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Factors influencing citizens' acceptance and non-acceptance of wind energy in Germany

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ABSTRACT

Among renewable energy technologies, wind energy accounts for the highest share in gross electricity consumption in Germany. To keep this renewable share up, wind energy project have to combine technological aspects with environmental and societally aspects. The successful planning and implementation of a wind farm crucially depends on acceptance of citizens living in the vicinity of the site. Factors influencing acceptance of wind energy can be categorised into processrelated variables, personal characteristics, perceived side effects and technical and geographical issues. However, research is still missing on how and to what extend the identified factors have an influence on the acceptance and non-acceptance. This article identifies the relevant factors within each of these four categories by investigating which of these factors have an impact upon acceptance or non-acceptance of a project. This identification enables policy makers and operators to implement wind energy projects with a certain acceptance level by the society. The study is based on a German wide online-survey with about 1,400 participants. Using a multinomial logistic regression analysis, the results show that factors in all categories are relevant in driving citizens' active acceptance, ambivalence or active non-acceptance of wind energy. The paper reveals that in particular the factors fear of infrasound and the opportunity for participation plays an essential role in the categories perceived side effects and process-related variables. The fear of infrasound has the most significant negative influence on the acceptance. Also the participation level, alibi participation, displays significant negative effects on the acceptance. Furthermore, the results suggest that some of the most recent changes in the legal framework regulating new wind energy projects in Germany counteract acceptance according the findings of this study. In particular, results show that the distance between the place of residence and wind turbines has no significant influence on the acceptance.

1. Introduction

The use of renewable energy sources are essential to mitigate climate change (Bruns, 2014). With respect to the energy transition, the German government aims to reach a share of electricity by renewable resources of between 55 and 60% by 2035. Additional efforts are necessary to reach this goal, as the electricity produced from renewable energy sources in Germany amounted in 2015 to only 31.6% of gross electricity consumption (Federal Ministry for Economic Affairs and Energy, 2016b). Among renewables, wind energy accounts with 34.3% for the highest share in the gross electricity consumption. The total installed capacity of wind energy reached 44,947 MW in 2015, while wind investment amounted to 9.7 billion € in the same year. Compared to 2014 this indicates an investment decrease of almost 20% with 12.1 billion € invested and a total installed capacity of 38,115 MW (Strom-Report, 2016). This decline in investments is mainly due to the continued fall in installation costs of onshore wind energy in recent years (Federal Ministry for Economic Affairs and Energy, 2015) and growing resistance against wind energy projects within the population (Jones and Eiser, 2010).

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Wind energy is of particular importance for the energy transition in Germany (Agora Energiewende, 2015; Alle et al., 2015). The main reasons are the relatively low costs of producing electricity from onshore wind energy, short amortization time of wind turbines, and higher yield per unit of land (Bund für Umwelt and Naturschutz Deutschland e.V. 2011). Despite the advantages of wind energy, the wider use of this renewable energy technology faces challenges from a social point of view. According to a qualitative study of Langer et al. (2016), in which the main factors influencing wind energy have been analysed, opponents often cite local environmental impacts such as e.g. visual landscape degradation as a reason for challenging the implementation of wind turbines. Furthermore, the steady increasing number of wind turbines and the corresponding repowering of old wind turbines have caused conflicts with citizens. In particular, citizens living close to wind turbines may have negative feelings towards wind energy (Alle et al., 2015). Also the perceived fairness by citizens of how wind turbines are distributed in a region can influence their acceptance (Bidwell, 2013). One of the biggest challenges of applying wind energy is its grid integration and grid reliability (Boroojeni et al., 2016) as the concentration of wind turbines in the northern part of Germany is higher due to greater wind velocities. This requires the expansion of the grid system to the southern part of Germany, to distribute wind energy to low wind sites, which can have an influence on the acceptance of the local citizens. Various studies have tried to better understand the motives that underlie opposition to wind energy (Masurowski et al., 2016; García et al., 2016; Colvin et al., 2016), as the public perception of wind turbines might be influenced by a number of factors. In particular, elements of citizen participation within a wind energy project impacts the acceptance (Corscadden et al., 2012; Upham and García Pérez, 2015). In this regard, energy cooperatives are an instrument to financially involve citizens into wind energy projects.

Regional governments of German federal states can foster or hinder the acceptance of wind energy through different measures. For instance, Mecklenburg-West Pomerania picked the financial approach to maintain acceptance. They developed a law about financial participation for citizen. This law requires binding financial participation for communities within a 5 km radius of a planned wind turbine to foster local acceptance (EUWID, 2016b). In contrast, Bavaria enacted the 10H regulation, implying that the minimum distance between wind turbines and residential areas must be at least ten times the height of the proposed wind turbine (Bavarian Ministry of Economic Affairs and Media, Energy and Technology, 2014). This law reduced the number of newly installed wind energy plants in Bavaria significantly (EUWID, 2016a). In addition, both measures encountered high resistance among representatives of the wind energy industry (EUWID, 2016a, 2016b).

In order to counteract the potential threat of an increasing rejection of wind energy projects, it is relevant to know which factors enhance or dampen the acceptance of this technology. According to Langer et al. (2016), influencing factors with respect to wind energy can be grouped into four categories: perceived side effects, process-related variables, personal characteristics, and technical and geographical issues. However, it is still unknown how and to what extent the identified factors in these categories have an influence on the active acceptance, ambivalence or active non-acceptance. Therefore, this paper highlights how these four different categories facilitate or hinder the development of wind energy. The main objective of this study is to identify within these four categories those factors that have a high influence on the active acceptance, ambivalence and active non-acceptance of citizens for wind energy in Germany to adjust and adapt wind farm planning to generate and maintain a high acceptance within the population. In addition, this paper analyses to what extent the active acceptance, ambivalence or active non-acceptance of wind energy is influenced by factors in these categories. Hence, the paper wants to emphasize which factors are of significant importance related to the acceptance process of citizens by using quantitative methods. The detection of significant factors enables policy makers and operators to implement a wind energy project with a high level of positive acceptance.

The paper is structured as follows: Section 2 provides a short literature review. Section 3 presents the implemented methods and statistical data analysis. Details about the data of our study are provided in Section 4. The next Section 5 offers the results and the discussion of the survey. Finally, conclusions are drawn in Section 6.

2. Background and literature review

2.1. Background on the regulatory framework in Germany

The development of renewable energy technologies in Germany has been stimulated by a regulatory framework that assures reliable conditions for investments to producers of renewable energies, which was initiated in the 1990s. This regulatory framework cumulated in the German Renewable Energy Act (EEG) that has continuously been modified over the years with the claimed intention to promote innovation, fasten technological expansion, and advance market integration of renewable energy sources. Regulatory approaches within this policy area are price and zoning regulations. In general, the government can control the expansion of wind energy through subsidies or taxes. The Grid Feed-In Act was introduced by the EEG 2000, implying a fixed feed-in tariff for 20-year periods, feed-in priority, privileged grid access and a degression mechanism (Agora Energiewende, 2016). This fixed feed-in tariff has guaranteed payment to producers of wind energy. The average feed-in tariffs for new wind energy turbines declined in the past as technology costs decreased (Agora Energiewende, 2016). According to a reference scenario (Agora Energiewende, 2016), the feed-in tariff for onshore wind farms is expected to decline from its 2015 level of 9.0 cents per kilowatt hour to 5.4 cents by 2035.

The cost of this feed-in tariff is born through indirect taxes in form of the EEG surcharge. The EEG surcharge is used to transfer the costs of funding renewable energy on the electricity consumer. It covers the difference between the cost of generating one unit of renewable electricity (in form of the feed-in-tariff paid to the generators) and the revenues from selling this unit on the wholesale market. The surcharge is levied on electricity consumers in form of a per unit tax on energy consumption. Energy-intensive industrial consumers, however, benefit from large exceptions on the EEG surcharge (Agora Energiewende, 2015; Pellizzone et al., 2017). The EEG surcharge is expected to increase until the beginning of the 2020s and converge to around 7.7 cents per kilowatt hour. This redistribution of the cost of the energy transition to the private households caused criticism in the public debate on renewable energies in general. It is to be expected though that as a result of declining feed-in tariffs and the ending of the funding period for old plants, the EEG surcharge will decline considerably in the long run and by 2035 reach a level of around 4.5 cents per kilowatt hour (Agora Energiewende, 2015, 2016).

Policy stimulations such as the 20-year funding periods for renewable energy technologies support the implementation of additional capacity and increase total annual public expenditures for renewable energy (Agora Energiewende, 2016). To control the capacity of wind energy added in the next years the German legislation introduced an auction systems for various renewable energy technologies including wind energy in the EEG 2017