# *the role of federal and state policies in wind energy deployment in the u.s.*

### Gireesh Shrimali, MIIS-Middlebury College, Phone +1 650 353 8221, E-mail: gshrimali@miis.edu

### Melissa Lynes, Kansas State University, Phone +1 407 729 8076, E-mail: lynesm13@gmail.com Joe Indvik, Spark Community Investment Co, Phone +1 515 230 4665, E-mail: joe.indvik@gmail.com

#### Overview

Many policymakers consider renewable energy technologies to be attractive, as they combat climate change by reducing greenhouse gas emissions and stimulate job growth and industrial productivity (Schmalensee, 2011). Renewable energy deployment has been increasing in the U.S., and it accounted for approximately 12.3% of electricity production in 2012 (EIA, 2013a). Of this 12.3%, nearly half is supplied by hydropower and nearly a quarter by wind energy, the dominant non-hydro renewable energy source.

The levelized cost of electricity from wind energy (at 7-10 US cents/kWh) remains greater than the cost of electricity generated from fossil fuels in the U.S. (EIA, 2013b). Wind-based electricity generation, therefore, requires the provision of subsidies to achieve grid parity in many regions. In the U.S., wind deployment has been supported by a variety of government subsidies, including those at the state and national level; in particular, by the national policy production tax credit (PTC).

Since deployment depends on the interplay of policy, economics, and geography, the causal link between policy and wind deployment remains tenuous in the U.S. (Carley, 2009). A growing body of empirical literature has addressed the impact of policy on wind power deployment (Menz and Vachon, 2006; Shrimali and Kneifel, 2011; Shrimali et al., 2013). However, ours is the first paper that examines not only the impact PTC of wind energy deployment in the U.S. states, but also its influence on the effectiveness of state-level policies.

#### Methods

Using a 50-state panel dataset over 1990-2011, we estimate wind capacity additions in state *i* in year *t* using the following state-level difference-in-differences model:

$Y\_{it}=β\_{0}+β\_{x}X\_{it}+β\_{p}P\_{it}+α\_{i}+γ\_{t}+ε\_{it}$ (1)

where *Y* represents a measure of annual in-state wind deployment (or capacity installed) in MW, *β0*is a constant, *X* represents a vector of social and economic variables that are expected to have an impact on in-state wind energy deployment, *P* is a vector of policy variables to control for policy effects and interactions between policies, the α terms are the state fixed effects, the γ terms are the time fixed effects, and ε is the remaining error term.

We examine the following state-level policies: renewable portfolio standards (RPS), clean energy funds, mandatory green power options, and state government green power purchasing. We consider three RPS policies: with sales or capacity requirements, and with sales goals. The control variables include: per capita GDP as a proxy for wealth; price of electricity; and league of conservation rating and share of electricity generation by coal as proxies for political support for renewables and fossil fuels, respectively.

#### Results

First, PTC is effective on its own in deploying wind energy, which supports the boom-and-bust cycles observed due to uncertainty surrounding it. PTC, on its own, may have been responsible for additions of wind energy capacity in the range of 30-100MW annually per state, which is equivalent to adding about 1,500-5,000MW of wind energy capacity annually in the U.S.

Second, PTC significantly influences the effectiveness of state-level policies, and most of impact typically attributed to state-level policies is due to their interaction with PTC. For example, this is true for RPS with capacity requirements, where every 1MW of capacity requirement results in about 0.8MW of wind capacity deploymemt, as well as mandatory green power options, whose presence results in an anual wind capacity increase of approximately 120-140MW in a state.

Third, the wind resources, in conjunction with other resources (e.g., solar) in a particular state influence the effectiveness of both PTC and state-level policies. For example, in the Northeast U.S., due to the low wind potential policies seem to be ineffective; whereas, policies are fairly effective in the Midwest, given its ample wind potential.

#### Conclusions

Our findings have several policy implications that will be interesting to both policymakers and academics. First, the national PTC is an important pillar in the U.S. wind policy regime and, therefore, regulatory uncertainty surrounding the PTC can profoundly influence wind power deployment and should be limited. That is, we empirically show what has been known in practice for quite some time.

Second, the responsiveness to renewable energy policies depends not only on the resource potential for the energy technology in question but also on the relative potential for other energy technologies. This indicates that state policymakers will need to: 1) tailor the design of renewable policies and related incentives to account for the full array of resources available; and 2) provide differentiated incentives to generate the desired deployment of specific technologies.

Third, conometric analyses that combine all states into a national dataset to make causal inferences about state policy impacts are limited. When states are disaggregated into regions with different wind resource potential, conclusions about policy effectiveness are often driven by a small subset of states that are particularly responsive to policy. Future research will need to focus on unique subsets of the population to better understand the impact of different policy tools in different settings.

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