



Quality uncertainty and the market for renewable energy: Evidence from German consumers



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ABSTRACT

Consumers can choose from a wide range of electricity supply contracts, including green power options. Electricity produced from renewable energy involves information asymmetries. With a sample of more than 2,000 German electricity consumers, we tested the proposition of a “lemon market” for renewable energy in a discrete choice experiment. Specifically, we found that, compared to investor-owned firms, additional willingness-to-pay for renewable energy is approximately double when offered by co-operatives or municipally-owned electricity utilities. Consumers who are experienced with switching suppliers have an additional willingness-to-pay of one Eurocent per kilowatt hour for cooperatives and two Eurocents for public enterprises. The results demonstrate that organizational transformation in dynamically-changing electricity markets is not only driven by political initiatives but also by consumers' choices on the market. Public policy may reduce information asymmetries by promoting government labeling of green energy products.

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1. Introduction

Over the past two decades, European retail markets for electricity have changed fundamentally, and market deregulation has occurred in most countries. Currently, electric utilities owned by municipalities compete for customers with investor-owned firms, newly formed consumer-owned cooperatives and other citizen-initiated business models in power generation (cf. [56,57]). In the fulfillment of international agreements, European countries strive for greening their energy systems, and various policy instruments have been established to ensure a reduction in carbon emissions from electricity generation [23]. For instance, Germany – Europe's largest economy – has decided to phase out the utilization of nuclear power and increase its share of renewable energy sources in electricity generation to at least 40% by the year 2025 [31].

At the municipal level, political referenda initiated by citizens have called for the reorganization of local energy supply. In Hamburg, Germany's second largest city, a majority has been achieved in a political referendum in favor of a deprivatization of the local electricity grid and generation capacities. In Berlin, a similar

initiative has reached a majority of 83%, but the necessary quorum of 25% was missed by 0.9%. In both cases, citizens proposed a remunicipalisation by the city or a cooperative model based on the joint investment of citizens in a democratically controlled and consumer-owned enterprise.

In addition to the role that citizens play in the political process, they have also started to choose the type of supplier they want on the market. Since 1998, German electricity consumers can freely choose from a wide range of electricity suppliers and tariffs, including green power options. Besides price, a supplier's general service, or the share of renewable energy, various characteristics of suppliers have been identified as important attributes of electricity contracts in discrete choice experiments [2]. Firm size, location, or commitments to price transparency affect consumers' willingness-to-pay for electricity [21,34], and differences exist between groups of customers [36]. However, these studies have overlooked the fact that supplier characteristics may interact with other properties of supply contracts. In particular, a consumer's willingness-to-pay for renewable energy may not only depend on the share of renewable energy in the mix, but may interact with the supplier's commitment to transparency. For the consumers it will be important to know how exactly the renewable energy they buy is produced and how easily these hidden attributes can be observed.

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The objective of this paper is therefore to study willingness-to-pay of consumers for renewable energy differentiated by the type of supplier. We use data from a discrete choice experiment with German electricity consumers to test if willingness-to-pay for renewable energy differs by supplier governance, namely between cooperative, municipally-owned, and privately owned electric utilities.

2. Literature and theoretical framework

2.1. Previous studies on consumer preferences for renewable energy

In Germany the market for renewable energy is well-developed, and consumers often pay premiums for electricity generated from renewable energy (cf. [21]). A large literature is concerned with estimating consumers' willingness-to-pay for renewable energy based on stated preferences methods in the absence of adequate revealed preferences market data (see Refs. [4,24,39,49] for recent meta-analyses).

Ma et al. (2015) [24] used a meta-regression to identify the most important factors influencing willingness-to-pay. Among other variables, the authors regressed study design, average income, and average electricity consumption on the willingness-to-pay for renewable energy in US\$ Cent per kilowatt hour (kWh). They found an average additional willingness-to-pay of 1.5 Cent per kWh, ranging from –39.6 Cents per kWh to 16.9 Cents per kWh. Willingness-to-pay was substantially higher if the survey used a discrete choice experiment and substantially lower if it was conducted online. Using a similar approach Bigerna & Polinori [4], were concerned with understanding the factors that drive consumers' acceptance of renewable energy. The authors found that additional willingness-to-pay for renewable energy is substantially higher in Europe and lower in the United States. Similarly, Sundt & Rehdanz [49] found that willingness-to-pay for renewable energy is lower in the United States. In contrast to Ma et al. [24] they did not find an impact of the method chosen. Soon & Ahmad [39] used a meta-regression to investigate differences in monthly willingness-to-pay for electricity from renewable energy. In their study, households would pay on average approximately seven US\$ per month to move from electricity produced from conventional sources to renewable energy. Contrary to Bigerna & Polinori [4] and Sundt & Rehdanz [49], households from the United States had a higher and households from Asia a lower willingness-to-pay when compared to Europe.

Based on a sample of 33 subjects from Germany and an innovative neuroscience-based method, Herbes et al. [17] estimated additional consumer willingness-to-pay for renewable energy at approximately 15% above that for conventional energy. Krishnamurthy & Kriström [22] used survey data from eleven OECD countries to estimate price and income elasticities for renewable energy. They found that demand for renewable energy is relatively price-inelastic in the Netherlands and Japan and relatively price-elastic in Australia, Canada, Chile, and Spain, whereas income elasticities are relatively low across all countries. Streimikienė & Balezentis [48] estimated willingness-to-pay for renewable energy in Lithuania which – in line with previous studies from other countries – was positive and driven by income, education, and environmental awareness. Vecchiato & Tempesta [54] found a positive willingness-to-pay for renewable energy among Italian consumers. The authors distinguished between different sources of renewable energy, and they found that solar was the preferred option.

Although there is growing consensus that consumers are generally willing to pay more for electricity from renewable energy [4,24,39,49], several drivers of consumers' willingness-to-pay are

not yet fully explored in the literature. Kaenzig et al. [21] have proposed that the organizational and institutional context of an electricity supplier influences consumers' willingness-to-pay for renewable energy. In a study of German consumers, they did not find a large impact of size of the utility. However, electricity produced in Eastern Europe showed a substantially lower willingness-to-pay, and the presence of certification schemes increased consumers' willingness-to-pay. Sagebiel & Rommel [35] investigated preferences for the organizational form of the electricity supplier using a sample of 800 private households in Hyderabad, India. They found a positive willingness-to-pay for a state-owned company by the majority of respondents.

Sagebiel et al. [34] picked up this idea and used a transaction cost economics framework to estimate willingness-to-pay for electricity among a convenience sample of German students. The study focused on specific organizational attributes of the providing utility, such as geographic distance to the consumer, number of owners, price transparency, and decision-making procedures. Based on the same data, Müller & Sagebiel [28] investigated the interaction of these properties with the share of renewable energy in the electricity mix.

In the same vein, we argue here that organizational properties of the providing utility mediate consumers' willingness-to-pay for renewable energy. This paper differs from earlier work in at least three aspects. First, unlike our previous studies [28,34], the analysis rests upon a large sample from a representative consumer panel provided by the marketing research institute *forsa.omninet*. Second, our theoretical framework introduces the idea of quality uncertainty and credence good characteristics into the more general discussion on labeling and trust. Third, instead of using a large number of specific organizational attributes, in this study, we opted for broader organizational labels that are well-known to respondents. This allows us to distinguish willingness-to-pay estimates by organizations that operate in the actual market under investigation.

2.2. Theoretical framework

Consumers can observe and experience numerous attributes of contracts with their electric utility. Some attributes are independent of the contract and known to the consumer *ex-ante* (e.g., the expected frequency of power cuts). Other attributes can be experienced by the consumer *ex-post* (e.g., response time after a complaint is placed). A third group can neither be observed *ex-ante* nor experienced *ex-post*. For instance, consumers cannot easily obtain information on the electricity generation process. This is important because, today, different standards regarding electricity generation from renewable energy exist, and firms have adopted a wide range of generation options. While some companies ensure instantaneous generation from renewable sources at all times, other companies base their green power tariffs on Tradable Renewable Certificates which give rise to relabeling and fraud (cf. [34]). It is difficult for consumers to observe the electricity generation process and assess its environmental impact, thus creating a potential “lemon market” [1] for renewable energy.

In Akerlof's [1] model, there are buyers and sellers of goods. Information is asymmetric, and sellers know the true quality of the good they sell. Buyers have information only on the distribution of quality in the market as a whole. A high quality seller would typically ask for a price higher than a buyer would be willing to pay, thus giving rise to adverse selection (i.e., low quality sellers are dragged into the market, and high quality sellers are pushed out). Market failure and even a complete breakdown of the market can be the result. Akerlof concludes that several economic institutions are created to counteract information asymmetries. For instance,

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