penalties or purchase RECs from other firms. This variation in firm response may help explain differences in states' RPS compliance.

States initially adopted the traditional RPS, a technology-neutral renewable energy mandate, as an effort to stimulate competition between different renewable energy technologies.[9] Experience with the traditional RPS policy has established, however, that the least costly technology is typically deployed and more costly technologies are avoided.[37–39] Given that wind energy has the lowest levelized cost of electricity relative to all other sources of renewable energy, developers have pursued wind energy almost exclusively.[9,10,27,29] As of 2011, 94% of all new RPS generation came from wind.[9]

Such imbalanced investment in wind may limit the future viability of other technologies that remain immature in market infiltration but that have great potential for meeting future environmental goals.[39] As Table 2 demonstrates, since the early days of RPS adoption, many states have added carve-outs or credit multipliers to their RPS policy designs, so as to provide extra support or incentives for higher cost renewable technologies. For example, Nevada has a carve-out mandate of 1.5% and a 240% credit multiplier for solar. Binding carve-outs for solar are as high as 4% in New Mexico and credit multipliers are as high as 300% in Michigan.[8] The proliferation of carve-outs demonstrates a regulatory response to a concern about the lack of diversity in RPS-induced electricity generation.[37] There are other policy options available for promoting diversification in the context of competing high- and low-cost technologies. For example, Olmos[39] calls for increased research and development funding for technologies that are currently not economically competitive. Thus far, however, carve-outs and multipliers have emerged as the two primary RPS design features specifically targeted toward diversification and other drivers such as increased research and development either remain private sector endeavors or are promoted by different state-level policy actions.

Despite the relatively recent trend in the use of carve-outs and multipliers, both design features have produced positive results. Wiser et al.[9] found that despite shortcomings in meeting solar provision targets, carve-outs have served as important drivers of solar development and deployment. This has been true for both small- and large-scale solar photovoltaic arrays as well as centralized solar power systems, which were recently deployed in Arizona (1 MW) and Nevada (64 MW). Carve-outs for DG are expected to also favor small-scale solar PV systems.[9] In terms of their relative effectiveness, empirical evidence suggests that credit multipliers have had a greater impact on increased diversification than carve-outs.[38]

Specific policy design details, however, may limit the potential effectiveness of this policy. For example, exemptions for specific utility types, such as a cooperative or municipal utility, limit the policy's potential.[40] Alternative compliance payments that are set too low will encourage utilities to favor paying the alternative payment rather than invest in new renewable energy or buy RECs. Design details that limit the flexibility of the policy, such as solar carve-outs, may also make it more difficult and costly to comply with the policy. Some flexibility mechanisms, such as the allowance of REC trading across state borders, should help utilities comply with their mandates in the most cost-effective manner, but may facilitate more out-of-state renewable energy development than in-state development.[30] These issues underscore some of the fundamental trade-offs that policymakers must consider when designing RPS policies, for example, how flexible to make the policy, whether in-state development is preferable, or whether the policy should target specific energy resources.

These shortcomings also reveal that the RPS policy may not be the best policy tool to target multiple policy goals concurrently. Yet the RPS instrument is often used to satisfy multiple objectives, such as decarbonization, diversification, and decentralization of the electricity sector. These objectives can sometimes counteract one another, and it is therefore important

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to analyze the ability of RPS programs to satisfy each of these goals separately.

The literature reveals mixed results about the ability of RPS policies to facilitate decarbonization. Although RPS policies have the potential—although, as discussed above, this potential is not always realized—to increase electricity generation from renewable energy sources and replace fossil fuel generation, and therefore reduce GHG and other emissions,[11,31,41] other policy instruments are more effective for climate policy objectives. Palmer and Burtraw[11] found that at the national level a cap-and-trade mechanism would be more effective than an RPS. Other analyses[42] have come to similar conclusions, finding the RPS to be less effective for carbon mitigation than a carbon price, emissions performance standard, or a tax on fossil fuel generation. A recent national energy modeling study from Bird et al.[41] found that the RPS does not guarantee decarbonization in the context of increasing electricity demand; similar to Palmer and Burtraw,[11] this study also concluded that the national RPS is less effective at carbon mitigation than a cap-and-trade policy, particularly in the long run. Although RPS policies may be somewhat effective at reducing carbon emissions, policies explicitly designed to address climate change are more efficient at decarbonization. A primary reason for this finding is that increases in renewable energy generation do not translate directly into significant decreases in GHG emissions when the renewable energy does not displace fossil fuel generation one for one.[31] The limited potential for RPSs to reduce carbon emissions is due, at least partially, to the fact that no RPS policies mandate reductions in either GHG emissions or electricity generated from fossil fuels.

A national RPS would be more effective, however, at achieving decarbonization than the current patchwork of state-level RPS policies.[40,43] Although the RPS policy has grown in popularity among US states, its implementation is not universal. States without RPS policies can consume electricity from fossil fuel sources that firms in regulated states had previously purchased.[25] This transfer of carbon-intensive electricity over state lines as a result of uneven policy implementation is referred to in the literature as ‘carbon leakage’. As a result, when an RPS state is surrounded by states without similar regulations there is no incentive to retire existing fossil fuel power plants because profits are still attainable through power sales to firms in neighboring states that are not subject to renewable energy regulations.[32]

As discussed above, decentralization, or the deployment of localized small-scale generation systems, can be pursued through specific RPS carve-outs and credit multipliers. The literature contains mixed findings on the ability of RPS policies to achieve decentralization. One author found that the RPS policy promotes the deployment of customer-owned DG, where the deployment of customer-owned systems is statistically more likely in states with an RPS than states without such regulation.[44] In complying with RPS obligations, a utility is more likely to prioritize large-scale systems over small-scale DG. Such competition over limited utility resources was also documented in Minnesota by Forsyth et al.,[45] who found that utilities increasingly prefer large-scale wind installations to small-scale distributed turbines. In response to these issues, some scholars argue that customer-owned DG should, through a regulatory requirement, be accepted by utilities to satisfy RPS program obligations if all other requirements have already been met.[28]

## Other Considerations

The literature has focused on two additional RPS policy effects: electricity price impacts and compliance costs. Despite the frequency of cost-capping mechanisms, researchers have found mixed effects on electricity prices in RPS states. Empirical research predicts modest price increases from RPS implementation.[11,31] Other researchers document negligible and even decreased electricity prices from RPS policies.[33,46] Fischer[47] found mixed effects on electricity rates, and observed that the direction and magnitude of rate changes are driven by the relative supply elasticities of renewable and nonrenewable sources of energy, as well as the operational stringency of the RPS target.

As discussed earlier, many RPS policies include cost-capping mechanisms that manage either compliance costs for utilities or customer electricity rates. In some cases, cost-capping may be unnecessary because compliance costs have been unexpectedly insignificant. In their analysis of Texas’ RPS policy instrument, Langniss and Wiser[17] found that compliance costs faced by utilities were insignificant due to a production tax credit, substantial wind power potential, and a sizeable RPS target that has driven economies of scale as well as confidence among firms to enter into long-term contracts. This experience is not, however, universal. For some states, solar technology carve-outs and RPS compliance costs conflict, where obligations to install solar generation units have drastically increased the cost of RPS program compliance. Compliance cost caps have limited states’ abilities to satisfy binding solar generation targets; states that do not have cost-capping mechanisms and also require generation from high-cost renewable technologies

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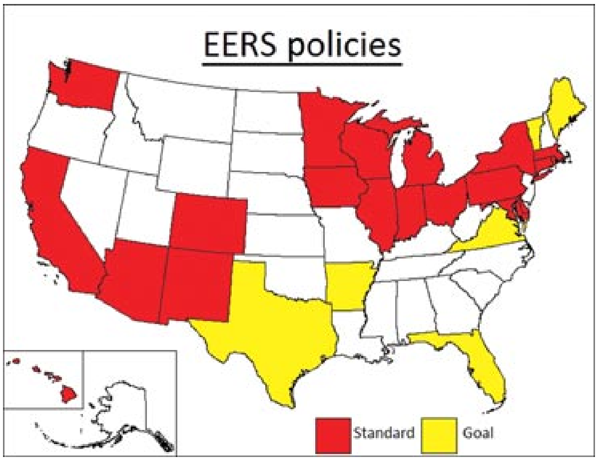


**FIGURE 2** | Energy efficiency resource standard (EERS) policy adoption among US states. Twenty states have adopted EERSs. Six states have enacted energy efficiency resource goals. (Created using data from the North Carolina Solar Center.)

have suffered from unrestricted increases in RPS compliance costs.[9]

## ENERGY EFFICIENCY RESOURCE STANDARDS

### Policy Landscape

Although it is less common than some other state-level energy policies, the EERS has become increasingly popular in the past decade. In fact, most states that have an EERS adopted it within the past decade. Texas was the first state to adopt an EERS policy in 1999, which became operational in 2003, and 25 states have followed suit with their own EERSs or goals.[8] Figure 2 shows a map of EERS adoption. EERSs are especially common in western states as well as states in the Midwest and Northeast that either rely heavily upon natural gas for winter heat or that have the opportunity to reduce electricity consumption by large industrial entities. As Table 1 shows, 12 of the 20 states with a binding EERS have energy efficiency requirements for natural gas and two of the six states with an energy efficiency resource goal have similar goals for natural gas. The average mandated energy efficiency savings among the 20 states with binding policies is estimated to account for 11.5% of total state electricity load.[48]

State-level energy efficiency policies aim to reduce electricity or natural gas consumption. The EERS policy requires that electric or natural gas utilities displace a percentage of their anticipated load with energy efficiency. EERS policies require that utilities improve the efficiencies of their own processes and distribution systems, as well as offer demand-side management programs and incentives that encourage end-user electricity savings.

Similar to other state energy policies, the design of EERS policies is highly varied across states. Annual targets for energy savings differ widely from state to state. Target reductions are measured in various ways including percentage of total sales, percentage of load growth, and absolute kWh savings.[49] States also vary in the manner in which the percentages or total requirements are calculated, where some establish a fixed reference year of electricity use and others create a rolling measure over a set number of years. Table 3, as adapted from Palmer et al.,[48] provides a basic overview of these policy designs across states with binding EERS policies.

States also employ different strategies for funding EERS-induced efficiency measures: some require that utilities divert their own generation procurement funds and others prescribe PBFs or electricity rate riders.[49] In addition, some states use noncompliance penalties and others provide rewards for compliance: as of early 2012, 7 states had noncompliance penalties and 10 had financial awards.[48] Palmer et al.[48] provide a detailed account of the differences among state EERS targets, as well as the methods by which different states measure EERS performance.

States adopt EERS policies for a variety of reasons, including for carbon mitigation and other environmental benefits, peak electricity reduction, consumer energy efficiency behavioral limitations, economic development, energy security, or some combination thereof.[50] States tend to adopt EERS policies in the presence of some of the same factors that motivate RPS policy adoption, in particular given liberal citizen ideology and high levels of air pollution.[15] Adoption trends indicate that this policy will likely become more prevalent in the near future[51] because its diffusion rate is significantly faster than most other state energy policies. Similarly, some researchers predict that both public and private funding for energy efficiency programs will increase over the next decade.[52] Such increases in funding are likely because, in some regions of the country, efficiency investments are more cost effective than new supply-side technologies and infrastructure. Some benefits that have already been found to drive EERS policy adoption include the improved ability to offset higher costs and more significant environmental impacts associated with the future electricity generation development and the provision of additional savings options for electricity and natural gas customers through demand side management programs.[53]

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**TABLE 3** | Energy Efficiency Resource Standard Mandates

| State | Terminal Year | Type of Reduction | Requirement (in % or TWh) | Method | Fixed Year | Rolling Period (in Years) |
|---|---|---|---|---|---|---|
| Arizona | 2020 | Cumulative percent | 22.00% | Rolling | | 1 |
| Arkansas | 2013 | Annual percent | 0.75% | Fixed | 2010 | |
| California | 2020 | Annual quantity | 1788 | None | | |
| Colorado | 2020 | Annual quantity | 549 | None | | |
| Florida | 2019 | Annual quantity | 703 | None | | |
| Hawaii | 2030 | Annual quantity | 195 | None | | |
| Iowa | 2020 | Annual percent | 1.50% | Rolling | | 3 |
| Illinois | 2020 | Annual percent | 2.00% | Rolling | | 1 |
| Indiana | 2020 | Annual percent | 2.00% | Rolling | | 3 |
| Maryland | 2015 | Cumulative percent | 15.00% | Fixed | 2007 | |
| Massachusetts | 2012 | Annual quantity | 1103 | None | | |
| Michigan | 2020 | Annual percent | 1.00% | Rolling | | 1 |
| Minnesota | 2020 | Annual percent | 1.50% | Rolling | | 3 |
| New Mexico | 2020 | Cumulative percent | 10.00% | Fixed | 2005 | |
| New York | 2015 | Cumulative quantity | 24,927 | None | | |
| Ohio | 2025 | Annual percent | 2.00% | Rolling | | 3 |
| Pennsylvania | 2013 | Cumulative percent | 3.00% | Fixed | 2009 | |
| Rhode Island | 2014 | Annual quantity | 189 | None | | |
| Vermont | 2011 | Annual quantity | 120 | None | | |
| Wisconsin | 2014 | Annual quantity | 1816 | None | | |

*Source*: Ref 48; North Carolina Solar Center (2012).
Terminal year refers to the final year to which the policy applies. Method refers to the manner in which the energy efficiency resource standard requirement is calculated: either rolling over a set number of years or fixed to a specific year of reference.

## EERS Effectiveness

The primary purpose of the EERS is to decrease energy consumption and thus, one could argue, provide decarbonization benefits. Literature examining the effectiveness of the EERS is currently quite limited as the policy is so new for most adopting states. In 2006, when only a few states had an EERS, Nadel[54] assessed EERS efficacy in 10 states and found that the policy effectively reduces electricity consumption. Because of the electricity sector's existing reliance on carbon-intensive generation, reductions in consumption mean that the EERS policy has notable carbon mitigation potential. Glatt and Schwentker[49] also found that EERS policies have been instrumental in helping states achieve energy efficiency savings. These authors noted that states have easily satisfied initial, although arguably conservative, energy savings targets, and suggest that more ambitious reductions in energy consumption are possible.

A recent study[55] of electricity consumption in 2008 found that EERS policies are statistically associated with demand-side management electricity savings. Not all utilities in states with EERS policies, however, participate in EERS programs, because some states have voluntary policies, some allow utilities to forgo investments if they are not deemed cost-effective, and others allow certain utilities to opt out of participation. In those states where an EERS policy is combined with its RPS policy, utilities generally can choose between renewable energy and energy efficiency investments; this policy design, however, may lead utilities to favor renewable energy investments over energy efficiency investments when the pay-back for renewable energy is guaranteed but the pay-back for energy efficiency is not.[55]

For an EERS policy to serve as an effective policy, it is necessary to make the policy binding, enforced, and without exemptions for certain utilities with significant market presence. EERS policies will also mitigate greater amounts of carbon if the electricity that is saved would have been otherwise sourced from more carbon-intensive energy resources. To the authors' knowledge, however, no study to date has assessed whether EERS-induced electricity savings are more or less carbon intensive.

One study argues, however, that an EERS policy is generally not an optimal policy instrument if the objective is to reduce electricity consumption, particularly when considering the carbon emissions' mitigation associated with the electricity savings. In this case, more direct policies such as energy taxes or a cap-and-trade program could serve as a more efficient mechanism to reduce electricity consumption and mitigate emissions.[50] Regardless of whether alternative


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policies are more efficient, in the event that an EERS policy is used to reduce electricity consumption, the use of flexibility mechanisms—such as banking and borrowing—can improve the cost-effectiveness of the policy.[50]

The EERS instrument is likely to gain popularity in the near future. Barbose[51] predicts that EERS policies, along with integrated resource planning and demand side management programs, will continue to reduce electricity retail sales. According to his projections, national annual savings in electricity consumption could triple, from approximately 0.3% in 2008 to 0.9% in 2020. Other analysts have projected potential annual savings as high as 2.60% by 2020 if all 50 states implement an EERS policy.[49]

### Other Considerations

Although the EERS primarily is designed to decarbonize the electricity sector through reduced energy consumption, it has additional impacts as well. First, the recent increase in EERS popularity has resulted in nationwide growth in the energy efficiency services sector, which is focused on the deployment and installation of products and measures that enhance energy efficiency. This sector has developed so rapidly, in fact, that policymakers and energy efficiency program administrators are concerned that the current energy efficiency services sector workforce is either too small or insufficiently trained to effectively meet the standards and goals put forward by new state policies.[49,56] Second, EERS policies have been found to reduce end-users' electricity prices as a result of decreased consumption[49] but this finding has yet to be verified elsewhere in the literature.

More in-depth analysis of EERS effects and effectiveness, however, is currently limited. It will become increasingly important over the next decade, as states gain more years of experience with their EERS programs and as additional states adopt their own EERS policy variations, for researchers, policymakers, and funders to evaluate the energy savings and other intended and unintended effects of these programs.

## NET METERING POLICIES AND INTERCONNECTION STANDARDS

### Policy Landscape

Net metering policies and interconnection standards are the most popular state-level energy policy instruments. Together, they target decentralization, with potential secondary benefits of decarbonization and diversification. Decentralization is achieved through

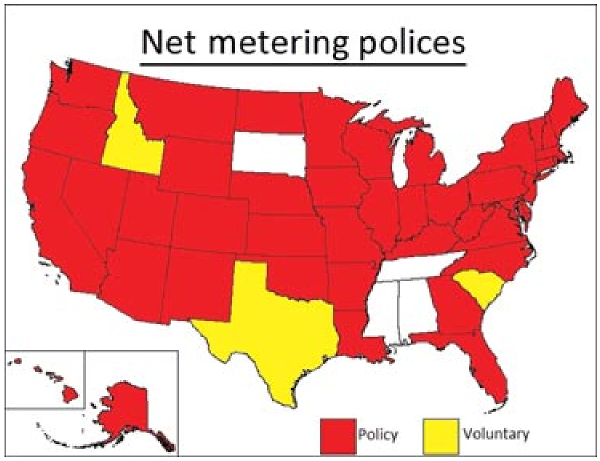


**FIGURE 3** | Net metering policy adoption among US states. Forty-three states, plus Washington D.C. and Puerto Rico, have adopted state net metering policies. Three states have only voluntary utility programs. (Created using data from the North Carolina Solar Center.)

the development and deployment of small-scale generation systems, also referred to as DG systems. These two policies are generally adopted in tandem. Interconnection standards safeguard efforts to connect customer-owned, net-metered generation systems to the electricity grid and make explicit various technical and procedural details related to small-scale energy system contracting.[28] Net metering policies allow for electricity to flow both to and from individual electricity consumers and the grid, and dictate the rate that utilities must pay for such electricity. Many net metering policies require the utility to pay the small-scale energy system owner for his or her electricity at a rate equal to avoided costs, thus allowing those with DG systems to offset their energy expenditures or even to earn income for producing excess electricity.[28,57]

As Table 1 illustrates, as of 2012, 32 states have interconnection standards and 43 states have net-metering policies. Thirty states have enacted both policy instruments together. Figure 3 shows the nationwide distribution of state interconnection standards and guidelines and Figure 4 shows the distribution of net metering policies and voluntary utility programs. As these figures display, the adoption of these two policies is nearly ubiquitous throughout the United States, even in the Southeast, where other energy policies are less common. Net metering policies and interconnection standards were originally developed in the early 1980s, first adopted by Wisconsin and Massachusetts, but, like other instruments, they have emerged nationwide primarily in the past two decades. Motivating factors for state adoption include

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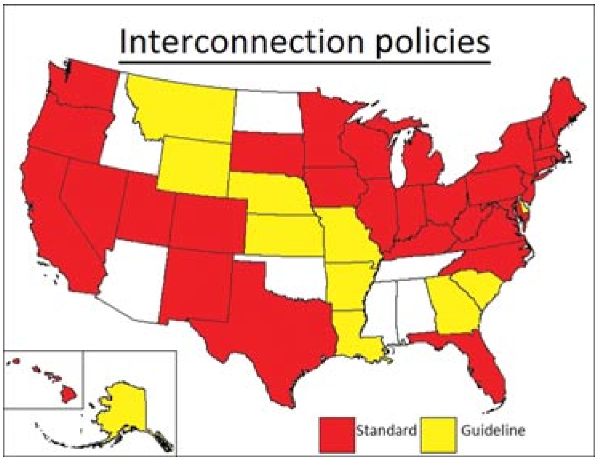


**FIGURE 4** | Interconnection policy adoption among US states. *Note*: Thirty-two states, plus Washington D.C. and Puerto Rico, have adopted state interconnection standards. Eleven states have adopted interconnection guidelines. (Created using data from the North Carolina Solar Center.)

ideological preferences, renewable energy potential, and democratic legislative control.

Similar to other energy policies, net metering and interconnection standards vary across states. As Table 1 displays, 13 states only allow their interconnection standards or guidelines to apply to net-metered systems, thus requiring a connection between the two policy instruments. In addition, 33 states limit the capacity of individual generation systems. Customers in these states can only connect net-metered DG systems that are below particular power output thresholds. For example, only DG systems smaller than 40 kW are recognized by Minnesota's net-metering policy.[8] Four states also have different limits for different types of utilities, such as a limit for all investor-owned utilities and a separate limit for all cooperatively owned utilities.[8] States recognize different kinds of energy resources and generation technologies. Some generation technologies such as wind turbines and solar arrays are commonly accepted, whereas others such as tidal systems are only accepted by a small number of states. Furthermore, there is a great deal of variation in how customers are credited for their DG. As discussed above, some states allow utilities to credit customers at a rate equal to avoided costs, but others require that customers receive credit equal to retail rates. Finally, there is variation in how state programs deal with net excess generation from month to month: some programs, such as in Alaska, allow DG owners to carry over gained credit indefinitely; others that normally credit customers at retail rates, such as in Arizona, require that excesses be reconciled annually at avoided cost rates; and still others, such as in Illinois, require that net excess generation credits be granted to utilities at the end of a 12-month billing cycle according to normal rate rules.[8]

## Net Metering Policy and Interconnection Standard Effectiveness

Analysis of these two policies is limited despite their unrivaled popularity throughout the states. Still, there is consensus among researchers that both policy instruments play a crucial role in removing market barriers to the development and deployment of DG systems and thus to the decentralization of the electricity sector.[28] Both policies promote decentralization both immediately and over time: interconnection standards provide consistent guidelines and clarity at the time of installation, whereas net metering policies reward owners of DG systems from the time of installation onward.[57] One analyst found with 2005 utility-level data that both net metering policies and interconnection standards were significantly associated with customer adoption of DG systems.[44] Furthermore, these customer systems were more likely fueled by renewable sources of energy than the DG systems frequently deployed by utilities. These results underscore the importance of considering which types of DG systems are developed as a result of state net metering and interconnection standard policies. If policy-induced DG systems are primarily run on natural gas, distillate oil, or diesel, these policies may provide limited decarbonization benefits, depending on the electricity resource that they displace.

Net metering and interconnection standards may require additional support from other policy mechanisms. In a 10-state case study, Forsyth et al.[45] found that customer-owned distributed wind generation systems are not necessarily promoted through net metering policies alone, and that to further encourage decentralization, additional incentives and educational programs that help to inform customers of various DG system options are necessary.

There are several factors specific to the design of individual net metering policies and interconnection standards that may reduce the effectiveness of these policies. First, system capacity limits prescribed in net metering policies and interconnection standards can constrain decentralization. This constraint is more relevant for industrial or commercial customers that have the financial or other capacity to develop relatively large DG systems than for individuals that do not have the capital available to invest in larger systems.[28] Inconsistent capacity limits across utility

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types can also create confusion among electricity consumers, and thereby discourage the development of customer-owned DG systems.[28] In addition, many states include in their interconnection standards a fee for connecting DG systems to the grid; such fees can serve as a disincentive, especially for cost-constrained individuals.[28] These fees, when combined with system capacity limits, can substantially hinder decentralization in the electricity sector.

## OTHER POLICY ACTIVITIES

Other state energy policies have worked either in parallel or in coordination with the RPS, EERS, and net metering and interconnection standards, including but not limited to tax incentives, PBFs, green power purchasing, energy efficiency standards, and building codes, among others. For a more extensive discussion of some of these policies, see Refs 5 and 58; or for continually up to date and detailed information on each states' policies see Ref 8. Tax incentives and PBFs are discussed in brief below because these two policy instruments are quite popular among US states to target both energy efficiency and renewable energy, and often play a complementary, supporting role to the policies reviewed above. Information on the effects and effectiveness of these policies is, however, limited. These policies are studied less frequently and less in depth than the RPS or EERS, in particular, for a couple of reasons. First, rarely do these policies exist as the only or even the primary instrument for diversification, decentralization, or decarbonization purposes. Instead, they provide a mechanism for allocating fiscal resources to different programs or end users, and generally work in concert with a more encompassing energy program, such as an RPS or EERS. Second, these policies tend to be harder to measure due to annual variation in funding levels and program availability. Whereas a policy instrument such as a portfolio standard is set for a specific number of years, a tax incentive or PBF may change from year to year due to resource constraints or political circumstances. Findings made in the literature to date are reviewed below but it is important to highlight the need for additional information on how these policies work, how to design them so they are as cost effective and efficient as possible, and how to coordinate them with other energy policy instruments.

Tax incentives help consumers overcome large upfront costs typically associated with the purchase of energy products, and generally target emerging energy efficiency and renewable energy technologies. There is a great deal of variation across states in the types of incentives used as well as in the target beneficiaries and policy administration. States typically employ some combination of tax credits, sales tax exemptions or reductions, and property tax incentives, such as exemptions or special assessments. These various incentives also vary in scope, where credits typically apply to individuals, corporations, or both, and exemptions are administered by states or local governments. Currently, 24 states offer at least one type of tax credit for renewable energy investments, 28 states offer sales tax exemptions or deductions, and 38 states allow for property tax exemptions or special assessments.[8]

Tax incentives have many advantages: they promote alternative technologies but do not directly raise the price of other, conventional technologies; and, like all financial incentives, tax incentives allow policy makers to control how many public dollars are spent on policy action. There are also several disadvantages associated with tax incentives. First, although tax incentives have the potential to promote emerging energy efficiency and renewable technologies, tax incentives do little to discourage the continued use of conventional, carbon-intensive technologies. Similarly, they do not promote energy conservation or curtailment. In fact, some research has revealed a connection between financial incentives and increased overall energy consumption.[59] Also, although policymakers can control the overall cost of a tax incentives, they cannot control how many energy investments are made. Third, tax incentives force policy makers to choose which technologies are worthy of support, and thus 'play favorites'. Finally, tax incentives can either last too long or be removed too early to have necessary market impact. In light of these advantages and disadvantages, analysts typically highlight the importance of making tax incentives as transparent and predictable as possible, and scaling them back once emerging technologies no longer require policy support.

The most common finding on the effectiveness of energy tax incentives is that they are best and most often used in a supporting or complementary role to other policy instruments. This conclusion is based on various policy performance studies that include at least some analysis of various tax incentives.[19,27] Also, tax incentives have been found to effectively promote the development of small-scale renewable installations, and this is especially true at the state level.[27] Unintended effects of tax incentives include free riding and carbon leakage. Free riding occurs when an individual or entity would have purchased a product or service without an extra incentive but is instead able to benefit from the tax incentive.[59] Tax incentives can also contribute to carbon leakage,

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whereby they drive down the price of renewable energy and thus reduce demand for conventional, typically fossil fuel-based energy. A reduction in demand causes the price of fossil energy to decrease, which may subsequently encourage consumption of that cheaper fossil energy in neighboring regions.[25] This potential for carbon leakage limits tax incentives' decarbonization potential; although the price impact and resulting leakage associated with tax incentives is less than that caused by other policies, such as the RPS.[25]

PBFs are pools of money devoted to energy efficiency, research and development, and renewable energy investments. Most often, these state funds are supported by electricity ratepayer fees or surcharges but state-level legislative appropriations and federal funding can also assist fund development. Almost all funds are open to ongoing collections but some states have either removed their funds entirely or have stopped collecting inputs, such as Ohio, which closed its fund to new collections in 2011.[8] Currently, 18 states and Washington D.C. administer PBFs. A majority of these funds began in the late 1990s and early 2000s and, whereas some do not have explicit expiration dates similar to Ohio, many are set to expire sometime between 2012 and 2020.[8]

In the analysis of PBF effects and effectiveness, most scholars consider impacts on energy efficiency and demand side management initiatives rather than renewable energy investment. One exception is an early study in which PBFs were not found to be significant drivers of wind energy development; however, the data used in this analysis were limited and thus the results may not be generalizable across all states.[29] The majority of PBF effectiveness studies are produced by the American Council for an Energy-Efficient Economy, including survey analyses produced in 2000 and 2004 by Nadel and Kushler[60] and Kushler et al.[61] respectively. Both studies explored industry perceptions of PBF policy performance and found that market participants generally consider PBF policies to be significant drivers of energy efficiency investments, especially in restructured markets. A more recent study on PBFs and other demand side management policies confirmed that PBFs are associated with utility energy efficiency investments but not unless the policy is coupled with other utility-targeted financial incentives, such as performance incentives.[55] Although these studies link PBFs to efficiency investments, albeit with some caveats, they also identify various policy shortcomings, including ambiguous policy language, insufficient funding levels, delays and complications in policy administration, limited state agency support, and funding raids.

All policy instruments reviewed thus far establish specific mandates, rules and regulations, and financial mechanisms to support energy efficiency or renewable energy. It is important to recognize that states and municipalities are also exploring other energy activities that involve institutional reform, such as the sustainable energy utility model that Delaware and other states have pursued.[5,62] A sustainable energy utility is a third-party, nonprofit entity that is responsible for providing energy efficiency, conservation, and customer-owned DG services to energy users. Spurred by state-level legislation, Delaware developed the nation's first sustainable energy utility in 2007; the concept of a sustainable energy utility was also investigated and subsequently implemented in the District of Columbia. Delaware's program is financed through special purpose tax-exempt bonds, as well as the state's PBF and emissions auction proceeds from the state's participation in the Regional Greenhouse Gas Initiative. Although no study has yet to investigate the impacts of Delaware's utility model on energy efficiency activities, exploratory studies on the topic emphasize the importance of implementing such a model in combination with other supportive energy policies, such as an RPS or net metering.[62]

## CONCLUSION

This analysis sought to synthesize findings from the literature and provide a summary of the landscapes, effects, and effectiveness of various state-level energy policy instruments. The majority of this analysis focused on four policy instruments that have been studied most extensively in the literature to date: the RPS, the EERS, net metering, and the interconnection standard. These four instruments also serve as a sample of a much larger collection of innovative state energy policies that have emerged in recent decades to decarbonize, decentralize, or diversify what has historically been a highly centralized and carbon-intensive electricity sector. This study also reviewed briefly three other common policies or efforts—tax incentives, PBFs, and institutional reforms—that are both increasing in popularity and serve supporting roles for broader electricity policy efforts. Because of the widespread adoption of this suite of policy instruments, as well as their ability to represent the goals of most state-level energy policies, it is important to understand general trends and effects associated with these policies.

Many states adopt RPS policies with the primary objective of diversification but some aim to achieve decarbonization or decentralization


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objectives as well. In considerations of its diversification effects, experience with the RPS policy has revealed that it successfully increases renewable energy development and deployment but it still remains to be proven whether the policy significantly affects the percentage of renewable energy out of states' total electricity portfolios, or whether states will be able to achieve their percentage mandates. Recent studies have also found that the traditional, technology-neutral RPS almost exclusively promotes wind energy development. Well over half of the states with an RPS have therefore implemented carve-outs or credit multipliers to promote other technologies as well, such as solar and DG. There is general consensus that such efforts have spurred at least modest investment in these alternative technologies, although some states are falling short of specific technology carve-out goals. In pursuit of decarbonization, many analysts have found that the RPS does not displace existing carbon-intensive infrastructure with carbon-neutral renewable technologies. RPS adoption is not universal and problems of carbon leakage also diminish this instrument's decarbonization potential.

The state energy policy literature has devoted significant attention to the evaluation of the RPS policy and its impacts, particularly relative to other policy instruments. The studies reviewed above firmly establish that the RPS policy is effective at increasing renewable energy generation but also suffers from some drawbacks that limit the full diversification and decarbonization potential of the policy. These findings highlight for policymakers the importance of setting realistic targets, enforcing the policy, applying noncompliance penalties, allowing some firm-level flexibility with RECs that can be banked and borrowed, and working to minimize carbon leakage.

Although the understanding of the RPS policy has evolved significantly since the early 2000s, there are several important questions about the policy and its impacts that still require further detailed analysis. First, it will be necessary to continue to assess the effectiveness of the RPS as states approach their terminal years, and evaluate what makes some states fall short of their mandates and others not. Is some states' noncompliance due to internal state factors such as political capacity, resource endowment limitations such as too little wind, or specific policy designs such as too ambitious or too rigid of benchmarks, not enough flexibility, too few carve-outs, or some other design detail? Second, the literature will benefit from assessments of which policies most effectively complement the RPS and why. Third, it is important that analysts continue to refine and improve the methods used to depict and measure RPS policy implementation and impacts, given the wide range in policy design across states. Fourth, an important factor in RPS effectiveness is the degree to which carbon is leaked across state lines due to incongruous state policies; future scholarship will need to evaluate which conditions lead to more or less carbon leakage, and how to ameliorate this and related state interaction problems. Finally, the literature will benefit from more extensive evaluation of REC markets—for example, do they operate as designed; what contributes to fewer or greater sales; which factors influence REC market transactions between market players?

The EERS is growing rapidly in popularity. Many states now have EERSs or goals to help reduce electricity consumption and, by extension, carbon emissions. Analysis of EERS effectiveness remains limited but there is general agreement among the limited program evaluations that the EERS has effectively reduced electricity retail sales and, thus, electricity consumption. For an EERS policy to serve as an effective decarbonization policy instrument, it is necessary that policymakers ensure that the policy is binding, enforced, and does not exempt certain utilities with significant market presence. Analysts predict that this policy will continue to grow in popularity in future years.

There is significant need for further assessment of states' experiences with the EERS to help inform policymakers of the strengths, limitations, and usefulness of the policy. Empirical research is needed that covers some of the same ground that the RPS policy literature has already explored, in addition to some of the same research extensions identified above for the RPS, including but not limited to the following. First, it will be important to assess whether states are on target to meet their annual benchmarks and finals mandates and to analyze which factors contribute to success or failure. Second, are other policies, such as cap-and-trade or efficiency standards, for example, more efficient or cost-effective? Third, what is the most effective way to design a joint RPS-EERS—referred to elsewhere as a sustainable energy portfolio standard[21]—so that the energy efficiency and renewable energy investments are complementary? Fourth, how should one measure EERS policies to account for the great variation in stringency and design, and also estimate empirically the effects and impacts of the diversity of EERS policies? Finally, how does the exchange of energy efficiency credits affect the cost of compliance or otherwise affect the performance of the EERS?

The majority of states have net metering policies, interconnection standards, or both. These policies aim to decentralize the electricity sector through

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the increased deployment of DG systems. Analysis of these policies is limited despite widespread adoption; the only studies published on the policies to date find that they are effective decentralization policy tools but must be carefully designed so as to not exclude potential market participants. Policymakers can improve the extension of these policies by ensuring that capacity limits are not too small, that compliance is mandated and consistent across different types of utilities, and that excess fees are avoided.

Future research on net metering and interconnection standards can provide valuable additional information about the effects of these policies. The following areas of inquiry will be of particular importance. First, no study has measured the effectiveness of these policies since the study discussed above that relied on 2005 data.[44] Subsequent studies could reevaluate the relationship between these policies and customer-owned DG using panel data from the early 1990s through present day, and consider whether these policies encourage one type of DG deployment over another (i.e., solar photovoltaic vs microhydro), or whether they are more successful in some states and not others due to resource endowment, political factors, or economic factors. Second, it will be helpful to identify which types of tax incentives are most complementary to net metering and interconnection standards, and how such tax incentives can be optimally designed to encourage DG deployment.

States have also adopted a variety of other policies throughout the era of state energy policy innovation, including but not limited to tax incentives, PBFs, and sustainable energy utility reforms. Although the literature has established that these policies and programs have the potential to play a significant supporting role in energy policy efforts, no studies have yet to find that they are primary drivers of diversification, decarbonization, or decentralization. Additional research is necessary to determine the conditions under which these policies are more or less effective, and how they can be optimally designed.

Nearly, every US state—except for Alabama, Mississippi, and Tennessee—currently has at least one of the four energy policies analyzed in depth in this study. Furthermore, almost every state with one policy standard or goal also has at least one other policy as well.[8] Synergies between different policy instruments are therefore also important to consider, especially when analyzing state regulators' and policymakers' overall effectiveness in promoting multiple policy goals. For example, the combination of an RPS and EERS policy may mitigate some of the decarbonization shortcomings of RPS policies, where the EERS could reduce or hold steady electricity demand and thus allow the RPS to affect existing supply infrastructure rather than just new generation capacity. Or the combination of an RPS, net metering, and interconnection standards could help facilitate greater rates of decentralization, where the net metering and interconnection standards allow customers the opportunity to connect to the grid and the RPS policy incentivizes the utility to pay some of these DG owners for their dispatched RECs. The literature to date has yet to explore these synergies in much detail, nor evaluate the effects of policy combinations on these three guiding policy objectives. One should not infer, however, that more policies automatically equate to greater effects. Policy effectiveness still necessitates that these policies are designed as optimally as possible, with binding targets, penalties for noncompliance, and complete participation, as well as enough flexibility for states to achieve their mandates in the most efficient manner possible. There is reason to believe, however, based on the empirical evidence reviewed in this study, that if these policies are effectively designed and coordinated, implementing some of these policies in combination could help a state achieve more than one policy objective.

Throughout the era of state energy policy innovation, states have adopted many different policy instruments in effort to decarbonize, diversify, and decentralize the electricity sector. Yet scholarly analysis of policy effectiveness remains limited and only the RPS has been thoroughly evaluated in the literature. There are other policy instruments that are more prevalent, such as net metering policies and interconnection standards, or more likely to experience increased rates of adoption in the near future, such as EERSs. Future efforts to understand the effectiveness of state-level energy policy innovation would benefit from a more thorough understanding of these and other policy instruments.

It is difficult to predict the future of US energy policy or the future composition of the electricity sector. Policy action will likely continue at the state level, as well as at the municipal and regional level. Whether the national government will eventually adopt a climate policy, such as a cap-and-trade or carbon tax, or an energy policy, such as a clean energy portfolio standard or an EERS, remains to be seen, and will largely depend on the composition of the executive and legislative branches following the 2012 elections and other national, competing policy priorities. Meanwhile, utilities, nonprofits, and other companies may seize opportunities to evolve and expand into new market spaces created during the era of state energy policy innovation, including those that involve energy efficiency, low-carbon technologies, and

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alternative energy, both large scale and small scale. The era of state energy policy innovation continues, and a thorough understanding of policy effectiveness is important not only for evaluating policy decisions but also for informing any and all future energy policy initiatives.

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