Adoption and Diffusion of State Energy Policies: A Comparative Assessment

October, 2012

Sanya Carley [a,*]
Chris J. Miller [a]

a. School of Public and Environmental Affairs, Indiana University, Bloomington, Indiana.

* Corresponding author: School of Public and Environmental Affairs, Indiana University, 1315 East Tenth St., Bloomington, Indiana; scarley@indiana.edu; 812-856-0920.

Abstract

Within the U.S., state-level policymakers have taken the lead on U.S. energy policy since the early 1990s. Recent work on evaluation of these state energy policy activities highlights the importance of distinguishing degrees of policy stringency, ranging from entirely voluntary participation to rigorous and strictly enforced mandates. In this comparative policy analysis, we devise stringency metrics for three of the most prevalent energy policies: renewable portfolio standards (RPS), energy efficiency resource standards (EERS) and net metering (NM) standards. The objectives of this analysis are twofold: first, to establish whether it is important to account for differences in policy stringency when evaluating these policies; second, to determine how the significant factors that influence adoption differ from one policy to another. We find that more substantive, evidence-based variables involving, for example, economic development and government capacity tend to drive NM policies, in contrast to the political factors underlying the RPS, with EERS policies situated in the middle of the spectrum. The findings highlighted in this analysis may inform more effective future policy choices, while the stringency approach central to this analysis may be adapted for use by other scholars concerned with topics both within and beyond the realm of energy policy.

Introduction

Sustainability has become central to contemporary public discourse, with far-reaching implications for economic, environmental, and political life (Fiorino 2010), and energy policy represents an important and fast-evolving policy arena ineluctably intertwined with sustainability issues. However, sustainable energy policy initiatives confront political, economic, scientific, and technological challenges, with far-reaching implications in each of these realms. Such efforts remain politically contentious and encounter notable resistance from established stakeholders, so much so that no comprehensive energy policy has been embraced in the national political arena since the 1970s, despite the growing salience of these issues.

Over the past two decades, however, many states have taken the initiative to explore and enact innovative, sustainable energy policy initiatives, in their classic role as “laboratories of democracy.” States have adopted a variety of renewable energy, energy efficiency, and small-scale distributed generation policies. Although there are discernible trends, there has been great variability across states in policy adoption and design. . The disparate influences and policy goals driving these choices invite comparative evaluation. In such an evaluation it is critical to understand how enacted policies compare to alternatives, how and why public officials have chosen to adopt and apply familiar policy instruments in different ways, and how these state-level policies might lay the foundation for eventual action at a national scale.

The objective of this study is therefore to assess why and how states have adopted renewable energy (RE) and energy efficiency (EE) policies. The study poses two related research questions: first, which factors motivate state policymakers to adopt different RE and EE policies, and how these factors differ from one another; and second, whether those factors and their relative influence are affected not just by differences *between* policies but by differences in design stringency *within* policies. The first question is important because most past literature tends to consider policy alternatives in isolation from one another, even within related issue areas. A comparative analysis can provide insights on how these policies are situated in relation to one another, illuminating when and how policymakers' choices may either complement or compete with each other. The second question is important because states have not only adopted different sets of RE and EE policies in recent years, but have also introduced wide variation within specific policy models. For example, when enacting the now-familiar renewable portfolio standard (RPS) policy, different states have chosen different target percentages, deadlines, and eligible energy sources, among other policy features. As more states adopt these policies, and the variations in design details become more intricate, the task of evaluating these variations becomes increasingly important, but also increasingly challenging (Carley and Miller 2012).

In focusing on policy drivers in a comparative context, this study also explores the manner in which policy diffusion shapes policy choice. Although it appears evident that diffusion is involved in policy adoption, the policy literature has focused predominantly on a fairly direct diffusion indicator, the percentage of geographically contiguous states with a policy, which does not account for other "peer" effects between states (Shipan and Volden 2012). The present analysis steps beyond this to consider alternative mechanisms by which policies diffuse across space and time.

This study, therefore, aims to extend the energy policy adoption literature in three ways: by providing a comparative evaluation of the disparate factors driving policy adoption; by developing a measure of policy stringency for each of the policies under examination, and using this measure to evaluate variations in stringency in relation to adoption; and by constructing and incorporating a new variable to measure state-to-state diffusion effects based on ideological peer congruence between states. In these complementary ways this research may shed light on what guides public policy decision-making in this critical and complex emerging policy arena, paving the way for better and more consistent sustainable energy policies.

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

Background

Categories of Energy Policy

Today's economy hinges on increasing supplies of energy, much of which is sourced from fossil fuels. The effects of heavy reliance on fossil fuels include greater concentration of greenhouse gases in the atmosphere, increased incidence of water pollution, and a variety of other forms of energy-related externalities (IPCC 2007). Additionally, both the security of individual nation-states, and political relations between nations, are rendered fragile by competition over finite supplies of fossil fuels.

Although multiple efforts in Congress (Sissine 2007) have thus far failed to produce a national energy policy for the United States, individual state governments have found opportunities within this policy vacuum. States are often cited as "laboratories" of democracy," in which competing policy ideas are put to the test (*New State Ice Co. v. Liebmann* 1932). Interrogating this concept, scholars have discovered some revealing patterns in the way policy issues rise to the top of states' political agendas and how policy ideas diffuse across space and time.

The realm of state-level energy policy has changed dramatically in the space of less than 20 years (Rabe 2006), and presents a complex case study in how multiple social and political factors interact within a fast-changing policy arena. Many state policy efforts in this arena have supported innovations in advanced, efficient, and low-carbon energy resources (Gallagher et al. 2006), including innovations in renewable energy (RE), energy efficiency (EE), and small-scale, localized energy systems.

To date, 45 states have enacted RE policies (NC Solar Center 2011), the most prevalent of which is the renewable portfolio standard (RPS), a hybrid command-and-control and market-based policy that incorporates graduated RE deployment goals over time (e.g., 15 percent of electricity production from RE by a target date of 2025). Flexible and popular, the RPS has been adopted far more widely than competing energy or climate policies such as carbon taxes or marketable greenhouse gas allowances (Wiser et al. 2004, Rabe 2008). Apart from RE, other commonplace energy policy models include the energy efficiency resource standard (EERS), similar to and newer than the RPS, which mandates specific EE savings by a designated target date (e.g., 12 percent EE savings from 2000 levels by 2025), and the widely popular net metering (NM), which allows smaller and less centralized energy systems—referred to as "distributed generation" (DG)—access to the electrical grid by mandating a state's utilities to allow independent DG owners to connect their systems to the grid.

Adoption and Diffusion

There remain substantial gaps in our understanding of the underlying processes that motivate state-level policy decisions in these interconnected areas. 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.

Consensus on drivers of policy adoption is lacking. While multiple studies find RE potential (e.g., high capacity for solar or wind energy production) to be meaningful, for instance, others find evidence to the contrary. Matisoff (2008), for example, does not find wind potential statistically significant in multiple analytical models, although he does find solar potential to be significant for RPS adoption specifically. Similarly Carley (2009) uncovers a surprising relationship between state-level wind potential and RPS policies, finding that strong wind potential was not associated with the greatest shares of RE. Conversely, however, Lyon and Yin (2010) find wind potential significant in multiple models, but not solar potential. And Stoutenborough and Beverlin (2008), measuring RE potential in terms of average wind speed and annual percent of sunlight, likewise find wind to be statistically significant in three variant models, but solar in none.

Despite such inconsistencies as these, however, some adoption patterns have emerged. Multiple scholars have found certain factors to be significant as drivers of state RE policies, including state-level political ideology, measured via citizen preferences or partisan legislative control (Lyon and Yin 2010, Huang et al. 2007, Matisoff 2008, Stoutenborough and Beverlin 2008, Chandler 2009), and state affluence, measured through either total gross state product (GSP) (Huang et al. 2007) or GSP per capita (Matisoff 2008, Chandler 2009, Wiener and Koontz 2010).

The literature has historically fallen short of its potential for analyzing policy diffusion, arguably due less to methodological limits (Volden 2006 offers helpful refinements, for example) than to inconsistency among analysts' attempts to accurately control for diffusion processes. In many cases the phenomenon is treated as a "black box" driving policy change, identifying patterns of adoption but leaving observers with no clear rationale to explain one state's decision versus another's. Although policy diffusion can be observed spatially and chronologically for many policy issues, and despite a wide literature on the topic, it lacks a unifying theoretical framework to explain its underlying processes or mechanisms (Shipan and Volden 2008, 2012).

Meanwhile, recent work has turned to the relationship between stringent policy design and policy effectiveness. Logically, one might expect that state policies incorporating strong mandates would more easily achieve (and evaluate) the desired energy policy reforms, while those with weak or non-binding mandates would encounter more difficulties. Yin and Powers (2010), analyzing RPS policies, confirm that effectiveness measurements elusive unless differences in policy strength are accounted for. Fischlein (2010) finds that measures of ovreall policy stringency, although they should not be allowed to overshadow more nuanced design features, are indeed associated with improved policy outcomes. Investigating the relationship between stringency and policy adoption, Carley and Miller (2012) suggest that simple binary measures of policy adoption may be misleading, finding that when variations in stringency are properly represented in an analytical model—ranging from voluntary participation to rigorous and strictly enforced targets with full utility-sector engagement—RPS policies of different levels of stringency are motivated by systematically different underlying factors.

RE policies such as the RPS, however, are not the only state-level energy policies that vary by stringency. EE and DG policies also demonstrate significant variations in policy design across states, with theoretically plausible influence on both the adoption and the implementation of these policies. This study therefore incorporates stringency metrics for EERS and NM policies as well, along lines similar to the abovementioned RPS metric, allowing for a comparative analysis both among and within these distinct policy approaches. Such a comparison may tease out insights about policy means, ends, effectiveness, and interactions, that cannot be discovered through a binary adoption analysis, nor discerned in the context of any single state's policy choices.

Methodology

Study Sample

This study focuses on three prominent energy policy instruments that have been adopted across the U.S. since the 1990s, and that, taken together, exemplify the range of sustainable energy options available to state-level policymakers.

- Renewable portfolio standards (RPS), which aim to increase renewable energy;
- Energy efficiency resource standards (EERS), which aim to increase energy efficiency;
- Net metering (NM), which seeks to reduce the barriers to distributed generation (DG) deployment.

The main objective is to evaluate which variables, including both internal state characteristics and external diffusion factors, motivate states to adopt different versions of these three policies and why. As a comparative analysis, this study focuses on whether these policies are driven by the same factors or whether fundamentally different issues motivate different policy models.

To this end, we have assembled a state-level panel data set spanning 1990-2009 for every state in the U.S., a time frame that captures critical policy activity for each of the three energy policy models, including data on adoption and revision. Data on state energy policies are public information, and are compiled on an ongoing basis by sources such as the North Carolina Solar Center at North Carolina State University (NC Solar Center 2011).

With 50 states across 20 years, our total sample size is 1000 observations. This sample is reduced to some extent depending on the specific policy and variables we are testing in a given model. For example, when analyzing RPS adoption, we have omitted the state of Iowa, for two reasons: Iowa's policy adoption event happened long 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 its mandate is defined differently than most states', specifying predetermined targets that are not proportional to total generation levels.[ii]

After gathering extensive state and year data on each of the three policies, we construct stringency metrics that incorporate insights from multiple sources, as detailed below. For example, a state with no EERS in a given year will be coded as zero, while a state with a binding and aggressive EERS will take on a value closer to the top of the stringency range. The range is then divided into logical categories designating voluntary, "weak," and "strong" degrees of policy stringency. These categories serve as the dependent variables.

Hypotheses

Our guiding hypothesis is that significant differences exist between the three models of sustainable energy policy: RPS, EERS, and NM. Net metering policies tend to be perceived as relatively intuitive and uncontroversial, inasmuch as they emphasize use of familiar energy sources while holding out the promise of decreased power bills through user-friendly new technology (Graab 2010), whereas alternative energy development involves a certain irreducible uncertainty that leads it to be perceived as more complex and risky, and correspondingly more prone to political controversy (Tylock 2012). Wilson and Stephens (2009) illustrate how wind power is highly sensitive to state-level political factors; RPS policies incorporating wind as well as other alternatives stand logically as even more so. Hence we expect to find that more evidence-based variables such as economic development and electricity price will be associated with NM policies, corresponding to their relatively apolitical valence, in contrast to more contentious political factors underlying the comparatively complex RPS, with EERS policies situated in the middle of this spectrum. For each of the three policies, however, as the stringency of the policy increases we expect that political factors will rise in importance. Policy diffusion from peer states is also likely to play an important role in adoption of more stringent policies.

Stringency Scores

To determine a cut-point between weaker and stronger policies, for both RPS and EERS policies we follow the method applied by Carley and Miller (2012), refining the work of Yin and Powers (2010), which incorporates the mandated change in RE or EE levels over time, divided by the time span involved, prorated by the percentage of a state's generating load covered by the policy:

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

This produces a continuous scale for policy stringency levels that allows us to compare a given state's policy, in the year of adoption, against the median stringency of other states that have adopted a policy as of that year.[iii] The result is a year-to-year rolling threshold that reflects the evolving state of the policy environment, categorizing states' policies as "strong" and "weak" according to their stringency relative to that threshold.

With NM policies, which do not have readily quantifiable target levels or dates in contrast to RPS or EERS policies, we have followed a slightly different approach. The Interstate Renewable Energy Council publishes an annual "report card" of state NM and DG policies (IREC 2010), assigning point scores (and letter grades) based on compliance with a selection of industry "best practices." We utilize these scores to derive our strong/weak rankings, again comparing an adopting state-year against the median score of prior adopting states.

For each policy type—RPS, EERS, and NM—the final version of each dependent variable is therefore categorical, coded as follows:

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

To ensure the validity of our results, and to acknowledge that some states' stringency scores do change at various points in time with policy revisions,[iv] we have also constructed and analyzed two alternative models: (1) a version of our base model derived from the *mean* rather than the median of concurrent policies, and (2) a version that compares the stringency at adoption against the median stringency of other similar policies over the *entire study period*, producing a threshold and a weak/strong designation that remain static over time.[v] These models demonstrate fairly robust relationships, and support the overall findings from the base model, notwithstanding minor variations. We do not present detailed results of these alternative robustness-check models in the body of this paper, but do address some nuances in the endnotes.

Independent Variables

Existing literature on state-level energy policy adoption informs our choice of independent variables for this analysis. Researchers have considered numerous variables influencing energy policy choices, especially in the area of RE (Lyon and Yin 2010, Huang et al. 2007, Matisoff 2008, Stoutenborough and Beverlin 2008, Chandler 2009, Wiener and Koontz 2010), including internal determinants as well as policy diffusion measured via various forms of geographic proximity. We also consider factors that remain theoretically relevant despite typically being found insignificant by analyses that did not account for variations in policy stringency.

The analysis includes economic, environmental, political, and diffusion factors. Economic factors include electricity prices, market deregulation, population growth, and state wealth. Environmental factors include climate-driven energy demand, wind and solar energy potential, and carbon dioxide emissions. Political factors include the ideological orientation of both the public and the state legislature. Diffusion factors include the actions of both geographic and politically ideological peer states.

Internal Determinants

Electricity price indicates the annual average real price of electricity in each state, in cents/kWh, drawn from Energy Information Administration data (USEIA 2010). We hypothesize that higher prices for current power, all else equal, can increase interest in alternative sources.

Electricity market deregulation, a binary variable, indicates whether a state had deregulated in a given year, based on Delmas et al. (2007). Per existing literature (Carley 2009, Lyon and Yin 2010), we hypothesize that deregulated states on average are more likely to adopt a new energy policy.

Population growth rates come from annual Census Bureau data (U.S. Census Bureau 1999, 2009). We expect that a higher population growth rate contributes to anticipated higher growth in energy demand, which can stimulate greater openness to RE or EE policies.

As a measure of economic affluence, some previous analyses have utilized total gross state product (GSP) (Huang et al. 2007), but a per capita number (Matisoff 2008, Chandler 2009) is preferable becauseit standardizes for discrepancies between large and small states that may not actually signify relative affluence. The GSP per capita variable in the present analysis is derived from Bureau of Economic Analysis data (BEA 2010). This variable serves an indicator of state government capacity: all else equal, we expect more affluent states to have more public resources available for RE investment and, therefore, to be more likely to adopt a policy than less wealthy states.[vi]

Heating and cooling degree days (HDD and CDD, respectively) measure energy demand for seasonal heating and cooling, calculated by comparing daily air temperature to a base temperature of 65° Fahrenheit. In this study the data used are those compiled by the National Oceanographic and Atmospheric Administration (NOAA 2009), and within each state the temperature data is weighted based on the share of the state's population near each local measurement point, based on the most recent U.S. Census, to assure that inferences about demand reflect conditions in the more populous areas. These cumulative HDD/CDD data can be used to compare demand across states in a given year. More pertinent to this analysis, the NOAA also normalizes the data by converting it to a percentage relative to cumulative historical norms, allowing it to reflect changing demand within a given state over time.

Renewable energy potential is operationalized as the summation of wind and solar potential, combined into a single measure, expressed in GWh/year. In contrast to the other variables, this variable is time-invariant for the study period. Wind power potential is based on measurements of the available windy land area, after exclusions, with a capacity factor of 30 percent at a height of 80 meters above ground (DOE 2011). Solar potential represents average solar radiation over a thirty-year span, 1961-1990, for a south-facing flat-plat collector, with zero degree tilt, multiplied by the total area within each state's boundaries and the number of days per year (NREL 1991). RE potential is not a direct measure of economic potential, but it does present a clear link to economic development opportunities from RE development.

In the RPS analysis we omit the climate degree day variable, on the rationale that the decision to adopt an RPS policy, as distinct from EE and NM policies, is not affected by hot or cold days, independent of the temperature's affect on renewable energy potential. In the EERS analysis we omit the RE potential variable, on the grounds that EE policies are neutral with regard to specific energy sources. The three regressions otherwise proceed identically.

Carbon dioxide (CO_2) emissions (EPA 2010) reflect emissions of the most commonplace atmospheric greenhouse gas, by state-year, measured in metric tons, and divided by the state's population to produce a variable reflecting carbon output per capita. The implications of this variable for policy adoption could theoretically be either positive or negative, depending on whether state poilicymakers are reacting to high emissions levels, or whether emissions are correlated with fossil fuel industry influence within the state.

State-level political ideology is always difficult to measure, given the absence of regular comprehensive polling of the sort available at the national level. In the literature it is commonly operationalized through broad-brush proxies such as party control of a legislature, but this, given its binary character, can falsely indicate much more volatility than is realistic. The least-problematic metrics currently available, the Berry/Ringquist/Fording/Hanson (BRFH) indices (Berry et al. 1998, 2007, 2010), are complex models that incorporate and weigh multiple factors including interest-group ratings of Congressional representatives, estimated ideologies of electoral challengers, vote weights by district, and a non-linear distribution of legislative partisanship. The results are expressed on a sliding scale of policy liberalism ranging from 0 to 100. The authors update these calculations regularly, and keep them 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. We hypothesize that both citizen and government ideological liberalism should be significant positive indicators of policy adoption, relatively more important for weak and strong policies respectively.

Diffusion Relationships

We take a two-pronged approach to capturing diffusion in our analysis. For consistency with established studies (Berry and Berry 1990, Glick and Hays 1991, Case, Hines and Rosen 1993, Mooney 2001), we include a measure of the percentage of neighboring states with a given policy, lagged by one year.

But geographic proximity is only one indicator of the key concept of “peer status,” reflecting empirical or perceived similarities that mark states as “structurally equivalent actors.”

There is an emerging strain of literature that seeks to identify other determinants of peer status, especially along dimensions involving political or economic congruities or identifiable communications networks (Boemke and Witmer 2004, Karch 2007). Diffusion dynamics can involve factors as diverse as imitation, learning, and competition. Jun and Weare (2011), following Karch in exploration of specific factors that promote or hinder diffusion, investigate the adoption of online “e-governance” practices over time and determine that external institutional factors such as peer competition tend to outweigh considerations of actual policy efficacy or efficiency. On the other hand, Jennings and Hall (2011) find that agency officials place significant weight on empirical and scientific information and other evidence-based practices when implementing new policies. There is also a school of thought suggesting that peer competition combined with economic pressures may result in a “race to the bottom” where regulatory policies such as environmental standards are concerned (Konisky 2008), contributing to increasingly lax regulations from state to state.

Neglecting non-geographic diffusion factors opens the door to omitted variable bias. Past studies of energy policy adoption in particular (Lyon and Yin 2010, Huang et al. 2007, Matisoff 2008, Stoutenborough and Beverlin 2008, Chandler 2009, Wiener and Koontz 2010, Carley and Miller 2012) have considered numerous contributing factors, including both internal determinants and geographic proximity, but all were conducted without considering non-geographic indicators of peer status. There are a few exceptions; some energy policy analysts have proposed more nuanced variables to explain geographic diffusion, such as ideological distance (Stoutenborough and Beverlin 2008) or regional EPA offices (Chandler 2009), but have not taken the step of considering these as diffusion factors in their own right.

To identify peer effects beyond geographic proximity, therefore, we expand on past work with a new metric, constructing a variable that measures congruence of government political ideology between all states, weighted by policy adoption, and lagged by a year. This new diffusion variable measures the influence that ideologically congruent states have on each other, reflecting our hypothesis that similar states will be more likely to follow one another's lead: for example, if State A is highly similar in political ideology to State B, and the State A adopts an RPS policy in time period 1, one can hypothesize that State B would be more likely to adopt an RPS policy in time period 2. We construct this variable using a variation on the approach described in Grossback, Nicholson-Crotty and Peterson (2004). Specifically, we operationalize ideological distance as the numerical distance between the government ideological liberalism of a given state—determined from the BRFH data described above—and the weighted average of (A) adopters of the same policy model in the most recent year, and (B) adopters in all previous years. This is expressed as an absolute value, so that the directionality of the difference (more liberal or more conservative) is immaterial.

Analytical Models

We evaluate the relationships between these independent variables and the three dependent variables, respectively, using event history analysis (EHA), a methodology that assesses which factors dictate the likelihood of an event (e.g., policy adoption) over a sequential timespan (Berry and Berry 1990). Using a "state-year" as its analytical unit, EHA allows a single model to account for both internal determinants and external diffusion factors. We estimate each of the three policy adoption events using three distinct models: a logistical regression using a binary version of the dependent variable, to confirm findings from past studies; 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 nature of the policy adoption event; and a multinomial logistical regression, using the categorical versions of the dependent variables, to account for variations in policy stringency.

The first phase of analysis involves the logit model, measuring the probability of observing the adoption of a policy each year, while controlling for political, socioeconomic, and other variables. The probability of policy adoption for state *i* at time *t* is

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

where *X* is a vector of explanatory variables, β is the corresponding parameter estimates, and *t* is time. .

In the second stage of our analysis, we seek to identify the effect of explanatory variables on the probability of one category of outcome relative to the alternatives.[vii] 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

$$\mathrm{P}_{ijt} = \exp(\beta'_j X_{ijt}) \,/\, \sum \exp(\beta'_j X_{ijt}),\ j = 0, 1, 2, 3 \qquad [2]$$

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

Results

During the study period, 34 states adopted RPS policies, 23 of which included non-voluntary requirements at the time of adoption; 25 states adopted EERS policies; and 36 states adopted NM policies.[viii] Table 1 presents summary statistics and variable descriptions for the full set of observations.

[Insert Table 1 about here]

Binary Dependent Variable Analyses

The logit and complementary log-log regression results for each policy type are presented in Tables 2, 3, and 4. The two types of models produce substantially similar results.

The variables that consistently emerge as statistically significant, across all three policies, are GSP per capita and citizen ideology.[ix] Both of these factors are highly significant ($p \leq 0.01$) for RPS policies, along with geographic diffusion, while RE potential is also weakly significant ($p \leq 0.1$). In the EERS results, state electricity market deregulation also emerges as weakly significant, with a negative coefficient. However, deregulation slips outside the significance threshold in the conditional log-log analysis. For NM, no other variables are significant.[x]

[Insert Table 2 about here]

[Insert Table 3 about here]

[Insert Table 4 about here]

Categorical Dependent Variable Analyses

Next we turn to a more nuanced analysis in which the dependent variable incorporates the categorical stringency distinctions introduced above. In each case, the MNL model reflects the likelihood of adopting an RPS at distinct levels of stringency, relative to no policy action at all. Parameter and standard error estimates in each case are based on holding “No Policy” as the omitted reference category. Although Cramer-Ridder tests confirm the validity of keeping the stringency rankings separate, in the case of EERS and NM policies the actual number of states with technically non-binding policies is sufficiently low that we deem it prudent to collapse the “voluntary” ranking into the “no policy” level. The results of the analyses are presented in Tables 5, 6, and 7.

Renewable Portfolio Standard Policies

[Insert Table 5 about here]

The MNL model indicates that for adopting a voluntary RPS program, the only statistically significant predictors are citizen ideology, GSP per capita, and geographic diffusion, the first two ($p \leq 0.05$) more so than the last ($p \leq 0.1$). For adoption of weak RPS policies, GSP per capita ($p \leq 0.01$) and citizen political ideology ($p \leq 0.05$) are statistically significant, but not geographic effects. Hence, holding all else constant, higher rates of citizen liberalism and average income, respectively, are associated with a greater likelihood of voluntary or weak RPS policy adoption versus no policy at all. Factors that increase the likelihood of strong RPS policy adoption, however, are different. GSP per capita remains highly significant but citizen ideology is not and government ideology takes its place as statistically significant ($p \leq 0.05$). RE potential and geographic diffusion effects are also significant; and ideological distance and CO_2 per capita are weakly significant ($p \leq 0.1$). Note that the coefficient on these two variables is negative. In the case of ideological distance this is to be expected; all else equal, the actions of a more ideologically remote state should be less influential. For CO_2 per capita the theoretical basis is less definite, as noted earlier, so the result points toward greater theoretical clarity, suggesting it may reflect greater fossil fuel industry influence within a state.

The two alternative models that vary our assumptions about the stringency comparison values confirm the robustness of the results presented in Table 5. Overall these alternative results demonstrate fairly minor variations in magnitude and p-values, and are not presented here.[xi]

Energy Efficiency Resource Standard Policies

[Insert Table 6 about here]

The MNL model indicates that for adoption of weak EERS policies, GSP per capita is highly significant ($p \leq 0.01$), just as in the RPS analysis. State deregulation is also statistically significant, however, with a negative coefficient[xii]. Geographic diffusion is weakly significant ($p \leq 0.1$).[xiii] Once more, we find that factors associated with the likelihood of strong RPS policy adoption are different. GSP per capita remains highly significant, but it is joined by the climate variables, rather than by government ideology. Electric prices, meanwhile, are weakly significant—albeit with a negative coefficient, contrary to hypothetical expectations. These findings hold true for our two alternative models that measure the stringency rankings differently, notwithstanding some minor fluctuations in p-levels; at no point does the positive or negative polarity vary for any statistically significant variable.

Net Metering Policies

[Insert Table 7 about here]

GSP per capita remains strongly significant for weak NM policies ($p \leq 0.01$), as with RPS and EERS policies. Electricity deregulation is also weakly significant ($p \leq 0.1$), and negative, as with EERS policies. RE potential, geographic diffusion, and ideological distance emerge as at least weakly significant. Interestingly, greater ideological distance among states demonstrates a positive correlation with weak policy adoption. For strong NM policies, both of the diffusion variables drop below the threshold of significance. We are left with only internal determinants: GSP per capita and RE potential, both strongly significant, as well as deregulation.[xiv]

Conclusions and Discussion

Considerable research on the factors that motivate adoption of innovative state-level policies, in sustainable energy as well as other arenas, has 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. Existing energy policy research, however, has developed only piecemeal insights, typically analyzing single policy models in isolation or making comparisons only across a subset of states, and oftentimes relying on inconsistent metrics to categorize and evaluate important policy details. For example, almost all existing work has approached adoption of a given energy policy only as a binary outcome—i.e., some policy versus no policy—without regard for crucial differences in stringency as reflected in policy design.

Our findings indicate that for every type of sustainable energy policy under consideration, a simple binary analysis of policy adoption versus non-adoption will show a state's GSP per capita and citizen ideological liberalism to be significant predictors of adoption. There is very little basis on which draw a meaningful distinction between the policy types at this level. The only difference is that for NM policies those two variables alone are significant, while for EERS policies electricity deregulation is also weakly significant (and negatively correlated with adoption)/ For RPS policies geographic diffusion and RE potential are also significant; this has not been the case in past analyses, and appears to be directly attributable to the inclusion of 2009 data.

However, when the comparative analysis categorizes policy types by their relative stringency, the findings grow more complex and distinctive. From the outset, our expectations have rested on the foundation that NM represents a policy model that is relatively intuitive to understand and uncontroversial, for both policymakers and citizens, whereas the RPS is both more complex and more politicized, while the EERS shares elements of both. We discover that GSP per capita remains significant for every policy, at every level. This is understandable, as it represents a strong proxy for the economic health of a state and thus the capacity of its government to undertake reforms. Beyond that, though, systematic variations reveal themselves.

Our findings show deregulation status and RE potential as significant predictors for NM policies of every level, and—for the "weak" NM policies alone—also the diffusion variables, both geographic and ideological. For NM, then, perceived as relatively unprovocative politically, visible economic factors appear more likely to enter into the adoption decision. The examples of other states, whether geographic or political peers, also exert influence at the weak but not the strong level; this is contrary to expectations, and we can only speculate that it may reflect greater external influence on lawmakers who are uncertain about how aggressive a policy to adopt.

At the other end of the spectrum from NM, adoption of the popular but more politically sensitive RPS is predicted not only by GSP per capita, but also by in-state citizen ideology, for both voluntary and weak policies. For strong policies, we instead find it predicted by government ideology—that is, the political stance of lawmakers themselves—as well as by RE potential, CO_2 emissions, and both diffusion variables. Political considerations, in other words, enter the policymaking calculus in multiple ways.

Situated between these two political poles, for the EERS model we find a significant negative association with electricity market deregulation for weak policies, but for stronger policies electricity price and the climate degree day variables are significant. EERS policy adoption, therefore, is most likely when political considerations are not preeminent over economic ones, suggesting that policymakers may be primarily concerned with practical problem-solving.

The specific role of policy diffusion remains uncertain, especially from ideological versus geographic peer states. Greater ideological distance shows a significant negative association with strong RPS policies, as anticipated, and a positive association with weak NM policies, also as anticipated—but these patterns are not consistent across policy models, and as yet there is insufficient information available to offer theoretical underpinnings for these findings. At any rate this influence, when it appears, reflects political ideology; there is reason to believe that only under fairly narrow circumstances does diffusion involve substantive learning about the underlying scientific and economic policy considerations (Jennings and Hall 2011). Still, the actual diffusion processes at work remain complex and not fully understood, for any stringency level or type of peer status.

The three components of this study not only extend the literature meaningfully, but may contribute critical insights to state and federal officials and analysts concerned with the adoption and use of these policy tools. Taken as a whole, these findings establish a significant platform for future work. Research on state energy policy diffusion and stringency may benefit from broader mixed-methods investigations, incorporating more detailed case studies. Such work may confirm or refine the conclusions of this study, and also illuminate, in particular, the criteria that identify states as peers, and the information networks through which policy information disseminates. Such future analysis may not only clarify the factors motivating RE and EE policy adoption, but also illuminate whether and how these factors, and related degrees of stringency, may ultimately affect policy implementation and outcomes.

References

Berry, Frances S. and William D. Berry. 1990. “State Lottery Adoptions as Policy Innovations: An Event History Analysis.” *The American Political Science Review* 84(2): 395-415.

Berry, William, Evan J. Ringquist, Richard C. Fording, and Russell L. Hanson. 1998. “Measuring Citizen and Government Ideology in the American States, 1960-1993.” *American Journal of Political Science*, 42(1):327-48.

Berry, William D., Evan J. Ringquist, Richard C. Fording, and Russell L. Hanson. 2007. “The Measurement and Stability of State Citizen Ideology.” *State Politics & Policy Quarterly* 7(2): 111-132.

Berry, William D., Richard C. Fording, Evan J. Ringquist, Russell L. Hanson, and Carl E. Klarner. 2010. “Measuring Citizen and Government Ideology in the U.S. States: A Re-appraisal.” *State Politics & Policy Quarterly* 10(2): 117 -135. Data through 2008 updated online at <https://icpsr.umich.edu/icpsrweb/ICPSR/studies/188/detail>; retrieved January 19, 2011.

Boehmke, Frederick J., and Richard Witmer. 2004. “Disentangling Diffusion: The Effects of Social Learning and Economic Competition on State Policy Innovation and Expansion.” *Political Research Quarterly* 57(1): 39–51.

Boushey, Graeme. 2010. *Policy Diffusion Dynamics in America.* New York, NY: Cambridge University Press.

Box-Steffensmeier, Janet M, and Bradford S. Jones.1997. “Time is of the Essence: Event History Models in Political Science. *American Journal of Political Science* 41(4): 1414-61.

Buckley, Jack, and Chad Westerland. 2004. “Duration Dependence, Functional Form, and Corrected Standard Errors: Improving EHA Models of State Policy Diffusion.” *State Politics and Policy Quarterly* 4(1):94–113.

Bureau of Economic Analysis. Nov. 24, 2010. *Regional Economic Accounts: Gross Domestic Product by State.* Online at <http://www.bea.gov/regional/gsp>. Retrieved Nov. 24, 2010.

Carley, Sanya. 2009. “State Renewable Energy Electricity Policies: An Empirical Evaluation of Effectiveness.” *Energy Policy* 37(8):3071-3081.

Carley, Sanya, and Chris J. Miller. 2012. “Regulatory Stringency and Policy Drivers: A Reassessment of Renewable Portfolio Standards.” *Policy Studies Journal*, forthcoming.

Case, Anne C., James R. Hines, Jr., and Harvey S. Rosen. 1993. “Budget Spillovers and Fiscal Policy Interdependence: Evidence from the States.” *Journal of Public Economics* 52(3):285-307.

Chandler, Jess. 2009. “Trendy Solutions: Why do States Adopt Sustainable Energy Portfolio Standards?” *Energy Policy* 37:3274-3281.

Delmas, Magali, Michael V. Russo, and Maria J. Montes-Sancho. 2007. “Deregulation and Environmental Differentiation in the Electric Utility Industry.” *Strategic Management Journal* 28:189–209.

Department of Energy. 2011. *Energy Efficiency and Renewable Energy: Wind Powering America.* Available online at <http://www.windpoweringamerica.gov/wind_maps.asp>. Retrieved September 21, 2011.

Environmental Protection Agency. 2010. “State CO2 Emissions from Fossil Fuel Combustion.” Available at < http://www.epa.gov/statelocalclimate/resources/state_energyco2inv.html>. Retrieved Mar. 28, 2012.

Fiorino, Daniel. 2010. "Sustainability as a Conceptual Focus for Public Administration." *Public Administration Review* special issue: S78-S88.

Gallagher, Kelly Sims, John P. Holdren, and Ambuj D. Sagar. 2006. "Energy-technology Innovation." *Annual Review of Environment and Resources* 31, 193-237.

Glick, Henry R., and Scott P. Hays. 1991. "Innovation and Reinvention in State Policymaking: Theory and Evolution of Living Will Laws." *Journal of Politics* 53(3): 835-50.

Graab, Alison C. 2010. "The Smart Grid: A Smart Solution to a Complicated Problem" *William & Mary Law Review* 52: 2051-2077.

Grossback, Lawrence J., Sean Nicholson-Crotty, and David A. M. Peterson. 2004. "Ideology and Learning in Policy Diffusion." *American Politics Research* 32(5):521-545.

Huang, Ming-Yuan, Janaki R.R. Alavalapati, Douglas R. Carter, and Matthew H. Langholtz. 2007. "Is the Choice of Renewable Portfolio Standards Random?" *Energy Policy* 35(11): 5571-5575.

Intergovernmental Panel on Climate Change. 2007. *Fourth Assessment Report: Synthesis.* Parry, M., Canziani, O., Palutikof, J, van der Linden, P, and Hanson, C, editors. Cambridge, UK: Cambridge University Press.

Jennings, Edward T., and Jeremy L. Hall. 2012. "Evidence-Based Practice and the Use of Information in State Agency Decision Making." *Journal of Public Administration Research and Theory* 22: 245-266.

Jensen, Jason L. 2003. "Policy Diffusion through Institutional Legitimation: State Lotteries." *Journal of Public Administration Research and Theory* 13: 521-541.

Jun, Kyu-Nahm, and Christopher Weare. 2011. "Institutional Motivations in the Adoption of Innovations: The Case of E-Government." *Journal of Public Administration Research and Theory* 21: 495-519.

Karch, Andrew. 2007. "Emerging Issues and Future Directions in State Policy Diffusion Research." *State Politics and Policy Quarterly* 7(1):54-80.

Konisky, David. 2008. "Regulator Attitudes and the Environmental Race to the Bottom Argument." *Journal of Public Administration Research and Theory* 18:321-344.

Lyon, Thomas P., and Haitao Yin. 2010. "Why Do States Adopt Renewable Portfolio Standards? An Empirical Investigation." *Energy Journal* 31(3):133-157.

Matisoff, Daniel C. 2008. "The Adoption of State Climate Change Policies and Renewable Portfolio Standards: Regional Diffusion or Internal Determinants?" *Review of Policy Research* 25(6):527-546.

Mooney, Christopher Z. 2001. "Modeling Regional Effects on State Policy Diffusion." *Political Research Quarterl*y 54(1):103-124.

National Oceanic and Atmospheric Administration: National Climatic Data Center. 2009. *Historical Climatological Series 5-1 and 5-2.* Available online at <http://www.ncdc.noaa.gov/oa/documentlibrary/hcs/hcs.html>. Retrieved Jan. 18, 2012.

National Renewable Energy Laboratory, 1991. *Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors.* Available at <http://rredc.nrel.gov/solar/pubs/redbook/S.> Accessed January 3, 2008.

New State Ice Co. v. Liebmann. 1932. 285 U.S. 262.

North Carolina Solar Center. 2011. *Database of State Incentives for Renewable Energy (DSIRE).* Available at <http://www.dsireusa.org>. Accessed Apr. 13, 2011.

Osterberg, David (former Iowa legislator and sponsor of original RPS legislation), e-mail correspondence, September 2011.

Rabe, Barry G. 2006. *Race to the Top: The Expanding Role of U.S. State Renewable Portfolio Standards.* Pew Center on Global Climate Change.

Rabe, Barry G. 2008. "States on Steroids: The Intergovernmental Odyssey of American Climate Policy." *Review of Policy Research* 25(2):105-128.

Ringquist, Evan J., and James C. Garand. 1999. "Policy Change in the American States." In *American State and Local Politics: Directions for the 21 Century*, eds. Ronald E. Weber and Paul Brace. New York: Chatham House.

Shipan, Charles R., and Craig Volden. 2008. "The Mechanisms of Policy Diffusion." *American Journal of Political Science* 52(4): 840-857.

Shipan, Charles R., and Craig Volden. 2012. "Policy Diffusion: Seven Lessons for Practitioners." *Public Administration Review* xx: 1-9.

Sissine, Fred. 2007. *Renewable Energy Portfolio Standard (RPS): Background and Debate Over a National Requirement.* Congressional Research Service Publication RL34116.

Stoutenborough, James W., and Matthew Beverlin. 2008. "Encouraging Pollution-Free Energy: The Diffusion of State Net Metering Policies." *Social Science Quarterly* 89(5):1230-1251.

Tylock, Stephen M. et al. 2012. Energy Management Under Policy and Technology Uncertainty. *Energy Policy* 47:156-163.

U.S. Census Bureau. 1999 and 2009. *State Population Estimates: Annual Time Series.* Population Estimates Program, Population Division, Washington, DC. Retrieved online at <http://www.census.gov/popest/data/historical/index.html>, April 21, 2012.

U.S. Energy Information Administration. 2010. *Electricity Price by State and End-User, 1990–2008.* Available at <http://www.eia.doe.gov/cneaf/electricity/page/>. Retrieved November 18, 2010.

Volden, Craig. 2006. “States as Policy Laboratories: Emulating Success in the Children's Health Insurance Program.” *American Journal of Political Science* 50(2): 294-312.

Walker, Jack L. 1969. “The Diffusion of Innovations Among the American States.” *American Political Science Review* 63(3): 880-899.

Wiener, Joshua G., and Tomas M. Koontz. 2010. “Shifting Winds: Explaining Variation in State Policies to Promote Small-Scale Wind Energy.” *Policy Studies Journal* 38(4): 629-651.

Wilson, Elizabeth J., and Jennie C. Stephens. 2009. “Wind Deployment in the United States: States, Resources, Policy, and Discourse.” *Environmental Science & Technology* 43(24): 9063-9070.

Wiser, Ryan, Kevin Porter, and Robert Grace. 2004. *Evaluating Experience with Renewables Portfolio Standards in the United States.* Berkeley: Lawrence Berkeley National Laboratory.

Yin, Haitao, and Nicholas Powers. 2010. “Do State Renewable Portfolio Standards Promote In-State Renewable Generation?” *Energy Policy* 38(2):1140-1149.

Tables and Figures

Table 1. Descriptive Summary Statistics

Variable	Description	Mean	Std. Dev.	Min	Max
Electricity price	Average real retail price of electricity, in ¢/kWh	7.06	2.51	3.17	27.47
Deregulated	Utility operates in a deregulated or restructured electricity market	0.185	0.388	0	1
Population growth rate	Annual rate of increase in population	0.0106	0.0108	-0.0622	0.104
GSP per capita	Gross state product per capita, in $millions/person	0.0334	0.00996	0.0150	0.0724
Climate degree days, normalized	Combined HDD and CDD, population weighted, as a percentage of period norms	201.04	21.23	96.9	269.8
RE potential	Renewable energy potential (wind and/or solar) in MWh/yr	2.93×10^8	2.79×10^8	5,696,333	1.51×10^9
CO_2 per capita	Emissions per state resident per year, in MT	25.59	19.54	8.86	133.33
Citizen ideology	Citizen liberalism calculated on a 0-100 scale	50.63	15.54	8.45	95.97
Government ideology	Government liberalism calculated on a 0-100 scale	50.35	12.91	23.64	74.05
Percent contiguous states with RPS	Percent of adjoining states with RPS in place, lagged by one year	0.180	0.280	0	1
Percent contiguous states with EERS	Percent of adjoining states with EERS in place, lagged by one year	0.066	0.171	0	1
Percent contiguous states with NM	Percent of adjoining states with NM in place, lagged by one year	0.358	0.340	0	1
Ideological distance from previous RPS adopters	Absolute value of ideological distance from states with RPS in place, weighted by time elapsed	10.65	7.61	0	35.25
Ideological distance from previous EERS adopters	Absolute value of ideological distance from states with EERS in place, weighted by time elapsed	5.92	8.41	0	38.11
Ideological distance from previous NM adopters	Absolute value of ideological distance from states with NM in place, weighted by time elapsed	10.60	8.54	0	37.90

Table 2. Models with Binary Dependent Variable: Adoption of an RPS

RPS	**Logit Coefficients**	**Complementary Log-Log Coefficients**
Electricity price	-0.135	0.131
	(0.111)	(0.101)
Deregulated	0.0687	0.00607
	(0.526)	(0.485)
Population growth rate	-11.68	14.69
	(21.80)	(20.54)
GSP per capita	106.95***	94.13**
	(25.58)	(20.44)
RE potential	$1.44\text{x}10^{-9}$ *	$1.33\text{x}10^{-9}$ *
	$(8.44\text{x}10^{-10})$	$(7.60\text{x}10^{-10})$
CO_2 per capita	-0.0261	-0.0252
	(0.0163)	(0.0161)
Citizen ideology	0.0715***	0.0639***
	(0.0215)	(0.0204)
Government ideology	-0.00161	0.00301
	(0.0191)	(0.185)
Percent contiguous states with RPS (lagged)	2.07***	1.91***
	(0.790)	(0.699)
Ideological distance from previous adopters	0.0113	0.0138
	(0.0285)	(0.0265)
Constant	-10.12	-9.34
	(1.58)	(1.37)
Number of observations	814	814

Standard errors in parentheses.
*Statistically significant at the 10% level. **Statistically significant at the 5% level. ***Statistically significant at the 1% level.

Table 3. Models with Binary Dependent Variable: Adoption of an EERS

EERS	**Logit Coefficients**	**Complementary Log-Log Coefficients**
Electricity price	-0.0699	-0.0882
	(0.130)	(0.117)
Deregulated	-1.18*	-1.07
	(0.716)	(0.686)
Population growth rate	-11.61	-20.02
	(28.12)	(25.41)
GSP per capita	132.97***	114.04***
	(30.30)	(25.52)
Climate degree days, normalized	0.00327	0.00593
	(0.0130)	(0.0124)
CO_2 per capita	-0.0343	-0.0356
	(0.0275)	(0.0284)
Citizen ideology	0.0522**	0.0446**
	(0.0254)	(0.0236)
Government ideology	0.0371	0.0352
	(0.0232)	(0.216)
Percent contiguous states with EERS (lagged)	1.62	1.45
	(1.07)	(0.933)
Ideological distance from previous adopters	0.0292	0.0333
	(0.0316)	(0.0280)
Constant	-13.09	-12.17
	(3.65)	(3.39)
Number of observations	899	899

Standard errors in parentheses.
*Statistically significant at the 10% level. **Statistically significant at the 5% level. ***Statistically significant at the 1% level.

Table 4. Models with Binary Dependent Variable: Adoption of NM

NM	Logit Coefficients	Complementary Log-Log Coefficients
Electricity price	-0.156	-0.121
	(0.146)	(0.134)
Deregulated	-0.474	-0.389
	(0.569)	(0.513)
Population growth rate	2.31	2.86
	(19.91)	(18.71)
GSP per capita	164..43***	146.89***
	(30.78)	(25.38)
Climate degree days, normalized	0.000205	0.000357
	(0.00913)	(0.00828)
RE potential	-5.07×10^{-11}	1.17×10^{-11}
	(8.66×10^{-10})	(7.92×10^{-10})
CO_2 per capita	0.00760	0.00785
	(0.0114)	(0.0110)
Citizen ideology	0.0599***	0.0565***
	(0.0211)	(0.0197)
Government ideology	-0.00640	-0.00670
	(0.0193)	(0.0176)
Percent contiguous states with NM (lagged)	1.62	0.336
	(1.07)	(0.629)
Ideological distance from previous adopters	-0.0182	-0.0196
	(0.0290)	(0.0273)
Constant	-9.87	-9.42
	(2.66)	(2.42)
Number of observations	620	620

Standard errors in parentheses.
*Statistically significant at the 10% level. **Statistically significant at the 5% level. ***Statistically significant at the 1% level.

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

RPS Stringency	Voluntary	Weak	Strong
Electricity price	-0.173	-0.189	0.0117
	(0.248)	(0.185)	(0.171)
Deregulated	-1.81	0.962	-0.131
	(1.39)	(0.750)	(0.848)
Population growth rate	7.95	16.06	-37.42
	(45.79)	(29.61)	(29.86)
GSP per capita	141.66**	100.69***	128.98***
	(56.68)	(36.98)	(40.98)
RE potential	-1.05×10^{-9}	1.90×10^{-9}	3.07×10^{-9} **
	(2.43×10^{-9})	(1.38×10^{-9})	(1.39×10^{-9})
CO_2 per capita	0.00220	0.0418	-0.0870*
	(0.0211)	(0.0378)	(0.0470)
Citizen ideology	0.123**	0.103**	0.0181**
	(0.0485)	(0.0417)	(0.0298)
Government ideology	-0.0405	-0.0413	0.108*
	(0.0394)	(0.0325)	(0.0488)
Percent contiguous states with RPS (lagged)	2.85*	0.102	2.85**
	(1.47)	(1.25)	(1.30)
Ideological distance from previous adopters	0.0913	-0.0121	-0.108*
	(0.0634)	(0.0450)	(0.0644)
Constant	-14.94	-9.77	-14.22
	(3.92)	(2.48)	(3.68)

Number of observations = 814. Standard errors in parentheses.
*Statistically significant at the 10% level. **Statistically significant at the 5% level. ***Statistically significant at the 1% level.

Table 6. Discrete Time Multinomial Logit Model with Dependent Variable Reflecting Stringency (Omitted Category: “No EERS/Voluntary”)

EERS Stringency	Weak	Strong
Electricity price	-0.175	-0.356*
	(0.167)	(0.210)
Deregulated	-2.44**	0.421
	(1.05)	(1.15)
Population growth rate	14.30	-55.70
	(28.83)	(36.85)
GSP per capita	136.85***	139.23***
	(38.60)	(46.77)
Climate degree days, normalized	0.0221	-0.0387
	(0.0162)	(0.0228)
CO_2 per capita	-0.0342	-0.0530
	(0.0361)	(0.0467)
Citizen ideology	0.0522	0.0658
	(0.0347)	(0.0448)
Government ideology	0.00803	0.0593
	(0.0300)	(0.0459)
Percent contiguous states with EERS (lagged)	2.80*	1.46
	(1.46)	(1.52)
Ideological distance from previous adopters	-0.0223	0.0451
	(0.0434)	(0.0516)
Constant	-16.16	-6.16
	(4.70)	(5.75)

Number of observations = 899. Standard errors in parentheses.
*Statistically significant at the 10% level. **Statistically significant at the 5% level. ***Statistically significant at the 1% level.

Table 7. Discrete Time Multinomial Logit Model with Dependent Variable Reflecting Stringency (Omitted Category: “No NM/Voluntary”)

NM Stringency	Weak	Strong
Electricity price	-0.215	0.254
	(0.216)	(0.284)
Deregulated	-1.44*	-2.31**
	(0.793)	(1.17)
Population growth rate	-64.45	-24.50
	(43.02)	(54.39)
GSP per capita	111.533***	209.95***
	(40.43)	(64.37)
Climate degree days, normalized	-0.000522	-0.0105
	(0.0122)	(0.0182)
RE potential	$1.85x10^{-9}$ *	$4.60x10^{-9}$ ***
	($1.07x10^{-9}$)	($1.79x10^{-9}$)
CO_2 per capita	-0.00692	-0.107
	(0.0160)	(0.0837)
Citizen ideology	0.0368	0.0610
	(0.0292)	(0.0441)
Government ideology	0.0146	0.0490
	(0.0239)	(0.0391)
Percent contiguous states with NM (lagged)	2.19**	1.24
	(0.867)	(1.34)
Ideological distance from previous adopters	0.0734*	-0.0123
	(0.0376)	(0.0558)
Constant	-9.38	-15.69
	(3.52)	(5.44)

Number of observations = 620. Standard errors in parentheses.
*Statistically significant at the 10% level. **Statistically significant at the 5% level. ***Statistically significant at the 1% level.

Endnotes

[ii] Iowa adopted its RPS in 1983 as a reaction to local circumstances, notably the strong need for in-state economci development (Osterberg 2011). It remained an outlier for many years, and when other states began enacting nominally similar policies, these clearly departed from Iowa's lead—opting for incremental changes in the renewable share of electricity production over time, not predetermined thresholds.

[iii] Although some states have enacted revisions to their policy mandates in later years, the initial adoption represents the only non-incremental policy action (Chandler 2009). While any cut-point is to some extent arbitrary, the median minimizes the effects of variations from outliers, and also has the virtue of logically defining the split between lower and higher values across any given range of states.

[iv] It is important to clarify that while these stringency calculations are based on the varying policy requirements in place in each individual state, the median against which they are compared is influenced by every other state with a similar policy. Thus, while the stringency measure itself stays consistent, the categorization of weak versus strong is never absolute, but always relative to other states with similar goals. Subsequent revisions are always a possibility for any state, as speaking practically no legislative enactment is ever in "final" form, but it is key to remember that the underlying variables influencing the decision to adopt do not change retroactively.

[v] A comparison incorporating different stringencies for each state in any year that includes a policy revision may be desirable, but stands beyond the capabilities of the regression techniques involved, which require a state to drop from the pool after the year of adoption in order to produce an accurate "hazard rate" of adoption for other states.

[vi] As mentioned regarding industry influence, the BEA changed its classification system in 1997, so this variable is based on Standard Industrial Classification (SIC) codes pre-1997 and the North American Industry Classification System (NAICS) codes from 1997 onward. However, we have confirmed that this change does not introduce any serious deviations in GSP per capita trends.

[vii] As a cautionary step, we run a series of Cramer-Ridder specification tests on all logical combinations of stringency rankings, to test the null hypothesis that a model with combined rankings shows the same effects as an unrestricted model. The tests confirm the validity of treating each stringency rank as a distinct categorical variable.

[viii] In addition, Iowa adopted a prototype RPS in 1983, and Iowa along with four other states enacted NM policies in the 1980s, precursors to our study period.

[ix] Although our primary specification includes the climate variable in normalized form, as we are tracking trends over time, we also tested several alternative specifications that vary the climate variables—e.g., with climate degree days expressed in raw numbers rather than normalized, disaggregated into HDD and CDD, or omitted completely. The significance of GSP per capita and ideology holds across, these variants, notwithstanding other minor variations: e.g., in the EERS analysis geographic diffusion and electricity price emerge as weakly significant, but only in the variant where *no* climate variable is included, which we therefore suspect as artifacts of omitted variable bias.

[x] The sole exception is that both HDD and CDD, weighted for population but not normalized, do emerge as highly significant ($p \leq 0.01$), and negative, in a variant model specification that breaks them out from the combined climate variable. There is no apparent theoretical justification for doing this, however.

[xi] In the first alternative model (measuring stringency against means instead of medians), GSP and citizen ideology remain significant for voluntary and weak policies, while RE potential emerges as marginally significant for weak policies. For strong policies, the significant variables remain identical as well, except that geographic diffusion effects and CO_2 per capita drop below the threshold of significance in the first alternative model.

[xii] The significance of deregulation remains consistent across several alternative model specifications (again, differing by choice of climate variables).

[xiii] Citizen ideology is sometimes weakly significant, but only in our alternative model specifications. Geographic diffusion sometimes increases in significance to ($p \leq 0.05$), but only when the normalized climate variable is disaggregated. Otherwise the findings remain consistent across different specifications.

[xiv] These results remain substantially consistent across alternative specifications and models. The only noteworthy change, again, is that HDD and CDD (non-normalized) emerge as significant, and negative, when disaggregated from the overall climate variable.