Wind power development in Germany: Interaction and trade-offs of spatial planning instruments

Themenbereich 2
Zukünftiges Erzeugungs-/Kraftwerksportfolio und Repowering oder
Zentrale/dezentrale Erzeugung und Speicherung

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Motivation

By 2030, the German government aims at producing 80% of gross electricity consumption from renewable energies [1]. To reach this goal, a substantial expansion of wind power onshore is necessary. Yet, wind turbines may also exert negative externalities for humans and nature. [2,3,4]. To reduce the negative externalities from wind turbines, the selection of areas for wind power development is usually governed by spatial planning tools, such as distance regulations or the exclusion of specific areas. In Germany, for example, wind power development is restricted in forest areas or at certain distances to settlements in individual states. While such spatial planning tools can be very effective in reducing the level of individual externalities, they typically do not account for changes in the level of other externalities that they provoke. For example, excluding forest areas from wind power development can imply that instead, wind turbines need to be installed closer to settlements, thereby increasing associated negative effects for residents (figure 1).

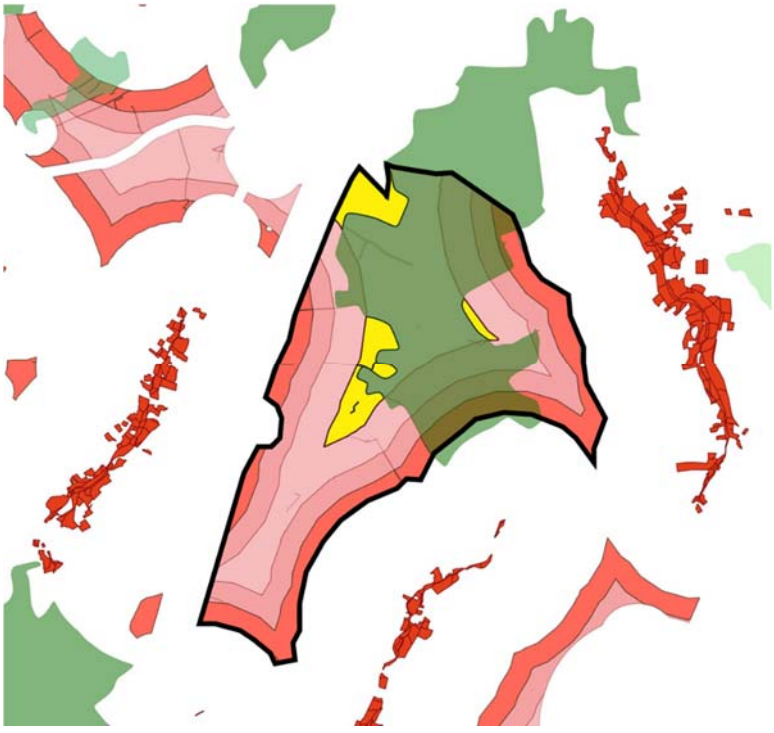

Figure 1: Example of the possible interaction of different setback distances (light red areas) from settlements (dark red) and a forest ban (green) on the potential area for wind power in the centre of the map. The remaining eligible potential area is highlighted in yellow.

So far, the externality trade-offs associated with individual spatial planning instruments are mainly neglected in public and political debates about policy design for the spatial regulation of wind power deployment.

Against this background, we analyse the economic, social and environmental effects of wind power development for different spatial planning policy scenarios in Germany. Likewise, we quantify the combined effect of all spatial planning tools considered on the availability of areas for wind power deployment

With our analysis, we want to inform the debate and create transparency regarding the opportunity costs of individual spatial planning tools.

Method

The analysis relies upon a multi-criteria GIS-based assessment of potential areas for onshore wind power development in Germany. To capture the social and ecological externalities associated with wind

power production in a specific area, several area characteristics are identified. These include the distance to settlements as well as whether an area is located in the forest or a bird protection zone. In addition, average LCOE are calculated for each area based on the respective average wind yield. The spatially-explicit GIS data is then used as input for the statistical analysis of area characteristics under different policy scenarios. Thereby, we quantify the externality trade-offs associated with specific spatial planning instruments.

The externality trade-offs are calculated for the following policy scenarios covering spatial planning restrictions:

A: forest ban, meaning the exclusion of all forest areas from the potential areas

B: minimum distances between wind turbines and settlements of 800m, 1km, 1,5km and 2km

Results and Conclusion

The preliminary results of our analysis show that addressing spatial externalities of wind power deployment with spatial planning tools can cause considerable externality trade-offs, especially between setback distances from settlements and a forest ban.

As forests are on average a predominant land use, restricting potential areas in forests the remaining potentials areas are on average located closer to settlements. This can increase disamenities for residents as one externality trade off. When setback distances to settlements are simultaneously increased as a further spatial planning restriction, the remaining potential area is reduced as an additional generation potential trade-off. In fact, the simultaneous implementation of both spatial planning restrictions results in the reduction of areas for the development of onshore wind power such that the production targets for 2030 and beyond cannot be achieved (compare figure 2). By quantifying these trade-offs, we demonstrate the opportunity costs associated with spatial planning.

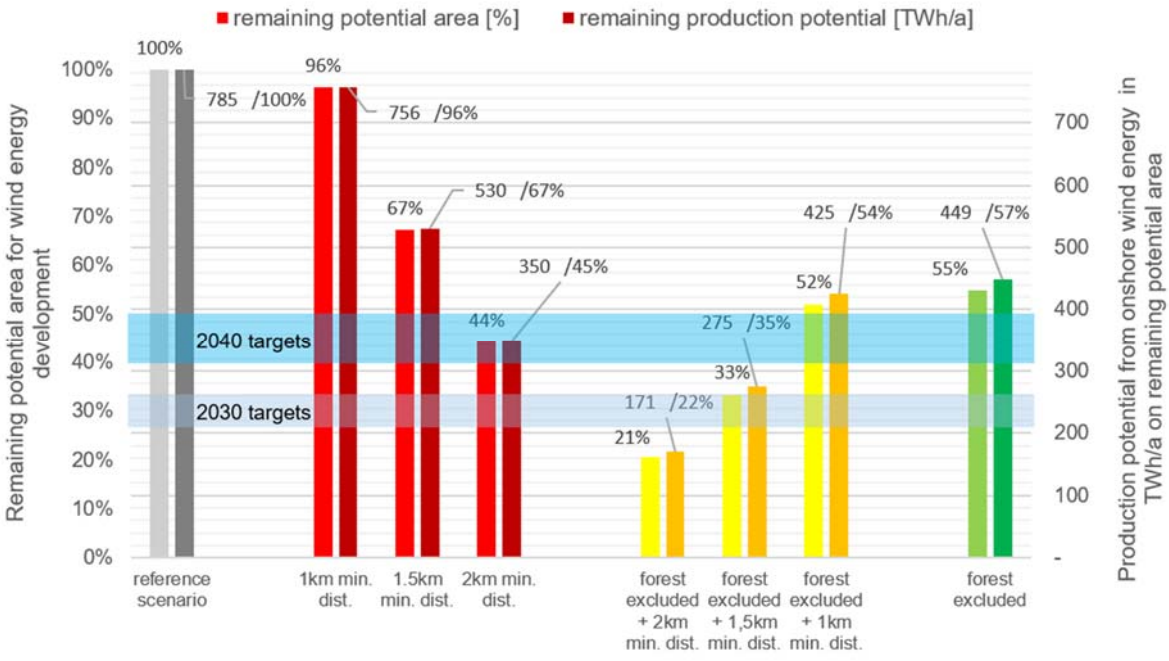

Figure 2: Overview of the remaining potential area and power production potential in Germany for different spatial planning restrictions and their combinations.

Literature

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