Essays on Power Markets and Renewable Energy
Şahan Yıldız

1 Investment in Wind Power: An application to German Electricity Generation System (Job Market Paper)

This paper investigates the shift of the German electricity generating industry towards a greater share of renewable sources of energy, specifically wind generation. I analyze how various government subsidy policies impact the timing and effectiveness (in terms of spatial distribution) of the investment into wind power. I construct a dynamic model of investors’ behavior, which incorporates the geographic dimension of investment, government subsidization, delays because of expected technological progress, and the pre-emption motive arising due to the scarcity of usable land. The model is estimated using data from various industry and environmental policy sources. The estimated parameters are used to evaluate (a) the expansion of wind generation in the absence of government subsidies, and (b) to compare the currently used subsidization of production to the subsidization of investment. The first analysis finds that in the absence of subsidies investment into off-shore generation (by far more productive than an on-land generation) would not realize; there would substantial delay into wind generation, and very large avoidable emissions of greenhouse gases. The second analysis indicates that given an equal amount of spending, the investment will be geographically inefficient, which will lead to large underproduction of energy and large avoidable emissions of greenhouse gases.

2 Comparing Subsidy Policies for Wind Electricity Supply in Germany

This paper investigates the impact of subsidy policies for wind power supply, namely feed-in-tariff (FiT) and feed-in-premium (FiP), on the strategic behavior of power generating firms in the wholesale electricity markets. The FiT policy guarantees a fixed tariff that is higher than the market price to the wind generators. Under this policy, firms with market power using conventional methods (for e.g., coal and nuclear) have an incentive to create price differentials between the day-ahead and the intra-day electricity markets. On the contrary, the wind generators receive the market clearing price under the FiP policy. They also receive a premium per-unit of output, over and above the market clearing price. Under this policy, wind generators have an incentive to arbitrage possible price differentials created by conventional generators by overselling in the day-ahead market as shown in Ito and Reguant (2016). In this paper, I find that the participation of wind generators in the electricity market alters the behavior of conventional generators with market power. Specifically, amongst firms using conventional generation methods, smaller firms produce more electricity than their larger counterparts, while total output remains unchanged. I estimate that in the context of Germany, the FiT policy leads to an annual gain of $94 million in consumer surplus relative to the FiP policy.

3 Quantifying the Market Power due to Transmission Congestion in Electricity Markets

This paper extends the uniform price auction estimation methods by incorporating the transmission constraints, which emerges from the limited capacity of transmission system, in the context of electricity markets. These constraints are especially important for electricity markets where the storage of the commodity is economically inefficient. In such an environment, it is expected for strategic bidders located in congested areas to enjoy further market power. Therefore, extracting the private valuation of generators by considering their strategic behaviour under transmission congestion will provide the true social value of investment in transmission infrastructure. This paper provides a theoretical framework, its identification argument and an estimation procedure for the electricity market auctions under transmission congestion.