



Re-focussing research efforts on the public acceptance of energy infrastructure: A critical review



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ABSTRACT

One of the key issues in adopting a sustainable and renewable energy system is gaining social acceptance for technological change. Many technological changes can adversely affect residents and lead to opposition. Extensive development of electricity infrastructure has been met with especially strong resistance from local stakeholders. An abundance of research has been conducted to study the process and driving factors of social acceptance in the context of these infrastructural developments. This paper develops a conceptual definition of social acceptance that is both explicit and allows for quantitative assessment. This definition will aid future literature by clearly defining the goal of social acceptance research from the outset. As examples of the problems faced in electricity system change, factors of discontent surrounding the social acceptance of wind farms, transmission lines, and pump hydro-storage facilities are identified and synthesized. Policy relevant conclusions from previous research are summarized for these three infrastructure types. It is concluded that while research has done well in understanding the causes of opposition, more work is needed to grasp the efficacy and implementation of acceptance improving strategies. Future research should be focused on devising procedures to facilitate quick and efficient negotiations between infrastructure developers and local groups.

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1. Introduction

The growing consensus of a global need to improve sustainability and reduce fossil fuel consumption has catalysed the efforts of countless academics into offering low-carbon solutions in the energy, transportation and food sectors. These efforts have yielded new technologies and implementable plans to bring about a low-carbon future and long-term sustainability. Research of carbon emission reductions and sustainability in the energy sector continues at an astounding pace, and has led to a myriad of suggestions and potential plans such as: smart grids, end user efficiency measures and renewable technologies. Perhaps the most lauded technological modification is the expansion of green energy generation and decarbonisation of the electricity grid proposed in the EU-2020 and 2050 plans [1,2]. However, the realization of the infrastructure overhaul envisioned by the European Commission is threatened by countless delays and setbacks caused by the resistance of local groups to nearby projects [2]. These experiences with the rejection

of new infrastructure highlight an important point with sustainable technology proliferation; no matter how brilliant the technology or perfect the scheme, changes in the energy system and energy usage can only come to fruition with the acceptance and participation of the public [3].

This article offers insights into the most pressing and most studied acceptance issue: the social acceptance of new energy infrastructure. This information can aid developers, academics and policy makers to better understand public acceptance as a challenge confronting energy system change and technological integration. We begin with a literature review and synthesis of the vast and varied research on the acceptance of infrastructure. Previous findings as to the causes of local opposition are collected for three specific types of electricity infrastructure (wind farms, transmission lines, and pump-hydro storage). The focus is placed on these three infrastructure types because of their importance to the decarbonisation of the energy grid. Also, each development stands as an example of a separate component in energy supply. Wind farms are one of the main renewable generation sites, transmission lines and pylons represent energy transportation, and PHS (pump-hydro storage) represents energy storage. The expansion of all three infrastructure types will be needed to decarbonize the electricity grid in Europe [1,4,5]. All three of these developments are large scale, and take place at the “meso” and “macro” levels [3]. Finally,

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we turn our focus to the policy relevant question of how to best foster social acceptance of new infrastructure by using the insights and results of past studies. We identify deficiencies that can be filled by future research. In these ways this paper adds to the literature on public acceptance, and can help policy makers and developers come to terms with local opposition to a planned development project.

2. Social acceptance of energy infrastructure

Across Europe public opinion of energy developments is generally favourable for many types of energy infrastructure, especially renewable sources [6,7]. Yet, many projects are met with local resistance or discontent, which in many cases is a significant barrier to development (e.g. Refs. [8–13]). This phenomenon has been studied extensively in recent years by numerous disciplines and is interchangeably referred to as: social acceptance, public acceptance, local acceptance, or conversely as social, public, or local opposition. The fear regarding social opposition in this context, is that local groups will impede the process of converting the current energy infrastructure into a decarbonized grid, resulting in a failure to significantly reduce CO₂ emissions.

The disparity between the general public's acceptance of new infrastructure projects and the opposition exhibited by those groups residing close to the planned development has been characterized as a NIMBY (not in my backyard) response. That is to say that while someone may enjoy the benefits, or the idea of new infrastructure from a distance, they are opposed to bearing the costs of having this infrastructure in their proximity. This response to planned construction is a reasonable one, as locals can be exposed to the negative impacts of development such as: diminished viewsheds, increased noise, pollution or traffic, and safety concerns [14]. Furthermore, there can be a direct economic effect on local communities in the form of decreased property values [15–17]. Despite the legitimacy of the NIMBY sentiment among locals, the concept has been criticized for inadequately explaining the complexities of social acceptance [14,18,19]. Van der Horst (2007) explicitly investigates the validity of the NIMBY construct, and finds that while proximity to a proposed project will, on average, lead to opposition, an emotional attachment to the proposed area of development plays a greater role in fuelling such opposition [18].

Previous authors have developed various conceptual frameworks for social acceptance [3,10,12,14,19]. Among them Devine–Wright (2009) proposes an alternative to NIMBY with place theory [19]. This theory links a proposal for a new development with social action through the subjective interpretation and evaluation of the impending change. The evaluation of the development will be positive if the outcome on the location is deemed to be positive. Bronfman et al. (2012) proposes a model with strong links between trust in government, perceived benefits and risks, and social acceptance [10]. This model is shown to fit the researcher's data in the cases of fossil fuel, hydro, and nuclear power. Wuestenhagen et al. (2007) shows that social acceptance can be broken into three dimensions each corresponding to different agents: socio-political acceptance, community acceptance, and market acceptance [12]. Devine–Wright (2008) defines the factors influencing social acceptance by three broad categories: personal (demographics), social-psychological (perceptions and experience), and contextual (siting, type of development) [3]. Finally, in Devine–Wright (2011), the author explains that the drivers of social acceptance are influenced by the locals' perceptions and awareness of both the outcomes of a new development, and the procedures of the development process [20].

While scores of papers have studied the phenomenon of social acceptance and offered useful conceptualizations, research suffers from the lack of a widely accepted understanding of what is meant by the term “social acceptance” [3]. One *de facto* definition that may be employed is to define acceptance as the lack of noticeable opposition to a project. This definition raises the corollary issue of defining a ‘lack of opposition’, which is equally problematic and could have countless interpretations. Krausel and Möst (2012) offer a converse definition whereby acceptance is defined as the existence of positive actions: “[Social] acceptance is defined as [a focus group or society's] positive attitude towards an issue at a determined point of time which is expressed in a certain opinion or in a certain behaviour such as endorsement, approval, approbation”¹ [21]. Definitions of this type are of questionable value since it remains open to interpretation which behaviours and opinions are sufficient to constitute acceptance, also they do not allow for an empirical measurement of acceptance. This second point is a critical need for studies that investigate the efficacy of particular strategies in improving acceptance, to enable a link between estimated changes in acceptance and the conceptual framework. Thus it would behoove the study of acceptance to have a definition that is both concrete, and allows for measurement of the phenomenon.

To formulate such a definition we draw on economic utility and welfare theories. Economists conceptualize welfare through the idea of individual utility. A positive change in utility can be understood as simply making the individual better off while a negative change makes the individual worse off. The aggregation of such changes in utility can be thought of as a change in social welfare. We take as given that if a governing body plans a new infrastructure project, then this project is predicted to lead to a positive increase in social welfare. However for a project to satisfy social acceptability it must satisfy the following definition for *all* agents.

Social acceptance of new infrastructure occurs when the welfare decreasing aspects of the project are balanced by welfare increasing aspects of the project to leave each agent *at worst* welfare neutral and indifferent to the completion of the project, or better off and supportive of the project.

Welfare decreasing aspects of new infrastructure are those that are perceived as ‘bad’ by local residents such as: diminished viewshed, safety concerns, noise, pollution, landscape destruction, ecological change, decreased property values, and procedural injustice. Welfare increasing aspects of a new project are those that are seen as ‘good’ by the locals such as: economic development, energy supply security, green benefits, community compensation, personal compensation, place distinctiveness (see Ref. [20]), and procedural justice. Thus we define social acceptance, not in terms of any action taken by residents, or as a lack of opposition, but as a set of outcomes and aspects that leave locals at least as well off as they were before the project.

It is important to note that this definition does not reduce the set of potential welfare altering elements of a project. Non-market goods such as perceptions, perceived justice, and feelings toward a place can all be captured by an individual's utility level. Furthermore, it is neither the assertion of economists nor the presented definition that residents conceptualize every aspect of a project and mentally equate them in monetary terms. Rather, it is economists' ability to use non-market valuation techniques to measure *changes* in utility due to changes in residential surroundings that make this definition appealing. Using these techniques and applying our definition of social acceptance allows for *quantitative* proof that acceptance for a project has been attained, or estimation of the compensation – through changing aspects of the project or

¹ Translated and taken from Ref. [22].

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