What does the wind cost? Inferring the revealed social cost of wind power from zoning decisions in Lower Austria

Energie-/Klimapolitik, Versorgungssicherheit
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Motivation und zentrale Fragestellung

Wind turbines are among the most relevant options to decarbonize energy systems worldwide. However, wind turbines are enormous and highly visible. Their rotors can move at high (tip) speeds, which may harm birds and bats, cause noise emissions and affect animal habitats. The severity of these effects depends on a wind turbine's site. At the same time, the chosen site also determines the time and quantity of a wind turbine's electricity production. Consequently, in wind turbine siting decisions, there is a possible trade-off between wind resource quality and a wind turbine's negative impact.

Vorgangsweise

We develop a theoretical model of the zoning decision of a social planner seeking to minimize the social cost of wind power, i.e. the cost of producing wind power, including its external cost. Based on our theoretical model, we draw on discrete choice methods [1, 2] to estimate the social planner's valuation of wind turbines' impacts implied by the wind power zoning decision.

Estimates from the latent variable model allow us to quantify the trade-off between wind resource quality and wind turbines' locational impacts that the social planner is facing. The marginal rate of substitution between a location's spatial characteristics and wind power generation cost gives us monetized, spatially resolved estimates of a wind turbine's external cost.

We apply our method to the wind power zoning observed in Lower Austria. Our empirical analysis relies on a rich data set in high (approximately 250m x 250m) spatial resolution. Based on the Global Wind Atlas 3, we simulate wind turbines' expected utilization on a raster of an approximate resolution of 250 m x 250 m [3]. We complement these data with data on buildings [4], protected areas [5], bird habitats [6], tourism [7], existing infrastructures, and other spatial characteristics at the exact spatial resolution.

Ergebnisse und Schlussfolgerungen

We estimate the social planner's valuation of wind turbines' social cost, comprising of the private investment cost of wind turbines and the external cost of its impacts on humans and the environment. Due to the vast number of potential wind power zones, we iteratively estimate discrete choice models for draws of potential wind power zones from the set of all Lower Austrian locations [1]. The results are robust to changes in model specification, while the estimated direction of effects is in line with expectations.

Preliminary findings suggest that erecting wind turbines in residential areas would increase the social cost of wind turbines by more than €60/MWh. Likewise, situating wind turbines afar from human-inhabited areas may reduce the social cost of wind turbines by up to €20/MWh. Erecting wind turbines in protected or bird areas is valued at a social cost of €10/MWh to €13/MWh.

Our results demonstrate the usability of our developed methodological approach and are directly policy-relevant up to the point of identifying specific locations suitable for wind turbine deployment. Furthermore, our work adds a novel dimension to understanding wind power potentials by assessing social costs. In turn, these potentials can inform capacity expansion decisions in power system models.

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Literatur

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