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What drives people's opinions of electricity infrastructure? Empirical evidence from Ireland

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ABSTRACT

Across the EU, significant infrastructure investment is needed in both generation from renewable energy sources (RES) and the electricity grid to meet the European targets on emission reduction and RES expansion. Experiences show, however, that citizens may object to new energy infrastructure in their localities which may cause delays in achieving the targets. To avoid delays, it is crucial to understand what drives people's opinions. To explore people's opinions of different electricity generation and transmission technologies in Ireland, we conducted a nationally-representative survey. Concerning the drivers, we distinguish between socio-demographics, technology-specific perceptions, and energy policy preferences. Our results show that people generally have positive views of RES technologies. While this indicates that Irish citizens agree to move towards cleaner electricity sources, we find reluctance amongst people to have these technologies located close to their places of residence. We find that, across most technologies, the tradeoff people make between economic and environmental policy objectives drives their opinions of, and their tendencies to oppose, technology developments. The significance of most socio-demographic variables, however, is largely technology-dependent. This highlights that policy makers need to understand how people make tradeoffs between policy objectives and how these tradeoffs relate to their opinions of different technologies.

1. Introduction

In order to reduce greenhouse gas emissions and mitigate climate change, the European Union aims for a 27% share of renewable energy sources (RES) in final energy consumption by 2030 according to its Framework for Climate and Energy. To meet the long-term goal of reducing EU-wide emissions to 80–95% below their 1990 levels by 2050, more than two thirds of gross final European energy consumption needs to be provided by RES. These targets will involve an increase in the proportion of RES in electricity generation from 25% today to at least 45% in 2030 and an almost entirely decarbonised electricity system by 2050 (EC, 2011). Since many of these new RES electricity generating facilities will be located far from the load centres (particularly in the case of wind power), the RES expansion necessitates an expansion of the power transmission grid to meet the resulting transport capacity requirements. In a nutshell, achieving the European climate targets will require significant energy infrastructure development in all member states. However, across the EU, experiences show that citizens may object to the construction of new energy infrastructure in their localities. While the socio-political acceptance of most RES technologies is reported to be generally high on an abstract level (Wüstenhagen et al., 2007; Van der Horst, 2007), the expansion of both RES generation and power grid infrastructure brings about challenges in terms of local opposition in many countries.[1]

To deliver on emission reduction, however, it is important that the deployment targets are achieved. Given that local opposition may cause delays in relation to the deployment (Battaglini et al., 2012; Ciupuliga and Cuppen, 2013), the achievement of the emission reduction targets is at risk. While this is a challenge across the EU, we focus on Ireland in this paper. The reasoning for this focus is threefold. *First*, with a target share of 40% of intermittent RES in electricity generation by 2020, Ireland ranks above the European average (37%), Denmark (35%) or Germany (35%) (SLR, 2014).

Second, despite this ambitious target and the high RES potential available, to date research on opinions related to energy infrastructure in Ireland is rare. SEI (2003) analysed the Irish public's attitude towards the development of wind farms. At that time, the installed wind power capacity was around 200 MW (which increased to around 3000 MW in 2016). Later, the National Economic and Social Council

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[1] This has been noted by, for example, Bell et al. (2005), Zoellner et al. (2008), Raven et al. (2009), Devine-Wright (2011), Musall and Kuik (2011), Guo et al. (2015).

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(NESC) commissioned research undertaken by SLR (2014) who focus on reviewing national legislation and international literature in relation to wind power development, but the NESC report does not account for other energy technologies. Other research, Van Rensburg et al. (2015), investigates the probability of wind farm planning approval using revealed preferences whereas Brennan and van Rensburg (2016) conduct a discrete choice experiment to analyse how willing people are to make tradeoffs to allow for wind power initiatives in their localities. What these three studies have in common is that, while they provide valuable insights, they focus on wind power without considering the system effects including other sources of (renewable) generation or the grid, all of which play a role in the transition to a low-carbon energy system.

Third, in their energy white paper released in December 2015, the Irish government emphasise the challenges related to local infrastructure siting concerns (DCENR, 2015). Moreover, they recognise the value of communication, sharing information and understanding different views to minimise opposition to infrastructure development. This is important as earlier research on technology opposition has debunked the notion that such opposition can be dismissed as mere NIMBYism (the Not-In-My-Backyard phenomenon, for discussions see Wolsink (2000), Burningham (2000), Devine-Wright (2005) and Wüstenhagen et al. (2007)). In addition, Wolsink (2007b) found that opposition levels can evolve as people become more accustomed to the idea of infrastructure development, while (Assefa and Frostell, 2007) found opposition levels to differ between new and existing infrastructure. Overall, the different findings from existing research highlight that it is crucial to understand what drives people's opinions to effectively communicate with those who will be affected by infrastructure development.

We therefore conduct a nationally-representative survey in Ireland aimed at understanding the drivers that shape people's opinions of different power generation and grid technologies. In this context, Batel and Devine-Wright (2015) emphasise that positive opinions of (renewable) energy technologies should not be taken for granted. The survey, which is based on Bertsch et al. (2016) who conducted a similar survey in Germany, therefore includes items to elicit people's opinions of energy technologies on both national and local levels. In terms of the drivers, we distinguish between (i) socio-demographic characteristics, (ii) technology-specific perceptions and preferences and (iii) national energy policy preferences and tradeoffs and the survey includes question blocks for each of these three groups (see Sections 2 and 3.1 below for further background). In terms of the analytical evaluation, Devine-Wright (2007) emphasises that most of the existing literature is solely based on descriptive statistics. We overcome this shortcoming by applying econometric techniques in our analysis, similar to those employed by Cohen et al. (2016) who conduct an econometric analysis of the willingness to accept transmission line expansion across the EU. To our knowledge, our paper is the first to use econometrics to determine the drivers of people's views of power generation and grid infrastructure technologies on different levels in Ireland.

This paper is structured as follows. In Section 2, we provide an overview of theoretical and empirical research on factors explaining public acceptance and opinions of energy infrastructure. In Section 3, we describe the survey design and the basic background of the econometric models used for our analysis. In Section 4, we provide an overview of the collected data and a summary of the corresponding descriptive statistics. Subsequently, we present the results of the econometric analysis in Section 5. In Section 6, we discuss our findings and limitations of our research. In Section 7, we summarise the main findings and derive policy implications. In addition, Appendix A provides further details concerning the structure and questions of our survey, Appendix B shows that our data are representative of the Irish population, and Appendix C provides additional results.

2. Theoretical and empirical background

Researchers have been studying people's environmental behaviour and attitudes and their influencing factors for many years. From a conceptual, theoretical perspective, Black et al. (1985) for instance distinguish between contextual (demographic, economic, structural) and personal (attitudes, beliefs, norms) factors. Similarly, Guagnano et al. (1995) distinguish between external and attitudinal/internal factors. Both categorisations are similar in that they develop causal models explaining environmental behaviour and in that they are related to the Fishbein attitude-behaviour model (Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1977), positing that effects of socio-demographic (external) factors on energy-related behaviour and attitudes are in most cases likely to be indirect rather than direct. Specifically focussing on determinants of people's attitudes towards power transmission lines, Furby et al. (1988) distinguish between direct effects (e.g., aesthetics, noise, health and safety as well as biological effects, environmental or economic impact) and management-related issues (e.g., equity effects, process characteristics, information and knowledge). Furthermore, focussing on public acceptance of energy-related infrastructure, Devine-Wright (2007) distinguishes between personal (socio-demographic), contextual (technology type/scale, (institutional) structures, spatial context and impact) and psychological (awareness and understanding, political and environmental beliefs and concern, place attachment, trust) factors.

In terms of the socio-demographic characteristics, many surveys found age to be a significant explanatory variable for the acceptance of renewable energy or grid developments. The exact impact, however, differs from case to case. While Cohen et al. (2016), for instance, find acceptance of transmission line expansion to decrease with age, Vorkinn and Riese (2001) find acceptance of a hydro power development to be lower among younger respondents. Gender only proved to be a significant predictor in few studies and, as with age, there is mixed evidence in terms of its effect. While Dietz et al. (1998) find women to be more strongly pro-environmental, Vorkinn and Riese (2001) find lower acceptance of hydro power among females. In terms of education, Bidwell (2013) finds this to be the only characteristic with a significant direct effect on wind attitude (with higher education levels slightly raising scores of wind caution). Concerning household income, Vorkinn and Riese (2001) find households with higher incomes to be more likely to object hydro power development. In addition to these characteristics, Devine-Wright and Batel (2013) find socio-economic status as a significant predictor explaining perception of fit of pylon design by the public.

Two further social-structural variables are worth mentioning: length of residence, i.e. how long have people been living in their current residence, and area of residence, i.e. urban vs. rural. These variables have been demonstrated to significantly affect landscape-related and place-related perceptions and preferences in existing studies (Yu, 1995; Anton and Lawrence, 2014). In terms of energy technology acceptance, Devine-Wright (2012) finds for instance that people who lived in their residence for longer periods of time were more likely to object to a power line while Devine-Wright and Batel (2013) find the area of residence to be a significant predictor for some of the analysed pylon designs. Overall, however, the diverse results on the effects of the external variables presented above on technology acceptance across a large number of studies show that these effects depend to large extent on the specific context and technology (see also Devine-Wright (2012) for a discussion).

In terms of the perceived impact of energy technology developments on their surroundings, the perceived visual landscape impact has been identified as one of the most important predictors of opinions in particular for wind turbines and power lines (Wolsink, 2000; SEI, 2003; Nadaï et al., 2010; Cotton and Devine-Wright, 2011; Devine-Wright and Batel, 2013; Bidwell, 2013). Moreover, the impact of noise on public attitudes is mentioned frequently (Wolsink, 2000; SEI, 2003;

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