The effectiveness of different policy regimes for promoting wind power: Experiences from the states

Fredric C. Menz, Stephan Vachon

Abstract

Governments at the state (and to a lesser extent, local) level in the United States have adopted an array of policies to promote wind and other types of “green” energy, including solar, geothermal, low-impact hydropower, and certain forms of biomass. However, because of different regulatory environments, energy resource endowments, political interests, and other factors, there is considerable variation among the states in their green power policies. This paper analyzes the contribution to wind power development of several state-level policies (renewable portfolio standards (RPS), fuel generation disclosure rules, mandatory green power options, and public benefits funds), along with retail choice (RET) facilitated by electricity restructuring. The empirical results support existing anecdotal and case studies in finding a positive relationship between RPS and wind power development. We also found that requiring electricity suppliers to provide green power options to customers is positively related to development of wind energy, while there is a negative relationship between wind energy development and RET (i.e., allowing retail customers to choose their electricity source).

Keywords: Wind power; Renewable electricity; Wind energy policies

1. Introduction

Prompted by rising energy prices, a desire to reduce reliance on foreign oil supplies, and greater environmental awareness, governments worldwide have shown increased interest in promoting the use of renewable energy sources for electricity generation. While such efforts often encourage production from all renewable energy sources, wind power has received particular attention because it can be economically competitive in situations where the wind resource is plentiful and has limited environmental impacts compared to conventional energy sources (National Renewable Energy Laboratory, 2004b). Efforts to promote wind energy in the United States have been translated into federal, state and local governmental actions that take several forms including direct regulations, financial incentives, and regulatory changes that have allowed retail electricity customers to purchase wind and other types of renewable electricity.

During the 1990s, wind energy was the second fastest growing source of renewable electricity in percentage terms worldwide (after solar photovoltaic), and the fastest growing renewable energy source in the United States (International Energy Agency, 2003). From 1990 to 2003, installed wind capacity in the United States increased from 1525 megawatts (MW) to 15258 MW.
6374 MW (American Wind Energy Association, 2004). During that time period, electricity generated from US wind sources increased by 282 percent (2.8 billion kilowatt hours [kWh] in 1990 to 10.7 billion kWh in 2003), while electricity generated from other renewable energy sources decreased by 3.2 percent (351 billion kWh to 339.7 billion kWh) and generation from conventional sources (fossil fuels and nuclear power) increased by 30.2 percent (2680.7 billion kWh to 3492.4 kWh) (US Department of Energy, 2004b). As of 2004, wind capacity existed in 31 states, ranging from negligible amounts in several states (Arkansas, Idaho, Montana, UT) to 1293 MW in Texas and 2042.6 MW in California (American Wind Energy Association, 2004).

While a number of factors might explain both the growth of wind energy and the disparity in wind capacity among states, policies adopted by state governments, including changes in the regulatory environment for electricity, could be expected to play an important role. This paper focuses on several key state-level policies that have been widely used to promote wind energy development in the United States. The purpose of the study is to determine whether particular policies have a greater impact in promoting wind power than others. Using linear regressions with several different policies and wind quality as independent variables, we assess the policies’ relative effectiveness in terms of their impact on the level of wind capacity existing in a state, the growth of wind capacity experienced in recent years, and the number of large projects that were undertaken in a given state over the last 5 years.

The next section of the paper reviews recent experience with wind energy development in the United States and discusses factors that appear to have driven wind market development, including deliberate government policies to promote wind and other forms of renewable electricity and changes in the regulatory environment for electricity suppliers. The third section of the paper describes the data and the methodology we use to assess the effectiveness of state policies. The fourth section presents the empirical results. Discussion and conclusions are presented in the final section of the paper.

2. Wind electricity in the United States

2.1. Recent growth in wind generation and capacity

Table 1 provides a profile of electricity capacity and production from renewable energy sources in the United States from 1998 to 2003. Electricity produced from renewable energy sources declined over this period and accounted for 9.3 percent of total electricity generation in the United States in 2003. The decline in electricity production from renewable sources from 1998 to 2003 was caused largely by a decline in hydropower production from a lack of rainfall in the Pacific Northwest. Hydropower is the predominant source of renewable electricity in the United States, accounting for more than 75 percent of electricity production from renewable energy sources during the 1998 to 2003 time period.

Although wind energy contributed just .3 percent of total electricity generation in 2003, it was the fastest growing renewable electricity resource in percentage terms in the United States from 1998 to 2003. During that period, generation from wind sources grew by more than 250 percent, and wind power accounted for about 3 percent of electricity generated from all renewable sources in 2003. Wind capacity increased by 182 percent over the same period. Generation from wind capacity is
expected to increase from 10.5 billion kWh in 2002 (.3 percent of generation from all sources) to 53 billion kWh in 2025 (.9 percent of total generation) (US Department of Energy, 2004a).

### 2.2. Determinants of wind power development

Development of wind energy is influenced by economic forces, the regulatory environment facing the electricity industry, government policies to support wind energy, and political interests. Important economic factors include the relative prices of energy sources and consumer awareness of wind energy and other green power products. The cost of generating wind power has declined consistently over the last several decades due to greater efficiency and lower production costs for wind turbines, resulting in a lower delivered cost for wind energy than any other new non-hydroelectric renewable resource (US Department of Energy, 1998; McVeigh et al., 1999; National Renewable Energy Laboratory, 2004b). However, the ability of wind to compete with other energy sources depends on the quality of the wind resource and access to transmission lines.

Regulatory changes, particularly restructuring of the electricity industry that has occurred in a number of states, can also influence the pace of wind energy development. Key federal laws to facilitate electricity market restructuring were the 1978 Public Utility Regulatory Policies Act (PURPA), which required utilities to purchase electricity produced by non-utility entities, and the Energy Policy Act of 1992 (EPACT). PURPA encouraged the development of small-scale electric generation facilities, particularly those using renewable resources. EPACT further opened the electricity market to competitive wholesale generation and required electric utilities to open their transmission lines to all electricity producers in 1996, thus allowing alternative energy suppliers—including wind power producers—access to the electricity market.4

Restructuring of the electricity industry began at the state level in 1996, when California and Rhode Island became the first states to pass legislation allowing retail customers to choose their electricity source. More than twenty states have adopted electricity restructuring legislation since then, but the restructuring process has been delayed or indefinitely suspended in 8 states following difficulties in California in 2001 (US Department of Energy, 2003). In states that have proceeded with restructuring, retail customers have access to multiple electricity sources and service providers. As part of the restructuring process, utility distribution companies have been pressured to inform the public about alternative energy choices, thus facilitating market entry by wind energy and other green electricity producers.

### 2.3. Federal policies to promote wind power

In addition to legislation to facilitate electricity market restructuring, the federal government has provided R&D funding, demonstration grants, tax credits, and other financial incentives to promote wind power and other renewable energy sources. The Energy Policy Act of 1992 (EPACT) included two types of financial incentives—a production tax credit (PTC) and a renewable energy production incentive (REPI). The PTC provides a 1.5 cents-per-kilowatt-hour (kWh) income tax credit adjusted annually for inflation (in 2004, 1.8 cents/kWh) to private investors and investor-owned electric utilities for electricity produced from certain resources, including wind, during the first 10 years of operation.5 Parallel to the PTC, the REPI provides a 1.5 cents-per-kWh incentive (also inflation-adjusted), subject to annual congressional appropriations, for electricity generated from wind and other qualifying facilities owned by tax-exempt publicly owned utilities, local and county governments, and rural electric cooperatives. The federal PTC has played an important role in recent wind energy development (Bird et al., 2005). The federal government also provides accelerated depreciation for corporate investments in solar, geothermal, and wind facilities.

### 2.4. State government policies to promote wind power

State governments and regulatory authorities have adopted a variety of specific policy measures to encourage development of wind and other renewable energy sources. Some states (e.g., California, Minnesota, and Oregon) have been aggressively promoting wind and other renewable energy sources for some time, while others (e.g., Alabama, Mississippi, and South Carolina) have taken little or no action in this regard. The policies adopted by state governments to promote wind power can be viewed as an assortment of policies (or policy

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3Green power usually refers to electricity produced from wind, solar, geothermal, biomass (except municipal solid waste) and low-impact hydropower (capacity <10 MW). Renewable energy resources are usually defined more broadly and include municipal solid waste and all hydropower.

4EPACT also provided financial incentives for electricity produced from new qualifying renewable energy facilities. These incentives—a production tax credit for private sources and a renewable energy production incentive for tax-exempt electricity suppliers—are discussed below.

5The PTC has expired several times (at the end of 1999, 2001, and 2003), but been extended by legislative action. The most recent extension was in September 2004, when it was extended retroactively to the end of 2005 as part of a tax package that included a number of personal and business tax provisions. The most recent extension of the PTC also covers additional technologies such as geothermal, solar energy, open-loop biomass, and certain kinds of hydro.
The policy regime concept is presented in Fig. 1.

2.4.1. Financial incentives

State governments have used various types of financial incentives to encourage greater use of wind and other renewable energy technologies. Financial incentives take many forms, including tax exemptions, deductions, or credits and various types of subsidies (grants, preferential rate loans, or production incentives). Financial incentives apply to either the initial capital cost or the operation of renewable energy technologies. The ultimate goal of these incentives is to overcome financial hurdles that make renewable technologies unattractive compared to conventional electricity-generating technologies. Financial incentives are intended to overcome financial hurdles that make renewable technologies unattractive compared to conventional electricity-generating technologies. Fifteen states finance these incentives with public benefits funds (PBF)—a form of trust fund financed by a monthly levy on customers’ electricity bills. A number of states established PBF during the process of electricity industry restructuring to replace similar incentives traditionally administered by regulated utilities.

2.4.2. Mandatory rules and regulations

State governments have adopted a number of mandatory rules and regulations to promote wind and other forms of renewable electricity. Perhaps the most significant requirement is the renewable portfolio standard (RPS), which requires a gradually increasing percentage of an electricity provider’s overall generating capacity or electricity sales to come from qualifying renewable energy sources by a certain date. Eighteen states had adopted an RPS as of November 2004, although the RPS differ markedly in their percentage requirements, timetables, and what types of renewables are included. RPS requirements in most states apply only to private electricity providers, and in some states the RPS can be met only through new investments in renewable sources. Some states (e.g., Maryland, Texas, and Wisconsin) allow retail electricity providers to use tradable renewable energy credits to satisfy the RPS requirement.

Generation disclosure and certification rules in 24 states require utilities to disclose information to their customers on a regular basis about the fuel sources and emissions associated with the electricity they provide. Electricity suppliers are also required to certify that they are using the type and amount of renewable energy that is claimed. A voluntary certification program called the Green-e Renewable Branding Program, administered by the Center for Resource Solutions, currently certifies renewable electricity products statewide in about fifteen states (Center for Resource Solutions, 2003). Generation disclosure and certification requirements are designed to educate consumers about the characteristics of electricity products, thereby allowing more informed choices in competitive electricity markets.

A number of states have adopted policies requiring electricity suppliers to offer green power options to consumers (National Renewable Energy Laboratory, 2004a). This mandatory green power option (MGPO) allows customers to purchase electricity generated from...
wind or other renewable energy sources by directly choosing an alternative green power supplier or by purchasing green electricity provided by their utility. In the latter case, the utilities can produce the green power themselves, contract with another producer, or in some cases meet the requirement by purchasing credits from a renewable energy provider certified by the state’s public utilities commission (North Carolina Solar Center, 2004).

2.4.3. Other actions to facilitate market entry of green-power products

In states with restructured electricity markets, retail customers can directly choose their source of electricity, and green electricity is increasingly available in a number of these states. As of mid-2004, electricity customers could purchase wind power at the retail or wholesale level in 8 states that were restructuring their electricity industry (National Renewable Energy Laboratory, 2004a). Providing wind and other green power choices for customers is often the only way for retail providers to differentiate their products in competitive electricity markets.

3. Empirical analysis: methodology and data

In order to test the effectiveness of various state policies, empirical analysis was conducted using wind power capacity, policy regime, and wind quality data for 39 states. Initially, eleven states were excluded from the study because data on wind quality was unavailable (Alaska and Hawaii) or because they have either no or very low wind quality, as measured by technical potential for producing wind energy. The time period covered by the analysis is 1998 to the end of 2003, a time during which many states began restructuring their electricity markets and/or adopted policies to promote wind power and other forms of green electricity.

3.1. Wind development indices (WDI)

In order to capture different dimensions of wind energy development, four inter-related dependent variables (hereafter called wind development indices or WDI) were developed for empirical analysis. The first index was the amount of installed wind capacity at the end of 2003. Two measures of growth in wind capacity were also examined: the absolute growth in capacity since 2000 and the absolute growth in capacity since 1998. The fourth WDI was the number of large wind energy projects (defined as projects with more than 25 MW in capacity) developed in a given state over the period. All data related to these dependent variables were from the American Wind Energy Association database and were current as of August 2004.

3.2. Policy regimes

Given the small sample size (39 states), the selection of policies for empirical analysis needed to be parsimonious (Evans and Olson, 2003). Since most states have adopted an array of different green power policies, our goal in selecting policy variables was to include measures drawn from each segment in the renewable electricity policy regime (Fig. 1). Consequently, we used the following: RPS, fuel generation disclosure requirements (FGD), MGPO, PBF, and retail choice (RET). RPS, FGD and MGPO are types of mandatory rules and regulations. Because most PBF provide financial assistance to wind and other renewable energy projects, PBF can be viewed as an all-inclusive variable that covers different types of financial incentives (e.g., low-interest rate loans, grants, etc.). Finally, RET allows customers in states with competitive electricity markets to select the source of their electricity.

Two sets of metrics pertaining to these five variables were developed. For the first metric, a dichotomous variable took the value of “1” if the policy had been implemented prior to 2003 and “0” otherwise. For example, a policy that was implemented in 2003 was coded “0”. The latest wind power development data were for 2003, hence this cut-off date allows a lag of at least 1 year between the policy implementation date and its potential outcome. The second set of metrics was the number of years that the policy had been implemented as of 2003 (hereafter called policy experience). For example, if an RPS had been implemented in 1998, the policy experience variable would have the value of 5 years (i.e., 2003 minus 1998).

11The states with no or very little wind technical potential are Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, Rhode Island, South Carolina, and Tennessee.

12Wind capacity growth was analyzed over two different time horizons to provide more robust empirical results.

13Absolute growth was used rather than growth rates (i.e., percentage increase) for two reasons. First, the absolute growth measure allows avoiding situations of explosive growth in states with very little wind capacity development at the start of the analysis period (e.g., growth from 1 to 51 MW would mean a 5000 percent growth rate). Second, some states in the sample had no wind capacity at all as of 1998, making the growth rate impossible to compute and requiring the exclusion of these states from the analysis. This would not be desirable for empirical purposes given the initial sample of just 39 states.


15The date of implementation is the date when the policy became effective (as opposed to the date when legislation was enacted).

16In competitive electricity markets with retail choice, if the dates for commercial and residential choice were different, the earlier of the two dates was used as the implementation date.
3.3. Wind technical potential

Wind differs from other energy resources in being both highly variable geographically and not directly transportable among regions. The extent of wind power development in a given region is subject to the availability of high quality wind resources. Thus, the technical potential of wind, measured as the theoretical potential of the wind resource in a given state without considering economic viability, was used as a control variable in all regressions. The technical potential for each state was estimated in a recent study by the Union of Concerned Scientists (Deyette et al., 2003). Their estimates of technical potential for wind and other renewable energy sources were based on earlier work by Elliott et al. (1991) and Doherty (1995). These earlier estimates were corrected for urban and environmentally sensitive areas, proximity of transmission lines, problematic landscape (e.g., mountains, forests, and agricultural land) and various land-use restrictions by Deyette et al. (2003).

3.4. Model estimation

The general form of the model estimated in the analysis can be written as follows:

\[
WDI = \beta_0 + \beta_1 \text{potential} + \beta_2 \text{RPS} + \beta_3 \text{FGD} + \beta_4 \text{MGPO} + \beta_5 \text{PBF} + \beta_6 \text{RET} + \epsilon,
\]

where potential is the technical potential of the wind resource in a given state and RPS, FGD, MGPO, PBF, and RET are the variables discussed above. All of the independent variables are expected to have a positive impact on wind power development. Therefore, we expect that the estimated coefficients from the regression to be significant and positive (i.e., \( \beta_1 \) to \( \beta_6 > 0 \)).

Coefficients were estimated using ordinary least-squares (OLS) methods. After the first set of regressions, however, it became clear that two states (California and Texas) were creating biased coefficient estimates. Both states were associated with large standardized residuals (greater than 4) and with influential statistics that were greater than the recommended threshold. This situation occurred because of the predominance of California and Texas in wind capacity development. Wind capacity added in California and Texas from 1998 to 2003 accounted for 40 percent of the total capacity added in the United States over that period and the two states accounted for more than 50 percent of total wind capacity in the United States as of 2003. Given that 37 states with sizable wind resources remain in the sample and that we were seeking to obtain generalizable results for the ‘average’ state rather than replicating the situations of California and Texas, the empirical analysis was conducted without California and Texas.

4. Empirical results

Bivariate correlations for the variables are reported in Table 2. The two sets of policy variables exhibited high inter-correlations, creating potential concerns about multicollinearity in the analysis. Multicollinearity can mislead the analysis by inflating the variance of the estimated coefficients (Kennedy, 2003). Hence, different statistics for testing the presence of multicollinearity such as condition indices, variance inflation factors (VIF), and significance of the incremental variance explained (or \( \Delta R^2 \)) were assessed. No major concerns related to multicollinearity were detected, assuring that the correlation among the different independent variables was not sufficiently high to be harmful to OLS estimates.

The relationship between the alternative WDI and the policies was tested using hierarchical linear regression analysis. In this approach, the regression models are structured to report the incremental variance explained by the policy regime (i.e., the mix of RPS, FGR, MGPO, PBF, and RET). By structuring the analysis in this way, the incremental variance explained by the policy regime as a whole can be explicitly assessed. The parameter estimates and incremental squared multiple correlation coefficients (\( R^2 \)) are reported for each regression.

The regressions were conducted in two blocks. The first block of regressions used the date of implementation (dummy variables) as indicators of the policy regime (i.e., the mix of RPS, FGR, MGPO, PBF, and RET). The second block used the experience related to each policy to replace the dummy variables. This allowed us to determine whether a policy has a long-term cumulative effect on wind development or results in a temporary spike in wind capacity (which would be captured by the dummy variables).
4.1. Policy implementation

Results pertaining to policy implementation (i.e., whether or not a particular policy had been implemented in a given state) are presented in Table 3. The coefficients of determination ($R^2$) indicate that the independent variables, when considered together, significantly explain the variations observed in the dependent variables (i.e., WDI). As indicated by the $F$-statistics, all $R^2$ were significant. In fact, the set of independent variables explained between 55 and 64 percent of the variance observed in different WDI. Table 3 also shows that the variance explained by the policy regime (i.e., the five policies taken together) was significant for all four WDI as indicated by the $\Delta R^2$ having $p$-values all below .01. This result means that, taken together, these policies had a significant impact on the amount of wind capacity, the growth in capacity over the two time intervals in recent years, and the number of large wind projects. Within the policy regime, we particularly note that two policies were driving the significant $\Delta R^2$: RPS and MGPO.

The estimated coefficients associated with the RPS variable were significant for two regressions: (i) the level of wind capacity in 2003 (coefficient of .346 with a $p < .05$), and (ii) growth in capacity from 1998 to 2003 (coefficient of .342 with a $p < .05$). While not significant, the relationships between RPS and 2000–2003 capacity growth and the number of large projects were directionally consistent with our expectations. Overall, these coefficients suggest that states with an RPS exhibited, on average, higher levels of capacity in 2003 and had larger expansion in wind capacity between 1998 and 2003 than states without an RPS.

Mandatory green power offerings also strongly influenced wind power development, as indicated by the MGPO coefficients in Table 3. All of the coefficients associated with MGPO were positive and significant with values ranging from .557 to .687 and $p$-values smaller than .01. These results imply that states with requirements that utilities offer retail customers a green power option achieved higher amounts of wind capacity, greater growth in wind capacity, and more large-scale wind projects than states without such requirements.

4.2. Policy experience

Empirical results pertaining to policy experience (i.e., the number of years a particular policy had been in effect in a given state during the 1998–2003 time period) are presented in Table 4. Again, we find that the independent variables considered together significantly explain the variation observed in the different WDI (all of the $R^2$ were significant, with $p < .01$). The policy regime, which includes the mix of the different policies, also explained significantly the variance observed in the different WDI, with $p < .01$ for all $\Delta R^2$. However, in contrast with the previous analysis (whether or not the policy had been implemented), three policies—RPS, MGPO, and RET—had statistically significant coefficients.
The estimated coefficients related to RPS experience were all positive (ranging from .240 to .476) and significant ($p < .01$). The results suggest that the impact of an RPS on wind power development increases as the number of years with the RPS in place increases. This result is expected as an RPS requires electricity providers to gradually increase the share of renewable electricity over time. The estimated coefficients associated with MGPO experience were also all positive and significant ranging from .367 to .493 with $p < .05$.

The estimated coefficients associated with the number of years that RET was in place were negative (values ranging from $-0.328$ to $-0.459$), and most were significant ($p < .10$). Hence, the longer a state has opened its policy experience on wind power development.

### Table 3
Impact of policy implementation on wind power development

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The standardized betas ($\beta$) are reported. $^a$p < .10, $^b$p < .05, $^c$p < .01.

$^a$Megawatts.

$^b$Difference between capacity in year 2003 and year 2000.

$^c$Difference between capacity in year 2003 and year 1998.

$^d$Large projects are defined as projects with more than 25 MW of capacity.

$^e$Dichotomous variable: “0” if the policy was not implemented before 2003 and “1” if the policy was implemented before 2003.

### Table 4
Impact of policy experience on wind power development

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$^a$Megawatts.

$^b$Difference between capacity in year 2003 and year 2000.

$^c$Difference between capacity in year 2003 and year 1998.

$^d$Large projects are defined as projects with more than 25 MW of capacity.

$^e$Number of years of experience as of 2003 (e.g., policy implemented in 1999 means 4 years of experience).

The estimated coefficients related to RPS experience were all positive (ranging from .240 to .476) and significant ($p < .10$). The results suggest that the impact of an RPS on wind power development increases as the number of years with the RPS in place increases. This result is expected as an RPS requires electricity providers to gradually increase the share of renewable electricity over time. The estimated coefficients associated with MGPO experience were also all positive and significant ranging from .367 to .493 with $p < .05$.

The estimated coefficients associated with the number of years that RET was in place were negative (values ranging from $-0.328$ to $-0.459$), and most were significant ($p < .10$). Hence, the longer a state has opened its policy experience on wind power development.

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The standardized betas ($\beta$) are reported. $^a$p < .10, $^b$p < .05, $^c$p < .01.

$^a$Megawatts.

$^b$Difference between capacity in year 2003 and year 2000.

$^c$Difference between capacity in year 2003 and year 1998.

$^d$Large projects are defined as projects with more than 25 MW of capacity.

$^e$Dichotomous variable: “0” if the policy was not implemented before 2003 and “1” if the policy was implemented before 2003.
electricity market to competition, giving RET to commercial and/or residential consumers, the less wind development is observed, on average, in that state. This somewhat surprising result is discussed below.

Overall, the results support our expectation that a state’s green power policy regime can have an impact on wind energy development. In particular, we found strong results of a positive relationship between RPS, MGPO, and different WDI. However, a negative relationship between RET and different WDI was found. Finally, it is also noteworthy that wind power development was positively linked to the amount of wind technical potential (as indicated by the significant development was positively linked to the amount of found. Finally, it is also noteworthy that wind power relationship between RET and different WDI was MGPO, and different WDI. However, a negative strong results of a positive relationship between RPS, wind energy development. In particular, we found somewhat surprising result is discussed below.

development of wind capacity is not surprising, and this last result confirms that natural endowment in wind resources is also an important factor for wind power development.

5. Discussion and conclusions

To our knowledge, this is the first study to use multivariate techniques to assess the effectiveness of different state policies that promote wind power. Most of the existing research on this topic consists of case studies that identify factors that drive development of wind and other renewable sources of electricity, particularly in cases where large-scale development has occurred. For example, Bird et al. (2005) explore the key factors and market drivers in the 12 states in which a substantial amount of wind energy has been developed or planned. The factors they examine include RPS, federal and state financial incentives, and market drivers, such as consumer demand for green energy, natural gas prices, and wholesale market rules.

Gouchoe et al. (2002) examine 10 state financial incentive programs in 6 states, using a case-study approach to clarify the key factors that influence their effectiveness at stimulating deployment of renewable energy technologies. Langniss and Wiser (2003) review the implementation of an RPS in Texas, concluding that a properly designed and carefully implemented RPS can be an effective support mechanism for renewable energy development. Deyette et al. (2003) evaluate the commitment of states to the support of wind, solar, and other renewable energy sources by comparing projected RPS commitments, renewable electricity funding, and state renewable energy purchases with each state’s renewable electricity generation and renewable energy potential.

The results of our empirical analysis suggest that development of wind capacity in a given state depends not only on a state’s natural endowment in wind resources (technical potential) but also on particular policies adopted by state governments to promote wind power. Our finding that RPS are effective in promoting the development of wind capacity is not surprising, and confirms anecdotal evidence and numerous cases studies (e.g., Bird et al., 2005; Chupka, 2003; Fan et al., 2005; Langniss and Wiser, 2003). However, our empirical analysis allows this finding to be generalized to “average states” in the entire country (with the exception of states that have no or low wind technical potential).

The result pertaining to the effect of RET on wind capacity development warrants discussion. Opening electricity markets to competitive forces might be expected to lead to more wind energy development, but our results suggest that this has not been the case. The relatively higher price for wind power than electricity produced from conventional energy sources could be a factor in this finding, but there is evidence that US consumers are willing to pay a premium to obtain electricity produced from renewable sources (Roe et al., 2001). However, electricity providers facing competitive pressures in restructured electricity markets have an incentive to turn to the cheapest source of electricity. There is a bias against wind and other green power sources because the cost of electricity generated from conventional energy sources does not typically reflect all of the environmental costs. Thus, there is more incentive to use conventional energy sources than would be the case if their prices more accurately reflected the real costs of their use. Another factor is that new technologies, including green power technologies, may not be as cost-effective in the short run as conventional energy sources. Thus, electricity produced from renewable sources is at a competitive disadvantage and has not grown as rapidly as might have been expected in restructured electricity markets.

Finally, our finding that public benefits funding (PBF) was not a significant factor in wind energy development contrasts with the usual view (e.g., Bolinger and Wiser, 2001; Deyette et al., 2003) that grants, loans, and other types of financial incentives supported by PBF are an important factor in promoting development of wind and other renewable energy sources. One explanation for our finding is that California, which has the largest public benefits fund, was not included in the analysis (for reasons discussed earlier). Another explanation is that PBF in some states (e.g., Wisconsin) explicitly targets demand-side rather than supply-side applications, and others (e.g., Connecticut, Massachusetts, and Pennsylvania) focus more on venture capital investments than utility-scale projects. Finally, public benefits funds are used to support other renewable energy technologies in addition to wind.21

There are some important limitations to this study. While the results of the empirical analysis were robust, the relatively small sample size limited the scope of our

20Of course, Texas may be an exception to this (see Langniss and Wiser, 2003), but Texas and California were dropped from our analysis, as discussed earlier in the paper.
21We are indebted to a referee for the last two points.
analysis. For example, it would have been informative to evaluate the interaction among the various policies by incorporating moderating variables in the regression analysis. The small sample size also constrains the number of independent variables that could have been included in the regressions and still allow meaningful results to be obtained. Also, the independent variables used in this study might have been characterized differently. For instance, as noted earlier, there is considerable variation in RPS among states, but this variation was not captured in our analysis. Finally, some development in wind capacity has clearly been associated with other states’ policies. For example, the 66 MW Mountaineer wind project in West Virginia was built to satisfy voluntary green power demand in Pennsylvania, New Jersey, and Maryland. This study was not able to control for such possible drivers.22

An important question is whether green power technologies must be mandated or whether voluntary (demand- or supply side) measures would be sufficient to insure increased development. The findings in this study suggest that two mandatory policy measures (RPS and MGPO) strongly support wind power development while financial incentives (represented by PBF) and voluntary green power choice in states with competitive electricity markets did not stimulate wind power development over the 1998–2003 time period. However, in light of the continuing rise in fossil fuel prices, green energy alternatives will become more economically attractive to consumers. In that context, market-based voluntary measures might play an increasingly important role in future wind power development.

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22The exclusion of such an external driver is reflected in the unexplained variance (1 – $R^2$), but does not constitute a source of bias for the coefficient estimates.

