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Public acceptance of energy technologies: The effects of labeling, time, and heterogeneity in a discrete choice experiment

Frank J. van Rijnsoever*, Allard van Mossel, Kevin P.F. Broecks

Innovation Studies, Copernicus Institute of Sustainable Development, Utrecht University, Heidelberglaan 2, 3584 CS, Utrecht, The Netherlands

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ABSTRACT

Public acceptance is crucial for successful implementation of energy technologies in society. However, studies that use the concept do so in diverse and often inconsistent ways. They also often limit themselves to specific technologies and do not account for the effects of labeling, time, and the heterogeneity of the general public, which may lead to a biased and incomplete understanding of public acceptance. This study first conceptualizes three forms of public acceptance: socio-political acceptance, market acceptance and community acceptance. It then relates the concept of socio-political acceptance to preference formation. Next, it uses two discrete choice experiments that were conducted in 2010 and 2012 to investigate these concerns. Our results show that public preferences for energy technologies are temporally stable, even in the face of exogenous shocks such as the Fukushima incident. Using mixed logit models, we further show that labeling has a profound influence on stated preferences. When technology labels are revealed, respondents favor renewable and natural gas technologies. When labels remain unobserved, nuclear energy and biomass take prominence. However, latent class models show that there are distinct classes of respondents, tied to specific socio-demographic characteristics that differ greatly in their sensitivity to labeling and in the temporal stability of their preferences. It follows that changes in public acceptance are not population-wide, but remain limited to specific sub-groups. We discuss the theoretical and policy implications of our findings and conclude that future studies and policy initiatives may overlook important insights if they disregard the effects of labels, time, and heterogeneity.

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* Corresponding author. Tel.: +31 30 253 7484.
E-mail address: f.j.vanrijnsoever@uu.nl (F.J. van Rijnsoever).

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1. Introduction

Public acceptance is crucial for successful implementation of technologies in society. Energy technologies currently encounter significant public opposition in several countries. The German government, for example, shut down all national nuclear facilities after the 2011 Fukushima incident incited widespread public opposition. High public acceptance eases the implementation of technologies in society, but when acceptance is low, it hinders – or even halts – their implementation. Attaining renewable energy targets while accounting for public preferences is a substantial challenge to policy makers. The current Dutch policy framework for renewable energy, for example, is based on an agreement between a range of national and local stakeholders, such as ENGOs, unions and companies [1]. Increasing understanding of the determinants of public acceptance and preference can aid policy makers in making more informed decisions for renewable energy policies.

The public acceptance of energy technologies has received limited scientific attention, despite its influence on innovation success [2]. Most studies on the topic are limited to specific technologies, such as carbon capture and storage (CCS) [3,4], wind energy [5–7], biomass energy [8,9], solar energy [10,11], or nuclear energy [12,13]. However, future energy systems will likely consist of multiple energy technologies. A focus on one technology is also too narrow for a real understanding of public acceptance, because it leads to a bias resulting from myopic decision-making [14]. For reliable measurement of the public acceptance of a technology it is therefore important to compare it with available alternatives, as was done empirically by Bergmann et al. [12,14], Zoellner et al. [16], and in meta-studies that combine the results of public acceptance studies [17].

Several additional caveats remain unexplored when it comes to systematically understanding the public acceptance of energy technologies.

First, there is a lot of ambiguity surrounding public acceptance [18] due to its multidimensional nature [2]. To fully understand the role of public acceptance in energy innovation processes, studies need to specify clearly which aspect of public acceptance they are studying and why this aspect in particular is relevant to the issue at hand.

Second, research shows that individuals not only base their choice on a technology's observed attributes, but also infer other attributes from a label. Labels such as product names, technology names or brand names function as heuristic cues [19,20]. The label can invoke thoughts and feelings that do not necessarily match the observed attributes of a technology. For example, nuclear energy often invokes feelings of dread, which greatly influences its acceptance by the public [21,22].

Third, preferences for alternatives are often unstable over time [14,23]. Thoughts and feelings associated with a label can change under the influence of new information. For example, the incidents at Chernobyl and Fukushima may strengthen the negative associations of with the label "nuclear energy."

Fourth, by only presenting the average valuations of different alternatives, many public acceptance studies implicitly ignore the fact that the general public is heterogeneous—the opinions of individuals can vary substantially [24,25]. Understanding this heterogeneity facilitates segmented communication approaches. This can improve the acceptance of technologies among subclasses and, thereby, reduce controversy.

In this paper, we first review existing literature on public acceptance of (energy) technologies, preference formation and preference diffusion. Next, we expand upon the state-of-the-art by demonstrating how labeling and time affect acceptance of energy technologies among different classes of the public. We do this by analyzing two latent class choice models, using data from two discrete choice experiments conducted in 2010 and 2012.

2. Review

2.1. Conceptualizing public acceptance

It is often unclear what the concept of public acceptance entails, since it has a dual meaning. It variably refers to an attitude towards a technology or to a form of behavior that supports or resists the implementation of a technology. However, psychological models [26] point out that attitudes do not always incite the associated behavior. Negative attitudes, for example, do not always lead to protests. As such, there are different indicators of public acceptance that are not necessarily consistent [18].

We base our conceptualization of public acceptance on the roles that individuals can play in the different stages of an innovation process. Two different role types, citizens and consumers, shape the public acceptance of a new technology [27,28]. Citizens are usually only indirectly involved in the development and diffusion of novel technologies. They shape the innovation process by voicing their opinions or by displaying actions that support or resist a technology, both before and after market introduction. Consumers effectively play two direct roles; as adopters and as users [29]. Although consumers often combine these roles, this is not always the case. Consumers can, for example, donate or share a purchased good. Moreover, it should be noted that consumers can also be organizations. Following Van Rijnsoever and Oppewal [30], we take the view that adopters and users are relevant at different stages in the innovation process. Adopters play a role in the acceptance process once opportunities for direct interaction with the technology become available, such as test facilities, prototypes, or products and services that can be purchased. Users are those who use the technology or experience its consequences.

Based on these roles, we arrive at the three interdependent dimensions of public acceptance by Wustenhagen et al. [2]: socio-political acceptance, community acceptance, and market acceptance.

- *Socio-political acceptance* refers to the role of citizens. It is primarily manifested through general support for a technology or for policies that support its development. This component of acceptance is often gauged through opinion polls that represent the aggregated attitudes of citizens [31,32]. Socio-political acceptance further comprises the acceptance by key stakeholders and policy makers, who can employ various strategies to influence socio-political acceptance (see [33] for an overview). Prominent strategies are the voicing of opinions by societal groups or stakeholders in the media, seeking the help of political parties, or engaging in direct dialogue with developers. Socio-political acceptance can foster market and community acceptance by legitimizing policies for social site characterization [34]