Impact of state policy on diffusion of solar PV in the US: An empirical analysis

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# Overview

Solar photovoltaic (PV) technology has attracted a lot of attention in the policy circles over the past decade due to its positive impacts on the environment, energy security, and industrial competitiveness (Barbose et al., 2010; Croucher, 2010). Given that solar is not cost competitive with most conventional energy sources yet (NREL, 2010), a lot of solar installations have been due to policies (Sherwood, 2010). The creation of such rapidly expanding markets has led the solar industry to achieve unprecedented economies of scale as well as learning-by-doing, encouraging global trade, and resulting in significant cost reductions (Nemet, 2006; Schaeffer et al., 2004).

The market for PV in the U.S. is driven by government incentives, including cash rebates, production-based incentives, purchase requirements, and federal and state tax benefits. Though there are some policies at the federal level, most of the renewable energy policy action is happening at state-level, with considerable variations in policy design and implementation (Sarzynski, 2009). Given that states differ in policy implementation as well as deployment and cost of solar PV systems, this variation creates a good backdrop for an *empirical* study on the impact of state-level policies on deployment and cost of solar PV.

Though some work exists on the impact of state-level policy on the deployment of renewable energy (Carley, 2009; Menz and Vachon, 2006; Shrimali and Kneifel, 2011; Yin and Powers, 2010); on the deployment of solar PV (Sarzynski et al., 2011; Shrimali and Kneifel, 2011); and on the cost of solar PV (Mortensen, 2001; Wiser et al., 2006), the discourse suffers from two major limitations: first, there is no work that focuses on the impact of state policies on cost; and second, there is no work that focuses on the impact of policies on cost on a sector-wise basis.

# Methods

Using a panel database for 27 programs in 16 U.S. states over 1998-2009, we assess the impact of 12 state-level policies on the cost and deployment of solar photovoltaic (PV) technologies for two sectors defined by system sizes: residential (*<* 10kW) and commercial (10*−*100kW). We use a regression model with fixed-effects to estimate the impact of state-level policy on deployment and cost of solar PV systems in various state-level programs.

Given that different policy designs may be targeting solar PV deployment and cost differently; and there may also be non-policy factors that affect solar deployment and cost-reduction; the model includes detailed policy and control variables for a state’s electricity market and political environment. The model can be written as:

*Yit* = *®*0 + *¯ ¤* R*it* + *± ¤*W*it* + *° ¤* S*i* + *µ ¤* T*t* + *²it,* (1)

where “*i*” is the program, and “*t*” is the year of the specific observation; *Yi t* is the dependent variable; R*it* is the vector of 12 state-level policies; and W*it* is the vector of five economic and political control variable; S*i* and T*t* are dummy variables representing state and time fixed-effects.

The dependent variable (Y*it*) represents one of four variables under study. Two of these correspond to cost (in $/W) and the rest correspond to the capacity installed (in Watts) in a year. Within each category, these variables correspond to the residential and commercial sector. The dependent variables (Y*it*) and control variables (W*it*) are continuous variables, whereas the policy variables (R*it*) are coded as binary variables: a variable corresponding to a policy equals “1” if the policy is present, and “0” in its absence. Inclusion of the fixed-effects avoids heterogeneity bias that would have occurred from imposing a common constant term. Program fixed-effects (S*i*) are included in the regressions to control for two factors: capacity installation prior to 1998 in a state and factors that differ across programs but are constant over time. Year dummy variables (T*t*) control for national trends, such as general solar energy economic viability and federal policy impacts.

# Results and Conclusions

We show that cash incentives increase the deployment of commercial systems. We also show that interconnection standards potentially promote the deployment of residential systems, whereas property tax incentives potentially foster the deployment of commercial systems.

We next examine the impact of policies on the cost of solar PV, and show that the key policies have different effects on costs. We find that the cost of residential systems declines faster if there are cash or property tax incentives in place; whereas the presence of interconnection standards potentially accelerates the decline in commercial system costs. Further, states with a renewable portfolio standard see residential system costs potentially declining slower than states without such a policy.

As solar PV is at the brink of becoming cost competitive, our findings assist regulators in fine-tuning their set of support tools. Some questions are left for future research, however. First, in the residential sector, why does econometric modeling reveal significant links between some policies and BOS costs while the connection between these policies and installed solar PV is somewhat dubious? Second, our data allows us to detect state-level policy impact only after programs start, and some of the possible impacts may remain undetected. In a perfect world, we had access to data outside the programs, and the scope and credibility of our results would further improve.

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