

THE IMPACT OF EXPANSION OF WIND POWER CAPACITY AND PRICING METHODS ON DAY-AHEAD ELECTRICITY MARKET PREMIUMS

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(1) Overview

Integration of wind energy has (at least) two direct effects on electricity wholesale markets. First, once wind capacity is installed, its generation cost is negligible compared to the costs of balancing power by conventional generators in real-time. Therefore, when available, wind energy is used before conventional units which suppresses real-time prices (Botterud, et al. 2010, Nicholson et al. 2010, Olsina, et al. 2007, Traber and Kemfert 2011, and Woo et al. 2011). Second, the intermittent nature of wind energy increases the frequency with which the output of conventional units is adjusted, thereby increasing operational costs of generators (see for example Hiroux and Saguan 2010, Vandezande et al. 2010).

One unintended impact of public support for investments in wind energy is that spot prices may be depressed to a point that market incentives to invest in conventional generators are too low (Olsina, et al. 2007; Traber and Kemfert 2011). In the presence of market power, the picture is quite different. Twomey and Neuhoff (2010) show that the emergence of wind energy in the form of fringe capacity allows large firms to amplify the effect of intermittent supply on market prices. This result is caused by large firms depressing prices when they need to buy back energy and increasing prices from their conventional units when wind power supply is low. Green and Vasilakos (2010) provides empirical support for this result, showing that conventional generators gain more than wind power producers as market concentration increases.

Policies that prioritize wind energy over conventionally-generated electricity are designed to promote deployment of renewable energy resources. But the feasibility of continuing such policies at high wind penetration rates is unclear. Under these circumstances, we ask which pricing method for wind power can be implemented to promote market efficiency? In particular, we compare day-ahead electricity premiums as wind power capacity expands for two central pricing mechanisms for wind energy; real-time balancing market and a Feed-In-Tariff (FIT) arrangement.

(2) Methods

We extend a recently developed equilibrium modeling approach (Rubin and Babcock 2011) to examine how the integration of wind energy impacts premiums in day-ahead electricity markets. The chosen theoretical framework is a double-sided auction model, and it thus accounts for the behavior of strategic firms on both sides of the market, i.e., Generator firms (GF) and load serving entities (LSE). The model provides equilibrium measures of the two-settlement process, which closely reflects the trade mechanism adopted by most deregulated electricity markets in the world.

(3) Results

The two pricing mechanisms under investigation provide opposite outcomes under increasing wind penetration (fig. 1). When wind prices are determined in the market, then forward premiums increase faster with increased wind penetration than do the efficient premiums (i.e. premiums associated with efficient allocations). The difference between the extreme case in which all wind energy owned by GFs and the case in which all wind energy owned by fringe firms is only 2.7% at 30% wind penetration rate. In contrast, the forward premium under the FIT pricing mechanism decreases as wind penetration rates increase because LSEs' exposure to real-time balancing in the spot market decreases. This results from wind energy that is priced outside the market replacing conventional electricity which was priced in the market. Therefore, facing a lower residual demand, the GFs compete more aggressively. In fact, our simulations show that at 30% wind penetration rate day-ahead premium under FIT is higher by no more than one percentage point more than the efficient premium level. These results suggest that FIT pricing of wind energy has the potential to reduce the market power of GFs.

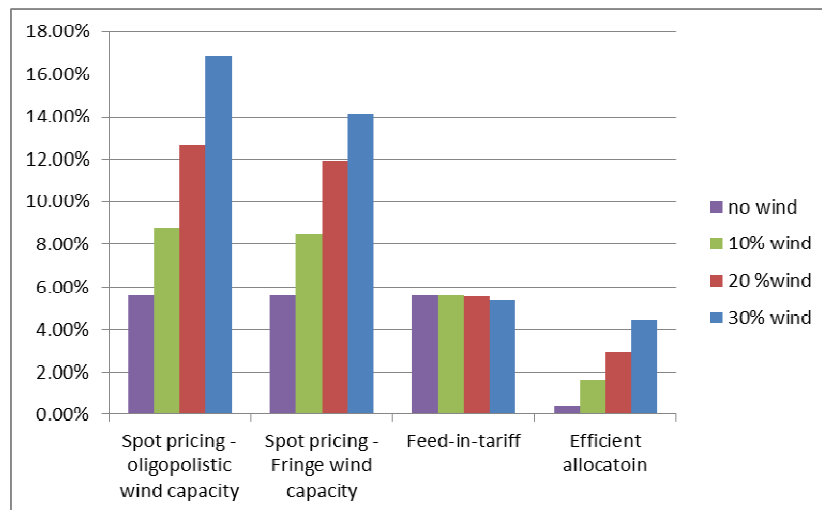


Fig. 1: Day-ahead premiums for conventional generators, the mechanism for pricing wind energy and ownership type of wind power capacity

(4) Conclusions

We find that the way that wind energy is priced is critical. We show that pricing wind energy inside the market increases firms' ability to extract oversized day-ahead premiums while in the case of FIT, market power is reduced as wind power capacity expands. On one hand, our numerical scenario for the FIT mechanism shows a decrease in market power in the sense that at around 30% wind penetration rate day-ahead premium approaches the efficient level. On the other, it is implied by our results that in less concentrated sectors the FIT mechanism may bring premiums down too fast. Our findings augment previous literature. Studies that assume perfect competition find that in the presence of public support for renewable energy the market signals for investments in conventional generators may be suboptimal. In the meantime, studies assuming oligopolistic competition show that the interaction of market power and wind power affects seriously the revenues generated by conventional power units.

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