THE EFFECT OF RENEWABLE SUBSIDY SCHEMES AND MARKET DESIGN ON THE SPATIAL DISTRIBUTION OF WIND ENERGY INSTALLATION

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(1) Overview

Among the member states of the European Union, the German government has set one of the most ambitious targets for covering electricity production by 55% from renewable sources in 2035 (80% in 2050). There is an ongoing political and scientific debate on how this aim can be achieved, i.e. with which policy instruments and at which places (e.g. at location with best production potential or close to load). In addition to the physical conditions, several aspects can influence locational choice for renewable energy generation: the support scheme (e.g. fixed feed-in, premium, quota), market design (e.g. nodal, uniform pricing) and grid integration (e.g. deep/ shallow connection costs) (c.f. Hiroux & Saguan, 2010).

While a range of studies analyze the optimal expansion of renewable energies from a welfare perspective (e.g. Dietrich et al. 2010, Schmid et al. 2013), few analyze the impact of the specific market designs and subsidy schemes on locational choice by investors. Grimm et al. (2014) show such effects for conventional power generators. Hiroux & Saguan (2010) give an overview on the interaction of support schemes for renewable energy supply (RES) and network integration designs concerning short and long-term locational signals. If renewable producers do not receive locational signals other than production potential, they will not take externalities of renewable feed-in on the network into account. To the author's knowledge, so far only Schmidt et al. 2013 examine the effect of different renewable subsidy schemes on the spatial diversification of wind power in Austria. Yet, they do not consider the effect of different market designs.

This paper seeks to close this gap by assessing the effect of a fixed feed-in tariff and a premium tariff on the spatial distribution of wind energy installation. We further analyze which effect different market designs (uniform vs. nodal pricing) have on the locational choice of RES generators. The analysis is first conducted in a simplified six node test model and then for Germany.

(2) Methods and Results

The effect of different subsidy schemes is analyzed by means of an optimization model. We apply net present value calculations to reproduce the investment decision of wind power producers. The producer bases her decision on expected income net of investment and operation costs.

We first analyze the effect for the different subsidy schemes and market designs in a six node test model based on Chao & Peck (1998). Second, we conduct the analysis for Germany in an energy load flow model (c.f. Pechan & Eisenack, 2014). The models are implemented in GAMS. A sensitivity analysis is undertaken to examine the robustness of the results.

In the fixed tariff case, the expected income is independent from the market price and hence from different market designs. The decisive variable is the expected wind production at the specific location. In the case of premium tariffs, the income also depends on the market price, and thus also on the pricing mechanism and the covariance between different wind production sites.

Preliminary results show that the covariance of wind feed-in and market price (so called merit order effect) leads to a spatially less centralized pattern of wind deployment with a premium than with a fixed feed-in tariff. The model results are still subject to ongoing research. In addition, nodal pricing shifts the choice of sites closer to load centers.

(3) Conclusions

While the socially optimal siting of renewable energy plants has been extensively explored, little attention has been given to the influence of different market designs on the choice of site by profit maximizing investors. This paper shows that the design of renewable subsidy schemes and the market design strongly influence the locational decision of RES generators. Without locational signals for renewable producers, costs of congestion can lead to high efficiency losses.

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