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Regulatory Stringency and Policy Drivers: A Reassessment of Renewable Portfolio Standards

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Renewable energy policy has far-reaching implications for national and international economic, environmental, and political sustainability, but thus far within the United States it has been almost entirely the province of state governments. This article examines the factors motivating state-level policymakers to adopt different forms of a renewable portfolio standard (RPS), highlighting the distinction between degrees of policy stringency, ranging from entirely voluntary participation to rigorous and strictly enforced targets. In the process we introduce a new metric for assessing stringency, more precise and reliable than the various proxies used previously, and analyze its relationship to drivers of policy adoption. We find that policies of different stringencies are motivated by systematically different underlying factors. State-level citizen political ideology is a significant predictor of RPS policy adoption, particularly for "voluntary" and "weak" policy designs. "Strong" policy designs, on the other hand, are best predicted by ideology at the government level, i.e., the degree of institutional liberalism. These findings may inform current implementation and program evaluation efforts, and potentially point the way toward more effective policy choices if and when an RPS moves forward on the national policy agenda, while the stringency metric central to this analysis can be of use to other policy scholars concerned with topics both within and beyond the realm of energy policy.

KEY WORDS: renewable portfolio standard, electricity market, energy policy, policy adoption, citizen ideology, renewable energy

Introduction

"It is one of the happy incidents of the federal system that a single courageous State may, if its citizens choose, serve as a laboratory; and try novel social and economic experiments without risk to the rest of the country," wrote Justice Louis Brandeis nearly 80 years ago (*New State Ice Co. v. Liebmann*, 1932, 311); and in the generations since then the concept of the individual states as America's "laboratories of democracy" has spread far and wide and come to be accepted as almost axiomatic. In reality, state legislatures are constrained by many of the same institutional characteristics as national ones, including the U.S. Congress, and are far from reliable sources of innovation. Institutional inertia tends to preserve policy equilibria based on existing balances of power (Baumgartner & Jones, 2009; Riker, 1982). However, from time to time a set of issues emerges that engages the attention of state legislators

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even as it languishes in Washington; and in such moments states can and do live up to the vision of bold policy experimentation embodied in Brandeis's statement. One such set of issues involves renewable energy (RE) policy.

Energy and climate policy concerns connect in a triad of significant and complex issues. First among these is climate change, driven at least partially by greenhouse gas (GHG) emissions from the combustion of fossil fuels. Second is economic competitiveness, both nationally and internationally, affected by the increasing extraction costs of fossil fuels and by the profit potential of RE markets. Third is energy security, a concept perhaps most easily summed up with the familiar adage "don't keep all your eggs in one basket": This is relevant at a national level as the United States finds itself entangled in recurring conflicts involving countries it relies upon as major sources of oil, but it pertains among states as well, as lawmakers seek to diversify their states' energy supplies and thus reduce their vulnerability to market shocks.

Despite the salience of these issues, the federal government has been slow to act on RE policy, in terms of either domestic goals and standards or international agreements. Although a comprehensive RE bill in some form has been introduced in every one of the past six Congresses, and has passed either the House or the Senate on multiple occasions, no bill has yet passed both chambers;[1] both the underlying issues and the proposed policy solutions remain politically contentious at a national level. An increasing number of U.S. states have stepped into this policy vacuum, however, adopting a wide variety of policy instruments that have shown themselves to be to be politically viable and even popular at the state level (Rabe, 2006). In the space of less than 20 years, 45 U.S. states have enacted detailed RE policies (North Carolina Solar Center, 2010), among which the most prevalent policy model by far has been the renewable portfolio standard (RPS).

An RPS, in its most essential form, is a policy that mandates specific percentages or levels of RE out of a state's total electricity production by specified target dates. The RPS has proven to be a remarkably popular policy model throughout the United States, adopted far more widely than alternatives, such as direct carbon taxes, marketable GHG allowances, or state production incentives (Rabe, 2008; Wiser, Porter, & Grace, 2004). RPS programs are of growing importance: As of 2007, some form of RPS applied to 46 percent of the country's electrical load (Wiser & Barbose, 2008). There is wide variation, however, in the stringency of different RPS policies across states.

The RPS remains a relatively new policy instrument, so both evaluations of its effectiveness and the reasons for its increasing adoption remain matters of dispute and of growing interest to scholars. Within the community of policy scholars a serious means of measuring policy variation is essential in order to assess accurately the relationships between different versions of RPS policies as well as states' motivations to adopt these policies. In response to these needs, this article devises a new metric for measuring stringency that is sensitive to critical policy design variations, providing a single intuitive number than can be used to compare policies among states, and then tests which factors predict policy adoption.

In its focus on the reasons for policy adoption, and especially on critical distinctions among different degrees of policy stringency, this article is motivated by informational needs on several levels. First, among policy practitioners, such an analysis can help indicate how and why some policies lead to greater rates of RE deployment than others, and provide a clearer understanding of the ways such policies are designed, adopted, and administered that can be of use to those charged with those tasks, both in states that have yet to formulate RE policies, and in those looking to revise and improve their current policies. One cannot meaningfully evaluate effectiveness without first having a firm understanding of which factors motivate a policy's existence. Second, scholars have observed that although some RPS policies have experienced early success, this success is by no means consistent across states. The very nature of the uneven efficacy of RPS policies, as measured in the literature to date, invites the question of why different states may choose to adopt different versions of this policy model, rather than converging on an approach that has the strongest prospects for increased RE development. Third, RE issues remain likely to emerge prominently onto the national stage: state-level policy innovation does not preclude and can potentially advance broader-scale solutions (Lutsey & Sperling, 2008); and this level of analysis may thereby also provide useful foresight for the U.S. government when it next considers a national clean energy standard.

We begin our analysis with a brief discussion of the history of RPS policies, and the literature published to date on RPS policy effectiveness, stringency, diffusion, and adoption. In the sections that follow, we discuss our methodological approach and then present our study sample, discuss specifications of our variables, and describe our method for calculating policy stringency. We then present our findings and a discussion of their theoretical implications, and conclude the analysis.

Background

Renewable Portfolio Standard Policies

The first RPS was enacted in Iowa in 1983, termed an alternate energy production requirement, before any other state had adopted a comparable policy. Iowa has been described as responding to economic development opportunities when both demand and the cost of new traditional power plants were high (D. Osterberg, personal communication, 2011), but it remained an outlier for a considerable time. Other states began to follow suit starting in 1997. As of 2011, some form of RPS has been adopted in 37 states (North Carolina Solar Center, 2010); 17 of those have been enacted just since 2005. See Figure 1 for a map illustrating the history of RPS adoption.

Specific policy requirements vary significantly from one state to another (Wiser et al., 2004), but the defining characteristics of an RPS in almost every instance are to set targets for the share of state energy production that must be filled by RE (e.g., 20 percent), either directly or through traded RE credits or certificates (RECs), and the date by which it must be achieved (e.g., 2025). The targets and dates vary dramatically, as do many other nuances. There are no uniform policy design criteria. Wiser and Barbose (2008) provide a detailed and comprehensive overview of RPS policy design variation. Among other variations, any given RPS may or may not include:

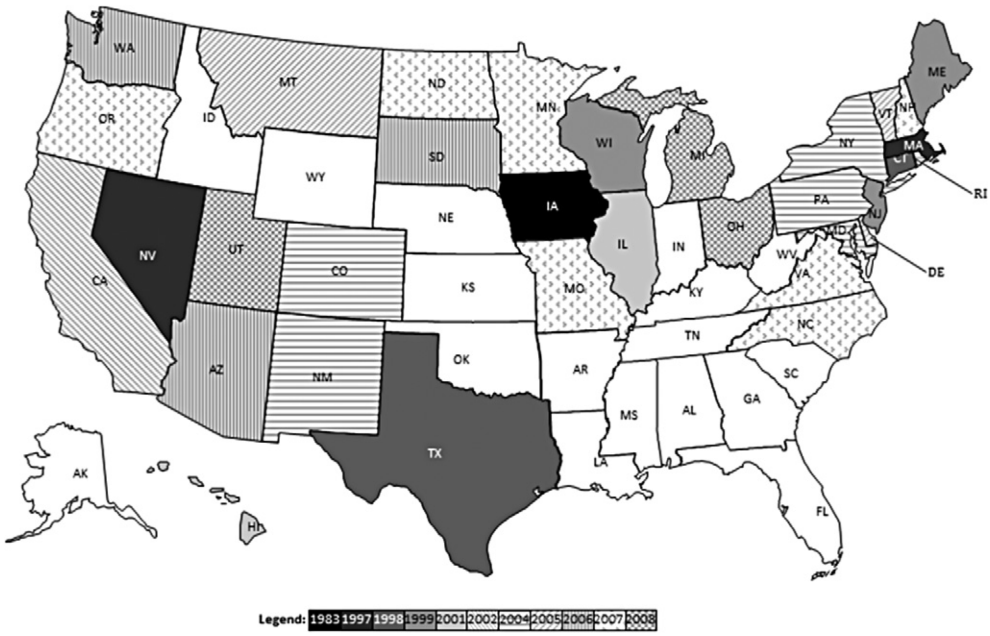

Figure 1. RPS Adoption Dates by State, through 2008.
Source of data: Wiser et al., 2007, p. 2; Wiser and Barbose, 2008, p. 7.

- Specific technologies either prohibited, allowed, or mandated;[2]
- Sourcing requirements, whereby some or all renewable power may be required to be generated within the state;
- Exemptions for selected energy producers, such as municipally owned utilities;
- Tradable REC markets, which may operate in-state or within regional boundaries, whereby a state can satisfy a portion of its RPS requirements by purchasing these credits from RE power producers;
- Monitoring and enforcement mechanisms, ranging from strict mandates with compounding financial penalties to completely voluntary regimes with no compliance requirements whatsoever.

Notwithstanding these wide variations, the RPS in general remains a consistently popular policy mechanism, in comparison with other alternatives. Indeed, some argue that the very flexibility of the policy model is one of the features that facilitates its wide adoption (Karch, 2007; Rabe, 2008).

Effectiveness and Stringency

RE policy is situated in a fast-moving environment, at least in terms of political time frames. Understanding of the issue—at both public and expert levels—is evolving quickly. Analysis of some early RPS adopters demonstrated promising policy results, such as the increased competition among wind-power producers in Texas that accelerated production well ahead of incremental targets by 2001 (Langniss & Wiser, 2003). While several analyses have found that RPS policies either should or do increase RE output (Carley, 2009; Fischer & Newell, 2004, Palmer & Burtraw, 2005; Yin & Powers, 2010), some empirical analyses have noted that, given reasonable assumptions, RPS policies are not associated with an increase in the percentage of RE in a market. Carley (2009), for example, shows that, as of 2006, RPS policies demonstrated no statistically significant association with the overall share of a state's electric market produced from RE. While RPS policies do show a positive relationship with total RE generation, it cannot be clearly determined whether these growth rates would be any different in the absence of such policies, in light of the fact that total energy usage also continues to climb at comparable rates, in states both with and without an RPS in place (Wiser & Barbose, 2008; Wiser, Namovicz, Gielecki, & Smith, 2007).

Multiple studies have found inconsistent results about whether states have achieved early RPS targets, and concluded that insofar as long-term outcome data are not consistently available, the best criteria to assess effectiveness involve (i) policy design features and (ii) market context, e.g., viable renewable resources (Wiser et al., 2004, 2007). Rabe (2006) notes a number of problematic issues common to a number of different RPS designs, including difficulties with interstate collaboration, favoritism regarding specific energy sources and technologies, and lack of a common metric for GHG emissions savings—the last of which, however, remains a problem for other policy alternatives as well—and echoes other scholars' concerns about effectiveness in general (Rabe, 2008). It seems plausible that states may be trying to achieve too many policy goals with a single tool, along the way introducing shortcomings such as cross-border carbon leakage, and weak policy design features such as ineffective or unenforced penalties (Carley, 2011; Rabe, 2008).

There is as yet no consensus on these points among energy scholars. Yi (2010) concludes that RPS policies do at least contribute to RE capacity, if not necessarily production, within states. Yin and Powers (2010) also conclude that RPS policies have had a "significant and striking" impact on RE development, but with the proviso that free trading of RECs may significantly weaken the impact of an RPS. However, REC trading to date has been limited, fragmented, and a source of unreliable price signals (Wiser & Barbose, 2008); and empirical analysis of these markets is currently underdeveloped in the literature. Most importantly, Yin and Powers (2010) warn that RPS effectiveness is obscured unless differences in strength among different states' policies are accounted for, since one should expect that states with more stringent policies will achieve higher rates of RE deployment.

Policy stringency has thus begun to emerge as a logical and important factor influencing effectiveness, since one might logically assume that a state with a stronger mandate would secure greater RE diversification and one with a weak or nonbinding mandate would experience less. Wiser and Barbose (2008) draw out distinctions between RPS variations, and careful analysis by Fischlein (2010) indicates that, while a rigid focus on single measures of policy strength can obscure understanding of more nuanced design features, overall both more stringent targets and increased discretion in means are associated with improved policy outcomes.

Adoption and Diffusion

Decades of scholarship have established that while some policy decisions are driven primarily by determinants internal to a state—for example, matters of economics, demographics, political capacity, or citizen ideology—many others arise as the result of policy diffusion from other states (Walker, 1969), the phenomenon whereby an innovation originating in one specific state or municipality later spreads to others. At a theoretical level, past scholars often tended to attribute state-level policy change to one of these two sources, typically considered in exclusion from one another. However, these paradigms are not mutually exclusive.

Within the discipline of political science, the pattern of much future work was set by Berry and Berry (1990), who introduced the technique of event history analysis (EHA). EHA accounts for both internal determinants and diffusion in a single model, using a "state-year" as its analytical unit. In seeking to clarify diffusion dynamics, Berry and Berry followed Mohr (1969) and divided the underlying policy determinants into two categories: those involving motivation to move an issue or idea onto the political agenda; and those involving available resources, either physical or informational, that help overcome obstacles in the path of particular policy options. Examples of state-level diffusion (e.g., Berry & Berry, 1990; Boushey, 2010) include reenactment of the death penalty, "three-strikes" sentencing requirements, state lotteries, officeholder term limits, charter schools, public smoking bans, and laws both for and against same-sex marriage.

RE policy provides no less fertile ground for analysis. As the RE policy arena has grown increasingly active in recent years, scholars have analyzed a wide variety of factors that potentially influence RE policy formation and adoption, with not entirely consistent results. Previous research on energy technology policy adoption in particular (Chandler, 2009; Huang, Alavalapati, Carter, & Langholtz, 2007; Lyon & Yin, 2010; Matisoff, 2008; Stoutenborough & Beverlin, 2008; Wiener & Koontz, 2010) has considered numerous factors contributing to policy adoption, including internal determinants and also policy diffusion measured via various forms of geographic proximity.

Even today, however, while diffusion and internal determinants are often included within a single model, they are routinely treated as unrelated phenomena divided by geography, one external and the other internal. The scholarship finds limited evidence and conflicting results as to when and how energy technology policies spread geographically, leaving the full process by which these policies diffuse across space and time still unexplained. Chandler (2009) finds regional diffusion consistently significant for state RE policy adoption, for instance, while Matisoff (2008) and Wiener and Koontz (2010) find it less significant than internal determinants, and Stoutenborough and Beverlin (2008) find it meaningful in the context of specific communications channels.

Recently, Berry and Berry (2007) and Karch (2007) have introduced refinements to diffusion theory that complement traditional geographic models, emphasizing key distinctions between learning, competition, and other modes of policy replication, and noting analyses that identify channels of information flow relevant to specific policies. The underlying diffusion process, however, remains in most cases a "black box," and as yet no comprehensive theory has taken hold that integrates these various proposed diffusion mechanisms, nor has any work to date examined their applicability to RE policy issues. In the absence of further research into information networks and organizations, much recent innovation in the case literature on diffusion cannot be captured in this analysis. The dominant nongeographic model, leader-laggard diffusion, in which particular states emerge as trendsetters, does not appear to be applicable: The pattern of adoption of RPS policies, just as with net metering policies (Stoutenborough & Beverlin, 2008), does not suggest early influence from expected leader states such as California, as Figure 1 demonstrates.

As for internal determinants, there is no clear consensus in current scholarship about which factors contribute to state energy policy adoption. For instance, although multiple studies find RE potential (e.g., high solar incidence or a great amount of land in wind class three or higher) to be meaningful, others find evidence to the contrary. Matisoff (2008) finds no statistical significance to wind potential under multiple analytical models, although he does find solar potential to be statistically significant in relation to RPS adoption. On the other hand, Lyon and Yin (2010) find wind potential to be significant in all but their simplest analytical model, but do not find solar potential significant. Stoutenborough and Beverlin (2008), in their study of net metering policies, measuring RE potential in terms of average wind speed and annual percent of sunlight, likewise find the former to be statistically significant in three variant models, but the latter in none. In the RPS effectiveness study discussed above, Carley (2009) discusses a counterintuitive relationship between wind potential and states with RPS policies, finding that as of 2006, strong wind potential in a state was not associated with the largest percentages of RE generation.

Specific policies vary widely, making it difficult to generalize reliably across policy domains. Nonetheless, certain common threads have emerged. Factors multiple scholars have found to be significant, with a positive association, for enactment of state energy policies[3] include:

- State-level political ideology, in terms of both citizen preferences and partisan legislative control (Chandler, 2009; Huang et al., 2007; Lyon & Yin, 2010; Matisoff, 2008; Stoutenborough & Beverlin, 2008);
- State affluence, measured through either total gross state product (GSP) (Huang et al., 2007) or GSP per capita (Chandler, 2009; Matisoff, 2008; Wiener & Koontz, 2010).

Meanwhile, contrary to expectations grounded in political economy, multiple scholars have found the presence of strong fossil fuel industries not to be significant: Huang et al. (2007) reach this conclusion about coal, while Matisoff (2008) concurs about coal and arrives at the same conclusion about natural gas.[4]

Other factors of hypothetical but uncertain relevance include variables such as corporate influence from not just fossil fuel industries but emerging RE companies, population growth, average educational attainment, average electricity price, and market deregulation—all factors internal to the state(s) in question—as well as, potentially, the policy enactments of neighboring states.

Another consideration underlying the variation in past findings may be the fact that the existing literature represents no consensus on the best metrics through which to operationalize key variables, nor on the most effective analytical models to employ. Thus, there is a need to revisit these issues with a carefully calibrated approach. Some relevant relationships may have been obscured, for instance, by the fact that the existing RPS adoption literature has thus far treated RPS adoption strictly as a binary variable. While several studies have assessed the effectiveness or efficiency of various RPS regimes, as discussed above, and some studies have considered variations in design, stringency, and enforceability as independent variables relating to those effectiveness results, that same level of nuance regarding policy details has not been brought to bear in assessing when, why, and how the policies are adopted.

These distinctions deserve to be taken into account. The relationship between drivers of policy adoption and the stringency of the policies that result is a question ripe for examination. RPS policies vary dramatically, and stringent policy design may be as interwoven with adoption criteria as it is with effectiveness. All else equal, there is likely to be a meaningful difference between the policymaking process in a state that chooses to adopt a “strong” RPS, one which adopts a “weak” RPS, and one which adopts merely a “voluntary” set of guidelines. Thus, we cannot meaningfully ask the question, “what are the key factors influencing state RPS adoption?” without simultaneously asking the related question, “is there a correlation between these factors and the strength or weakness of the specific RPS policies under consideration, as determined by RE target levels and related design details?”

Methodology

This analysis seeks to address both of the research questions above, and test the factors that lead states to adopt variants of RPS policies, year by year, through means of an EHA. The analysis proceeds in two stages. First, we consider RPS adoption as a binary dependent variable in the same fashion as previous studies: In a given year, a policy is either adopted or not adopted. We then supplement these results with a second stage of analysis that differentiates existing state policies into four categories according to stringency level: no RPS, a voluntary RPS, a weak RPS, or a strong RPS.

The methodological approach employed in this analysis begins with a logit model that measures the probability of observing the event, adoption of an RPS (independent of type), each year, while controlling for political, socioeconomic, and other variables. The probability of RPS adoption for state i at time t is

$$\mathrm{P}_{it} = \mathrm{e}^{\beta Xti} / (\mathrm{e}^{\beta Xti} + 1), \tag{1}$$

where X is a vector of explanatory variables, β is the corresponding parameter estimates, and t is time. We also estimate the probability of RPS adoption using a complementary log-log distribution, as advocated by Buckley and Westerland (2004), since this distribution has a steeper slope and is better able to handle the rare event nature of policy adoption.

In our second stage of analysis, we seek to identify the effect of explanatory variables on the probability of one type of outcome relative to the alternative outcomes. We therefore estimate a multinomial logit (MNL) model to capture multiple discrete outcomes. The probability that the i^{th} state will choose the j^{th} option is

$$\mathrm{P}_{ijt} = \exp(\beta_j' X_{ijt}) \Big/ \sum \exp(\beta_j' X_{ijt}),\ j = 0, 1, 2, 3 \tag{2}$$

With MNL, the probability of all outcomes ($j = 0$, 1, 2, or 3) adds up to one. All the explanatory variables relate to state-level characteristics potentially affecting the decision whether to adopt a policy.

Data

Study Sample

Data on state RE policy are public information, and are compiled on an ongoing basis by the North Carolina Solar Center at North Carolina State University (North Carolina Solar Center, 2010). From this starting point we have assembled a data set from a variety of sources covering 49 U.S. states across the years 1990–2008, for a total sample size of 931 observations. We have omitted the state of Iowa, for two reasons: Iowa's policy adoption event happened well before the time frame of the analysis, suggesting contributing factors meaningfully differentiating it from other states; and Iowa's policy design does not conform to a common stringency metric as outlined below, since Iowa's mandate is defined differently than most states', specifying predetermined targets that are not proportional to total generation levels.[5] Given that the methodological approach employed in this study is an EHA, of necessity we drop all observations for a given state for years following its adoption of an RPS policy. The final sample size is therefore 796 observations.

Policy Variation and Renewable Portfolio Standard Enactment

The metric constructed herein to distinguish policies as weaker or stronger is based on a calculation incorporating several critical factors of policy design. It reflects the rate of change in RE generation over time required by each RPS policy, adjusted by the share of a state's electrical load to which the RPS actually applies. This calculation thereby incorporates multiple essential components of policy stringency without risk of fluctuating in response to exogenous influences, and provides a single intuitive number that can be compared against the policies of other states.

The calculation starts with the final RPS target: the share of total energy generation that must come from RE in the terminal policy year. From that target we subtract the starting mandate for RE share, if any, at the outset of the policy, to determine the total level of change in RE share being sought. This number is divided by the number of years from initial policy adoption to the target year, producing a prorated average annual level of change.[6] Finally, this average is multiplied by the percentage of a state's electrical load that is actually covered by the RPS regulation, accounting for exclusions—for instance, for specific industries or publicly owned utilities—that dilute the overall scope of the policy. These steps are summarized in the following equation:

$$Stringency = \left(\frac{Mandate_{final} - Mandate_{starting}}{Year_{final} - Year_{starting}} \right) \cdot (RPS\_Coverage) \qquad (3)$$

This stringency ratio is calculated at the time of initial policy adoption. The theoretical maximum stringency is 10,000, representing a hypothetical superambitious state moving from 0 to 100 percent RE in the space of 1 year, but actual observed stringency levels cluster in a range somewhat below 100. For example, as of the beginning of 2009, the stringency measure ranges from a low of 37.50 to a high of 105.07, with a mean of 65.93 and a median of 67.83.

Yin and Powers (2010) take a similar approach, but also incorporate a ratio reflecting a state's total energy generation versus existing RE capacity in each given year, which introduces questions of reliability, since states differ in both their definitions and their reporting of existing RE capacity, and which also produces a stringency measure that shifts from year to year even when the underlying policy remains unchanged. Fischlein (2010) proposes a different metric, involving several other aspects of policy design in addition to quantitative stringency, notably including (i) degree of discretion as to means and (ii) penalty regimes for failure to meet targets. However, many of these design features either reduce to binaries or cannot meaningfully be compared across states. The result is a metric that tallies up each factor as a single "plus" or "minus," relying on the author's choice of how to categorize design features and to some degree blurring the more nuanced level of detail it was intended to reveal. We have opted to avoid these complications and construct a stringency index that is straightforward, intuitive, and represented in one variable.

To determine a cut point between weaker and stronger policies, we employ a primary model that takes the stringency level for a given state's RPS at the time of adoption (i.e., for a state-year), and compares it against the median stringency of other states that have adopted a policy as of that year. Notwithstanding some states' later policy revisions as reflected in Table 1 the initial adoption represents the only non-incremental policy action (Chandler, 2009). We use the median stringency value, instead of the mean, to minimize potential variations introduced by outliers. Were we instead to rely on the mean, unrelated actions by another state or states could more easily skew the value and, for example, shift a formerly "strong" state into the "weak" category, implying different causal factors even though nothing internal had changed. While any cut point is to some extent arbitrary, the median also has the logical virtue of representing, by definition, the split between lower and higher

Table 1. State RPS Policies, Arranged by Level of Stringency, Including Revisions through 2008

State	Year RPS Adopted	Initial RE Target (%)	Target Year	Starting Mandate (%)	Initial Load Covered (%)	Voluntary	Stringency Measure	Revision 1	Revision 1 Stringency	Revision 2	Revision 2 Stringency
NH	2007	23.8	2025	4.54	98.2	N	105.07	2008	105.07		
CT	1998	27	2020	6	93.4	N	89.15				
RI	2004	16	2019	3	99.3	N	86.06				
NJ	1999	6.5	2012	3.25	98.3	N	24.58	2004	35.50	2006	86.01
MD	2004	7.5	2022	3.51	93.4	N	20.73	2007	31.11	2008	85.59
OR	2007	25	2025	5	74.6	N	82.89				
MI	2008	10	2015	4.8	100	N	74.29				
CA	2002	20.0	2010	14	98.2	N	73.65				
WA	2006	15	2020	3	84.7	N	72.60				
DE	2005	10	2019	2.01	56.5	N	32.24	2007	72.60		
MA	1997	4	2009	1	86	N	21.5	2008	70.79		
PA	2004	18	2020	5.7	97.3	N	74.80	2007	70.40	2008	70.40
OH	2008	12.5	2024	0.25	88.6	N	67.83				
MT	2005	15	2015	5	66.6	N	66.60				
MO	2007	11	2020	0	0	Y	0.00	2008	65.00		
CO	2004	10	2020	3	58.7	N	25.68	2007	62.37		
MN	2007	30	2020	15	47.8	N	55.15				
HI	2001	9.0	2010	0	0	Y	0.00	2004	52.63		
NC	2007	12.5	2021	2.95	75.2	N	51.30				
NV	1997	3	2001	0	88.2	N	66.15	2001	49.61		
ME	1999	30	2017	30	98.3	N	0.00	2006	49.15	2007	49.15
NY	2004	25	2013	20.2	84.7	N	45.17	2005	45.17		
TX[a]	1998	6.4	2009	0	75.9	N	43.82	2005	44.83	2007	44.83
IL	2001	15	2020	0	0	Y	0.00	2007	43.31		
AZ	2006	15	2025	1.33	58.8	N	42.32				
NM	2004	10	2011	10	67.7	N	0.00	2007	41.68		
WI	1999	2.2	2012	0	100	N	16.92	2006	37.50		
SD	2006	10	2015	0	0	Y	0.00	2008	0.00		
VT	2005	20	2015	0	0	Y	0.00				
ND	2007	10	2015	0	0	Y	0.00				
UT	2008	20	2015	0	0	Y	0.00				
IA[a]	1983	N/A	2000	0	75.7	N	N/A	1991	N/A	2003	N/A
VA[a]	2007	N/A	2025	0	0	Y	N/A				

Gray area indicates states currently designated as "weak" in relation to the most recent median stringency.
[a]Policy designed with flat generation thresholds, not percentages of total.

values across whatever range of states is involved. This calculation produces a year-to-year rolling threshold that reflects the evolving state of the policy environment, and that allows us to divide states into categories according to their stringency relative to that threshold, comparing each adoption-event value against the most up-to-date pool of other RPS states.

To ensure the validity of our results, and because it is worthwhile to consider that some states' stringency scores do change at various points in time with policy revisions,[7] we have also constructed and analyzed three alternative models: (i) a version of our base model derived from the *mean* rather than the median of concurrent policies; (ii) a version that compares the stringency at adoption against the median stringency of all other state RPS policies over the *entire study period*, producing a threshold and a weak/strong designation that remain static over time; and (iii) a version comparing each policy's *most recent* stringency value against the current median of other states' policies, to incorporate the more aggressive targets and timelines imposed in some states as the policy environment evolves. In this final model, we take the value of the most recent policy revision's stringency score and enter it retroactively as the stringency value at the year of original adoption.[8] These models demonstrate fairly robust relationships, and support our overall findings as extracted from the base model, notwithstanding minor variations. We do not present detailed results of these alternative robustness-check models in the body of this article, but do address this issue in the endnotes.

The list of state RPS policies under analysis, which includes all those in place as of the beginning of 2009, along with the underlying stringency factors, is summarized in Table 1. Texas's policy expresses targets in terms of a flat RE output rather than a share of total generation, but we have gathered additional data to allow a conversion into units consistent with the stringency formula. Two other states, Iowa and Virginia, also use flat targets, but similar attempts at conversion would be moot in those cases.[9] Seven additional states initially adopted voluntary measures, so the requirement sums to zero. Enforcement and compliance details vary, but cannot be systematically quantified; a few states have incorporated "escape clauses" into their policies allowing some requirements to be waived under certain circumstances, for example, but there is no evidence these clauses have interfered with enforcement efforts (North Carolina Solar Center, 2010).[10]

Of the 32 states that adopted RPS policies during the period under study, therefore, 24 adopted measurable, nonvoluntary policies. Of these, we have designated those above the annual median as "strong" and those below it as "weak." The final version of the dependent variable, *RPS scale*, is coded as follows:

- 0 if the state has no RPS policy;
- 1 if the state has a voluntary, nonbinding policy;
- 2 if the state has a weak RPS, and;
- 3 if the state has a strong RPS.

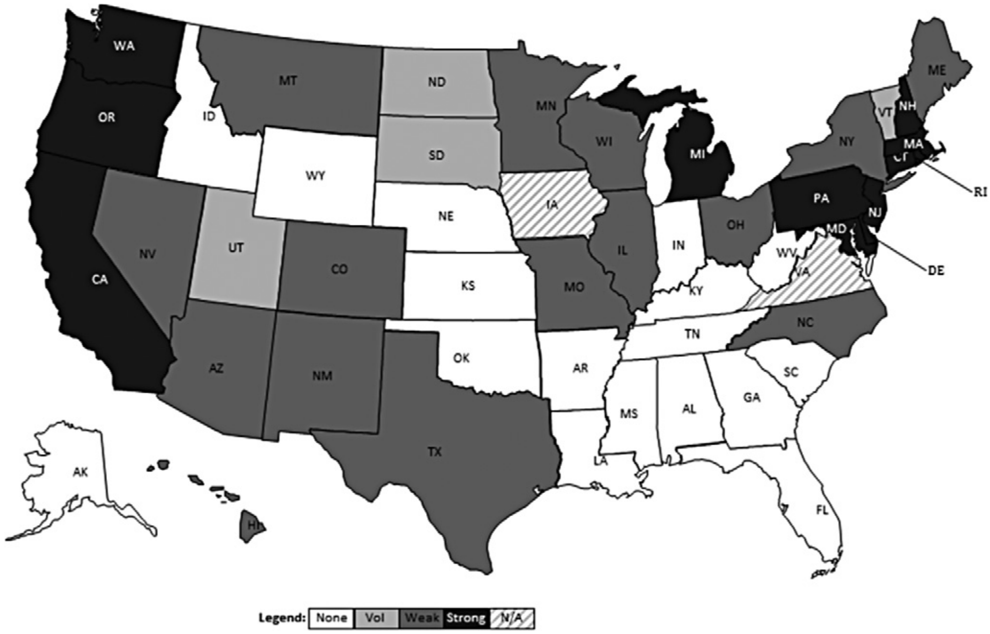

Figure 2. RPS Stringency by State, as of 2008.

Table 1 presents this information in detail, listing RPS strength by state in 2008, with the gray background indicating the "weak" policies, and Figure 2 presents a map visualizing the same information.

Table 2 presents the trends in RPS adoption and stringency levels over time, tracking mean stringency values by year across all states, and also across only those states with nonzero stringencies. Figure 3 provides a chart representing these trends visually, where the left y-axis tracks the average stringency value of all nonvoluntary RPS policy states and the right y-axis tracks the number of states with any RPS policy, including voluntary policies. Even though Iowa is excluded from this statistical analysis, it is included in the count of RPS states on this graph. It is interesting to note that, notwithstanding a surge in 1998 and subsequent reversion to mean, the trend over time shows a fairly steady increase in stringency levels as additional states adopt RPS policies.

Independent Variables

The independent variables we include in this analysis are those determined to be significant for energy and environmental policy by existing state-level policy adoption studies (Chandler, 2009; Huang et al., 2007; Lyon & Yin, 2010; Matisoff, 2008; Ringquist & Garand, 1999; Stoutenborough & Beverlin, 2008; Wiener & Koontz, 2010), as well as those considered theoretically relevant but typically found insignificant by analyses that did not account for variations in policy strength. We divide these variables into three categories. In the first category are state-level citizen

Table 2. RPS Adoption and Stringency Over Time

	Mean RPS Scale[a]	Number of States with an RPS[b]	Mean Stringency Score across All States[b]	Mean Stringency Score among Those States with a Nonzero RPS
1990	0	1	0	0
1991	0	1	0	0
1992	0	1	0	0
1993	0	1	0	0
1994	0	1	0	0
1995	0	1	0	0
1996	0	1	0	0
1997	0.102	3	1.75	43.83
1998	0.204	5	4.41	55.15
1999	0.347	8	5.24	43.69
2000	0.347	8	5.24	43.69
2001	0.388	10	4.91	40.93
2002	0.449	11	6.38	45.60
2003	0.449	11	6.38	45.60
2004	0.776	17	12.70	48.86
2005	0.880	20	14.70	49.01
2006	1.020	23	19.40	53.90
2007	1.327	30	28.65	59.69
2008	1.510	33	35.60	65.93

[a]Calculated using the full sample of states each year throughout the entire study period, with no truncation after states adopt a policy. Possible values for RPS Scale include 0 = no policy, 1 = voluntary policy, 2 = "weak" policy, and 3 = "strong" policy.
[b]Includes the state of Iowa.

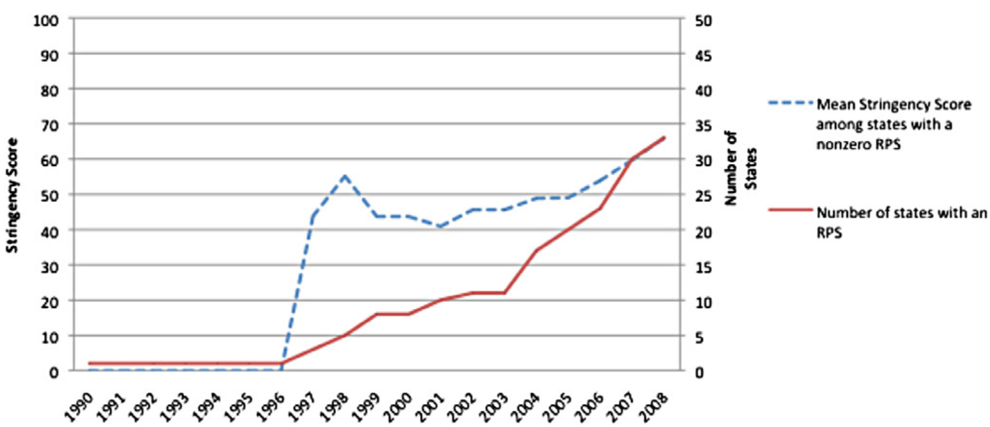

Figure 3. RPS Stringency and Adoption Over Time.

ideology and state-level government ideology. In the second category are economic factors, including average electricity price, electric market deregulation, and wind- and solar-based RE potential. The third category of independent variables, socioeconomic factors, includes affluence as a function of GSP per capita, as well as population growth rate. We also include a diffusion variable that indicates RPS policy presence in neighboring states, and a time trend variable.

Political and Citizen Ideology

In the absence of regular comprehensive polling of the sort available at the national level, state-level political ideology is difficult to measure; political ideology is most commonly operationalized through broad-brush proxies, such as partisan legislative control, which, given its binary character, often winds up indicating much more volatility than is plausible. The least-problematic metrics currently available, the Berry/Ringquist/Fording/Hanson (BRFH) indices (Berry, Fording, Ringquist, Hanson, & Klarner, 2010; Berry, Ringquist, Fording, & Hanson, 1998, 2007), are complex models incorporating and weighting multiple factors, including interest-group ratings of congressional representatives, estimated ideologies of electoral challengers, vote weights by district, and a nonlinear distribution of legislative partisanship. The results are represented numerically on a sliding scale of policy liberalism ranging from 0 to 100. The authors have kept these calculations updated regularly, and available for scholarly use. We use the most recent formulations of both BRFH indices: one targeting state-level citizen ideology, constructed using Americans for Democratic Action (ADA) scores, and one targeting state-level government ideology, constructed using DW-Nominate (NOM) scores. Our hypothesis, based on the literature, is that both citizen and government ideological liberalism should emerge as significant positive indicators of RPS adoption.

To guard against omitted variable bias,[11] we also include a variable reflecting partisan influence: percent of Democratic seats in each state's House, or comparable lower legislative chamber.[12] While such a variable is sometimes used as a proxy for ideology, there are in fact important distinctions to recognize: party status tracks much less closely with liberalism in some states than in others, and manifests in different ways (e.g., caucus-based control of committee assignments or party-line voting). The percentage of Democrats in the House thus merits inclusion as a distinct and separate variable. We also test to confirm that the two variables are not so highly correlated as to result in multicollinearity.

Electricity Market Factors

RE potential is operationalized in the present analysis as the summation of wind and solar potential.[13] In contrast to the other variables included in this study, this variable is time-invariant. Wind power potential is based on measurements of the available windy land area, after exclusions, with a gross capacity factor of 30 percent or greater at a height of 80 meters above ground (Elliot, Wendell, & Gower, 1991). Solar potential is derived from average solar radiation over a 30-year span, 1961–90, for a south-facing flat-plate collector, with zero degree tilt, multiplied by the total area within each state's boundaries and the number of days per year (National Renewable Energy Laboratory, 1991). For statistical analysis, we combine both categories into a single measure of RE potential, expressed in GWh/year.[14] While RE potential is not directly a measure of economic potential, which depends on technology as well, among other factors, it does present a clear link to economic development opportunities—and possibly, more broadly, to energy resource diversification—for policymakers who may be seeking such.

Electricity price is a straightforward measure of average price paid by electricity end users in each state, expressed in cents/kWh, and drawn from Energy Information Administration data (U.S. Energy Information Administration, 2010b). We hypothesize that a higher price for power from current sources, all else equal, can increase acceptance of investment in alternative sources.

Electricity market deregulation is a binary variable that expresses whether or not a state had deregulated by the year in question, using data drawn from Delmas, Russo, and Montes-Sancho (2007). Based on existing literature (Carley, 2009; Lyon & Yin, 2010), we hypothesize that states that have deregulated are more likely to adopt an RPS policy, on average.

Socioeconomic Factors

When measuring state affluence and economic activity, some previous analyses have included total GSP as an independent variable (Huang et al., 2007); but adjusting this figure to a per capita number (Chandler, 2009; Matisoff, 2008) is a preferable approach, since it standardizes for otherwise dramatic discrepancies between large and small states that may not actually be representative of relative affluence. The GSP per capita variable used in the present analysis is extracted from Bureau of Economic Analysis data (Bureau of Economic Analysis, 2010). When holding all else equal, more affluent states may have more public resources available for RE investment and may, therefore, be more inclined to adopt an RPS than poorer states.[15]

Population growth rates are derived from Census Bureau data (U.S. Census Bureau, 1999). The hypothetical expectation for this variable is that a higher population growth rate contributes to a higher rate of energy demand growth, which can lead to a greater sense of need for RE generation. States with larger population growth rates, therefore, would be more likely to adopt an RPS to facilitate this RE development.

Geographic Diffusion

In keeping with the previous literature, we incorporate a variable that tracks the percentage of contiguous states that have an RPS policy, lagged by 1 year, to determine whether there is a directly observable relationship between the policy actions of a given state and the existing policies of its neighbors. We create this geographic or "neighbor" diffusion variable using the Database for State Incentives for Renewables and Efficiency policy data (North Carolina Solar Center, 2010) and a social accounting matrix that documents which states share borders. RPS policy presence is counted from a contiguous state matrix, and then divided by the total number of contiguous states. Hawaii is treated as adjacent to California; Alaska to no other state. The resulting variable ranges from 0, when no bordering states have an RPS, to 100 percent, when all bordering states have an RPS. It is important to note that although

Table 3. Descriptive Summary Statistics[20]

Variable	Description	Mean	Standard Deviation	Min	Max
RE potential	Renewable energy potential (wind and/or solar) in MWh/year	2.93×10^8	2.70×10^8	5,696,333	1.51×10^9
Percent contiguous states with RPS	Percent of adjoining states with RPS policy in place, lagged by 1 year	0.126	0.216	0	1
Citizen ideology	Citizen liberalism calculated on a 0–100 scale	47.59	14.15	8.45	95.97
Government ideology	Government liberalism calculated on a 0–100 scale	49.50	12.92	23.64	73.43
Percent Democratic (House)	Share of state's lower legislative seats held by Democrats	0.525	0.161	0.13	0.92
Electricity price	Average retail price of electricity, in ¢/kWh	6.90	1.98	3.37	14.73
Deregulated	Utility operates in a deregulated or restructured electricity market	0.101	0.301	0	1
Population growth rate	Annual rate of increase in population	0.0108	0.0107	–0.0622	0.0752
GSP per capita	Gross state product per capita, in $millions/person	0.0307	0.00834	0.015	0.0724

observations for Iowa are not included in this analysis, this diffusion variable captures the influence of Iowa's RPS policy on neighboring states' diffusion values.[16]

We expected that this variable could produce mixed results. If its coefficient is positive, as is routinely expected, one may conclude that there is some degree of policy diffusion from state to state. A negative coefficient on a diffusion trend variable, however, is also a legitimate outcome (Hays & Glick, 1997); in such a case one may infer that a state becomes less likely to adopt a policy if its neighboring states already have that policy in place.

Time Trends

We include a simple time trend variable to account for the effect of time on states' policy decisions, which ranges from 1 in the first year of analysis, 1990, to 19 in the last year, 2008. The time trend variable helps stabilize the hazard rate and accounts for the increased likelihood of policy adoption over time.

Results

Table 3 presents all summary statistics and variable descriptions for the sample of 796 observations. During the study period, 32 states adopted RPS policies.

A logit regression of RPS adoption—in binary terms, sans stringency measures—on the independent variables produces the results shown in Table 4. The variables that emerge as statistically significant are citizen ideology and the time trend. The complementary log-log model, also presented in Table 4, demonstrates almost identical results, with GSP per capita crossing the cusp of statistical significance.[17] Increases in citizen liberalism and GSP per capita both show positive relationships with RPS adoption, confirming hypothetical expectations.

Next, we run two sets of MNL specification tests to confirm the requisite modeling assumptions. First, MNL models require that the error terms are independent across outcome categories, and that the ratio of any two probabilities is independent of the remaining choices. This assumption of independence of irrelevant alternatives (IIA) is rigorous but testable. We use multiple methods, calculating both Hausman and "seemingly unrelated estimation" tests on all logical combinations of categories, to ensure that the data satisfy the IIA requirement. These tests confirm that we have not violated the IIA assumption.

Second, we need to ensure that the division of categories is appropriate or, alternatively, whether specific dependent variable categories ought to be collapsed into one option (e.g., whether the Voluntary and No RPS categories should be combined). To test these assumptions, we run a series of Cramer–Ridder specification tests on all logical category combinations. The Cramer–Ridder tests confirm that

Table 4. Models with Binary Dependent Variable: Adoption of an RPS

RPS	Logit Coefficients	Complementary Log-Log Coefficients
RE potential	7.56×10^{-10}	3.55×10^{-10}
	(8.63×10^{-10})	(7.57×10^{-10})
Electricity price	0.0308	0.241
	(0.106)	(0.957)
Deregulated	0.326	0.350
	(0.484)	(0.436)
Percent contiguous states with RPS (lagged)	0.461	0.456
	(0.860)	(0.787)
Citizen ideology	0.0782***	0.0675***
	(0.0219)	(0.0194)
Government ideology	–0.00130	0.000983
	(0.0198)	(0.186)
Percent Democratic in House	0.376	0.114
	(1.67)	(1.42)
Population growth rate	23.95	19.55
	(20.72)	(17.77)
GSP per capita	49.73	42.30*
	(30.36)	(25.62)
Year trend	0.213***	0.205***
	(0.0664)	(0.0609)
Constant	–12.76	–11.64
	(1.91)	(1.62)
Number of observations	796	796

Standard errors in parentheses.
*Statistically significant at the 10% level. ***Statistically significant at the 1% level.

the categories assigned to the dependent variable should not be combined, and each discrete choice outcome should remain its own separate category. The results of this specification check confirm that the stringency categories are meaningfully distinct.

With these results in place for purposes of comparison to prior literature, we turn to the analysis in which the dependent variable incorporates the categorical stringency distinctions described above. In each case, the MNL model reflects the likelihood of adopting an RPS at three distinct levels of stringency, relative to no policy action at all. These results are presented in Table 5. This table presents parameter and standard error estimates based on holding "No RPS Policy" as the omitted reference category.

The MNL models indicate that for adoption of the least demanding form of RPS, voluntary programs, citizen ideology, and the time trend variables are the only statistically significant predictors. Higher rates of citizen liberalism are associated with a greater likelihood of voluntary RPS policy adoption versus no policy at all. For adoption of *weak* RPS policies, citizen political ideology remains the only statistically significant variable. This remains consistent with findings of previous studies (e.g., Wiener and Koontz [2010] find citizen liberalism to be central to adoption of wind-oriented RE policies).

Table 5. Discrete Time Multinomial Logit Model with Dependent Variable Reflecting Stringency (Omitted Category: "No RPS")

RPS Stringency	Voluntary	Weak	Strong
RE potential	-1.66×10^{-9}	1.34×10^{-9}	1.29×10^{-9}
	(2.72×10^{-9})	(1.24×10^{-9})	(1.26×10^{-9})
Electricity price	0.0547	–0.106	0.0730
	(0.211)	(0.184)	(0.163)
Deregulated	–1.56	1.11	0.727
	(1.33)	(0.709)	(0.774)
Contiguous states with RPS (lagged)	1.50	–0.570	0.877
	(1.71)	(1.29)	(1.33)
Citizen ideology	0.107**	0.105***	0.0306
	(0.0450)	(0.0397)	(0.0303)
Government ideology	–0.0294	–0.0401	0.0884**
	(0.0422)	(0.0310)	(0.0418)
Percent Democratic in House	–4.56	1.58	3.06
	(3.50)	(2.59)	(3.03)
Population growth rate	29.58	31.63	9.68
	(50.72)	(26.95)	(31.04)
GSP per capita	54.07	72.59	69.93
	(61.42)	(44.99)	(50.88)
Year trend	0.336*	0.0996	0.263**
	(0.174)	(0.0945)	(0.116)
Constant	–13.85	–12.40	–19.83
	(4.47)	(2.58)	(4.26)

Number of observations = 796. Standard errors in parentheses.
*Statistically significant at the 10% level. **Statistically significant at the 5% level. ***Statistically significant at the 1% level.

Factors that increase the likelihood of *strong* RPS policy adoption are different, and include government ideology and the year trend variable, while citizen ideology drops from significance. Higher average government liberalism scores are associated with an increase in the likelihood of strong RPS adoption, all else constant. Similarly, as time elapses, a state becomes more likely to adopt a strong RPS than maintain no RPS.

The three alternative models that vary our assumptions about the stringency cutoff values and the stringency score confirm the robustness of the results presented in Table 5. Overall these alternative results demonstrate fairly minor variations in magnitude and *p*-values,[18] and are not presented here. Citizen and government ideology remain reliably significant.

Discussion

This analysis sought to evaluate which of a range of theoretically plausible factors influence state RPS adoption, and more importantly, whether these factors differ according to the type of RPS adopted, as specified by RE target levels and related design details. In addressing the first component of the question, we found that RPS adoption, when measured as a binary variable in accord with all past studies, is motivated by citizen ideology. These findings are consistent with past results on RE policy adoption (Chandler, 2009; Matisoff, 2008; Wiener & Koontz, 2010). Since this analysis operationalizes political ideology using different and more precise metrics than utilized in most previous literature, we could not assume that we would find correspondence with others' results; however, the finding that citizens' ideological liberalism is a positive predictor is consistent with theoretical expectations. These results remain consistent when implementing the complementary log-log methodology as well, although GSP per capita emerges in this model as a marginally stronger predictor of RPS adoption than in the basic logit model. It is important to note that, while our results are compatible with previous studies, our study frame differs to some degree from previous analyses and, thus, it is reasonable to expect at least minor differences in results: Notably, our analysis includes a greater range of years, Alaska and Hawaii, and a time trend stabilizer, whereas almost all other studies have omitted these due to data shortcomings.

To address the second component of our research question, we devised an RPS policy stringency score and divided RPS states into voluntary, weak, and strong policy categories; we then ran an MNL model to assess which factors are most significantly associated with these different policy variations. The results reveal some interesting nuances not available from past analyses, and also underscore the importance of distinguishing between different policy designs. Citizen ideological liberalism demonstrates statistical significance for both voluntary and weak RPS policies, but not strong RPS policies. The possible underlying mechanisms linking this particular variable to policy adoptions only at these levels offer an invitation for future research, as it appears plausible that policymakers' choices may be partially motivated by the extent to which such RPS designs can satisfy constituents' ideological preferences by functioning as symbolic politics.

The actual effect of weaker policies may undermine policymakers' risk-averse logic, however, as *ceteris paribus* they are less likely to create the market conditions for greater RE growth and, thus, to produce effects visible to citizens. This suggests avenues for further research about circumstances in which sufficient underlying conditions for strong policy adoption may not be present, despite apparently positive underlying fundamentals, if for example RE potential is plentiful but the political context provides inadequate incentives to maximize its deployment.

The strongest RPS policies, relative to all states' policies, are not predicted by measurable indicators of citizen ideological liberalism, however, but instead by government ideological liberalism. Government ideological liberalism is highly statistically significant for strong RPS states, which fits theoretical expectations—one might reasonably expect government ideology to have at least as direct a bearing on policy choice as citizen ideology, and as one might also anticipate, all else equal, policymakers with a clear ideological commitment are more likely to be motivated to craft a more ambitious policy.

An illustrative comparison helps put these results in context. Consider California, a state long seen as a leader in environmental policy, where lawmakers adopted an RPS in 2002. The BRFH government ideology index measure for California that year, incorporating DW-NOM scores, stood at 71.76, markedly higher than its BRFH citizen ideology index rating of 56.29. The RPS enacted reveals itself to have the second-highest stringency rating then extant, at 73.65. Fully 98.2 percent of statewide electrical generation is covered, and the goal was to reach 20 percent of generation from RE by the year 2010, from a starting point of 14 percent.[19] By way of contrast, Wisconsin—although an early adopter—enacted an RPS in 1999 that is in the "weak" category, with a stringency rating of 16.92, well below the rolling median value of 34.20. Wisconsin's BRFH (NOM) government ideology score for 1999 stood at only 33.70, significantly lower than its simultaneous BRFH citizen ideology index score of 52.28. The state's goal was to reach only 2.2 percent generation from RE by 2012—a level far lower than California's starting point. A revision in 2006 adjusted its goals to be slightly more ambitious, but still firmly in the "weak" category. Although one might be tempted to suspect some degree of endogeneity between citizen and government liberalism, in fact they have no systematic correlation; citizen populations are distributed very differently from electoral districts—or for that matter interest groups—and Wisconsin is known for intense pockets of liberalism in key population centers.

In part, these results, in contrast to the somewhat inconsistent findings in the existing literature regarding political ideology and other political factors, may be attributable to the closer focus in this analysis on variations in the stringency of policies. In part they may be attributable to the more precise approach taken to operationalizing the notoriously complex ideological variables, foregoing rough proxies in favor of more exact and nuanced measures. We have followed the lead of Berry et al. (2010), who confirm that on a continuum of operational ideology—or "policy mood," as opposed to mere self-identification—measuring all years from 1959 to the present, a government ideology metric incorporating NOM common-space scores is superior to alternative constructs. For citizen ideology, meanwhile, they demonstrate that a metric built on ADA ratings remains highly reliable.

GSP per capita, meanwhile, is just outside of standard statistical significance thresholds for all nonvoluntary RPS policies in our primary model, but the direction of the association is positive for each RPS category. Since this is one of the only variables that demonstrates consistent directionality across different policy categories—except for the citizen ideology variable, which demonstrates a similar trend—it is not surprising that this variable is statistically significant in the binary RPS policy model, when differences among the policy design features are obscured. This pattern underscores the lesson that different factors drive policymaking decisions about different types of seemingly similar policies, and that it is important to consider the nuances in policy design when evaluating policy adoption.

In keeping with several others' findings, as reviewed above, the policy diffusion variable included in our analysis does not emerge as a significant predictor of any level of RPS policy. One possible explanation for this finding is that RPS policies simply do not follow any visible diffusion pattern—their spread is effectively random across space. Another possible explanation is that the measure of diffusion, geographic or closest-neighbor diffusion, is not a sufficiently sophisticated measure to account for the flow of policy information and motivation across space. The body of work in related disciplines attempting to unlock diffusion's "black box" has grown dramatically in recent years (e.g., Berry & Berry, 2007; Karch, 2007), however, pointing the way toward new tools and new kinds of variables. Future studies might build on these findings by constructing and testing measures to dissect the influence on state energy policy of factors such as information flows, nongeographic relationships, or policy entrepreneurs and their relation to distinct modes of diffusion (Shipan & Volden, 2008).

Conclusions

The effort involved in determining and applying a metric for RPS policy stringency appears to be fruitful, clarifying ambiguities in earlier work on this popular policy instrument. The drivers of voluntary, weak, and strong RPS policies are distinct from one another. Ideological factors stand out as highly important drivers of policy adoption, with citizen ideology the most significant driver of voluntary and weak policy adoption, and government ideology the most significant driver of strong policy adoption.

The RPS is by no means the only policy instrument available to pursue energy or climate objectives such as electricity diversification, GHG abatement, or energy security, but its rapid spread provides critical insight into the circumstances under which states make policy decisions, and points the way toward multiple avenues of future research. For policymakers and advocates, it is valuable to know the circumstances most conducive to adoption of a particular kind of policy design. In scholarly terms, the foundation is laid for more nuanced inquiries into the mechanisms of diffusion for policy innovations.

Meanwhile, the approach we introduce for measuring and comparing policy stringency may help other analysts formulate more systematic metrics for similar situations. This approach avoids many problems of previous measures (e.g., compression into binaries or subjective weighting), while offering greater precision, and may thereby contribute analytical value beyond the realm of energy policy. Many kinds of policies cannot be evaluated fully except in the long term, after all, yet still present a wide range of variations to scholars and practitioners that must operate in the moment; and in such situations a comparable construct could readily be useful.

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Notes

1. Some form of national RPS has been included in energy bills in every Congress since 1997, passing the Senate in the 107th, 108th, and 109th Congresses (Sissine, 2007) and the House in the 110th and 111th, but has yet to become law.
2. Hydroelectric power is especially controversial, for example, and often excluded from the RE designation, while solar power is often favored by designated “carve-outs” specifying a set level of renewable energy that must be solar generated.
3. Some studies examine these factors in relation to other types of RE policy as well; e.g., net metering (Stoutenborough & Beverlin, 2008) and energy efficiency programs (Matisoff, 2008).
4. While we would prefer to include fossil fuel industry presence in this analysis, we were not able to do so due to inconsistencies in fossil fuel industry data over time. In particular, the Bureau of Economic Analysis switched from Standard Industrial Classification to North American Industry Classification System codes for GSP estimates in 1997. While the overall GSP trends did not significantly shift between 1996 and 1997 based on these changes, trends associated with the fossil fuel industry’s proportion of total GSP changed significantly.
5. As mentioned in the text, Iowa in the 1980s was responding to economic development opportunities at a time when both demand and the cost of new traditional power plants was high (D. Osterberg, personal communication, 2011). It remained an outlier for a considerable time, and when other states did begin enacting nominally similar policies, they marked a clear departure from Iowa’s lead—opting for incremental changes in the renewable share of total electricity production over time, rather than for specific predetermined thresholds.
6. Many states’ policies have partial targets at intermediate years that may or may not reflect a consistent rate of change. However, the average over time is the more informative data point, as it bears a clear and consistent logical relation to the overall goal.
7. It is important to underscore that the stringency calculations are based on the versions of RPS standards in place in each individual state, but the median against which they are compared is influenced by every other state with a similar policy. While the measure of stringency itself stays consistent, therefore, the demarcation of weakness versus strength is not absolute, but always

relative, seen in comparison to other states pursuing similar goals. As Table 1 also shows, several states have revised their policies since initial adoption. This is always a possibility for any state, since no legislative enactment is ever truly in "final" form. In the case of five states, utilizing the more recent stringency value would shift the state's category, as would also of course be true for the three voluntary states that subsequently imposed mandatory policies. It is however important to remember that while this shifting interstate policy context may affect the designated stringency category, the underlying independent variables influencing the decision to adopt or revise remain unchanged.

8. Whereas our base model categorizes states based on their initial policy choices without giving credit for later improvements, alternative model 3 avoids this shortcoming only by crediting those improvements in advance of their actual implementation. A comparison that incorporates different stringencies for each state in every year that includes a policy revision is beyond the capabilities of the regression processes involved, which require a state to drop from the pool after the year of adoption in order to produce an accurate hazard rate of policy adoption in relation to the underlying independent variables.
9. We converted the flat targets for Texas into proportional RE levels, since the initial legislation stipulated a starting mandate in MW at a level that can be compared to total electric generation for that year in MWh, and subsequent targets that can also be compared against projected total generation levels based on historical averages (U.S. Energy Information Administration, 2010a). Electric generation in Texas represents a substantial portion of the entire Southwest, and Texas was an early adopter of an RPS, so although this conversion process does introduce a level of uncertainty we deem it preferable to the bias that might arise by omitting the state from the data set. The other two states are Virginia and Iowa. We did not attempt a conversion for Virginia, as its program is voluntary, making such measurements moot; nor for Iowa, as it was dropped from the data set as discussed earlier, since sufficient data were lacking.
10. Kansas has an exemption from penalties if the impact of compliance on electricity rates exceeds 1 percent; New Mexico does the same if it exceeds 2 percent; and in Minnesota the Public Utilities Commission can excuse noncompliance with a general "public interest" exception. In Nevada it appears to be a discretionary matter, in which authorities "may" penalize noncompliance. Arizona, Colorado, New York, and North Carolina appear to have no specified penalties for noncompliance, so the enforcement mechanisms are unclear. However, all of these states are in fact tracking compliance and reporting progress (North Carolina Solar Center, 2010).
11. We also considered incorporating a variable for legislative professionalism, as discussed by Ringquist (1993) and Squire (2007), or for administrative capacity (Nelson, 2012). However, we are concerned that either measure might introduce confusion as to the unit of analysis, as the former assesses state legislatures according to a shifting standard set by Congress at a national level, while the latter is primarily concerned with individual officials, not state-level institutions. Moreover, in both cases the years for which data are available are sporadic; in the first instance they do not postdate 2003, while in the second they do not predate 1999, and either one would require interpolating measurements for most years in question, making both inadequate for our purposes.
12. Note that Nebraska has a unicameral legislature, in which all members are elected without regard to party affiliation. While individual Nebraska politicians technically do have party affiliations, the state constitution prohibits structuring an election around those affiliations, and the legislature does not determine leadership based on party identity. Moreover, recent scholarship indicates that party cleavages have a reduced effect on members' roll-call voting in Nebraska as compared with other states (Wright & Schaffner, 2002). Accordingly, rather than dropping Nebraska from the sample, we have elected to code its partisan balance as 50 percent (i.e., 50/50) for all years in the study period, reflecting the lack of traditional partisan control and its concomitant effect on agenda-setting. The *ideology* of Nebraska government officials, on the other hand, may still be quite significant and reflected in their policy choices.
13. Wind power has a much larger installed base at this point, and there is an argument that combining these two factors may obscure relevant information, allowing one potential to hide the influence of the other. On the other hand, it is also arguable that disaggregating them might artificially underplay the significance of RE potential, since even if (e.g.) solar is not a significant contributing factor by itself, it may still weigh into the adoption process when considered in combination with wind. We are persuaded by the rationale that actual policymakers are more likely to see an RPS policy as more attractive if a state has untapped RE potential of any sort, without differentiating by type.

14. It is worth noting that this unit of measurement represents renewable energy potential based on standard assumptions about technological performance. If wind and solar efficiencies and capacity factors improve in the future, the total potential should also increase.
15. It is important to note that this variable is based on Standard Industrial Classification (SIC) codes pre-1997 and the North American Industry Classification System (NAICS) codes from 1997 onward, since the Bureau of Economic Analysis changed its classification system in 1997. We have confirmed that this change does not introduce any serious deviations in GSP per capita trends, and also ran all regressions with a dummy variable for 1997 in absence of the time trend variable to control for the change in methodology during this year, but did not find any statistical significance for the 1997 variable. Accordingly, while we are cognizant of the cautions, the final versions of our models do not include a control for 1997, and simply combine the SIC and NAICS codes into one variable.
16. We also constructed a lagged diffusion variable that adds up the stringency scores of all contiguous states, wherein the score is equal to zero if a state does not have a policy in the previous year, but equal to the stringency score if the state does have a policy in that year. This variable did not produce fundamentally different results from the diffusion variable derived from the percentage of surrounding states with RPS policies, so we elected to use the latter, in conformity with the way that other scholars have operationalized regional neighbor diffusion variables in the past.
17. Technically GSP per capita is on the very edge of statistical significance, so although there is a difference of only 0.002 between the logit and complementary log-log *p*-values, that difference happens to put it just outside the 0.10 threshold for the former (0.101) and just within that threshold for the latter (0.099).
18. Differences among the alternative specification models are minor, and mostly represent small shifts in statistical significance, where a model specification pushes a parameter estimate just above or below the significance threshold. Economic factors such as GSP per capita, RE potential, and a deregulated electricity market *may* also increase the likelihood that a state will adopt a nonvoluntary RPS, but these emerge as statistically significant only inconsistently across the alternative models. In the first alternative model, using the annual mean stringency rather than the median as the cutoff value, government ideology and GSP per capita emerge as weakly significant for weak RPS policies, as well as deregulation and the time trend for strong policies. In the second alternative, comparing against median stringency over the entire study period, the only statistically significant addition for weak policies is GSP per capita, and only the time trend for strong policies. Only in the third alternative model, in which policy stringency is ranked retroactively based on the states' most recent policy designs, does RE potential emerge as statistically significant, but for weak policies only, while for strong policies citizen and government ideology swap sides of the significance threshold and GSP per capita again appears significant. This makes some theoretical sense, inasmuch as concrete information about untapped resources (e.g., wind or solar) is logically the sort of variable likely to reduce, albeit not eliminate, the reservations of policymakers inclined to harbor uncertainties about new technologies and volatile energy markets; the third alternative may be suspect as a test of political variables, however, as it essentially attributes later decisions to earlier legislatures. Factors that remain consistently significant across the alternative specifications include citizen ideology for voluntary policies and weak policies, and government ideology for strong policies, except in the third alternative. Detailed results of these alternative models can be made available by the authors upon request.
19. This policy was revised to be even stronger in 2009, just outside our study period, adjusting the target to 33 percent by 2020, thus raising the stringency score to 103.45.
20. Note that the summary statistics shown in Table 3 represent the truncated version of the sample, with states removed from the model after the year of policy adoption.

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