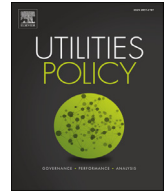




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# How to approach consumers' nonmonetary evaluation of electricity supply security? The case of Germany from a multidisciplinary perspective

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## ABSTRACT

Consumers' preferences regarding the security of supply (SoS) of electricity are generally assessed through economic estimates of the *value of lost load*. However, this monodisciplinary approach typically builds on homo oeconomicus assumptions and neglects consumers' nonmonetary evaluations of SoS. This can result in short-sighted regulation, especially in the context of a transition like Germany's *Energiewende*. This paper provides a consumer-centered perspective on SoS employing psychological and sociological research on energy. German consumers' strong involvement in the *Energiewende* and their strong commitment to it make them a fascinating case. To determine the practical implications, we explore under what circumstances altered levels of SoS could be acceptable to consumers.

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## 1. Introduction

The transition to a renewable energy system raises issues of security of supply (SoS). The German decision to phase out nuclear power and adopt renewable power sources was clearly a political one (Borden and Stonington, 2014; Hake et al., 2015). The government is seeking to minimize the risks from nonrenewable sources (most prominently nuclear power) and focusing on values such as health and environment (Ethikkommission, 2011). Currently, the network and power utilities have to face the resulting challenge to assure the same high level of SoS as was previously guaranteed. By the beginning of 2014, the share of intermittent power from renewable sources increased tremendously to 35.9 GW of solar and 34.7 GW of wind power (AGEE-Stat, 2014). This is impressive compared to a peak load of about 81 GW (ENTSO-E, 2014). Although politics and civil society have debated and decided on the acceptability of different power generation technologies, they have not discussed the potential acceptability and social desirability of intentionally altering the level of SoS.

The three goals of energy policy, namely sustainability,

affordability/competitiveness, and security conflict with each other. Most policy solutions represent a compromise between fulfilling each of these goals. For example, a capacity remuneration mechanism and the building of new gas or coal power plants would serve the goal of SoS (e.g., Finon and Pignon, 2008; Joskow, 2008) at the expense of economic efficiency (e.g., de Vries and Heijnen, 2008). Interestingly enough, neither scientists nor politicians dare to seriously consider the option of slightly lowering the level of SoS in order to achieve high gains on the sustainability and affordability goals. Controlled outages, i.e. temporary demand capacity limits for private consumers—which we will now refer to as cut offs—of even as few as 10 min during periods of low sun and wind power generation could considerably decrease the necessity for public funding to build greater generation capacity,<sup>1</sup> for example new gas power plants. Building new capacity by direct or indirect public funding is likely to result in a further increase in electricity prices, which would negatively affect all electricity customers.

A reason for the option of an intentionally lower supply level being neglected in the political and public debate is the anticipated reaction of private consumers. Decision makers are concerned about the risk that consumers will react with immediate rejection

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<sup>1</sup> In this paper, we do not discuss storage technology and other technological solutions. Instead, we concentrate on private demand side evaluations and behaviors.

of such suggestions, no matter whether they are brought up by politicians or by utility companies. However, from an efficiency and global optimization perspective, every policy option should be considered, investigated, and evaluated with regard to its potential risks and benefits for society.

The terms “security of supply” and “energy security” are undergoing a process of revision. Gracceva and Zeniewski (2014) suggest a new set of systemic properties to fully capture the energy security of a low-carbon EU energy system. Winzer (2012) gives a systematic overview of the numerous different definitions of energy security. He concludes that the term energy security should be used to refer to the continuity of energy supplies relative to demand. We adopt this definition of SoS for our following analysis.

Several studies have been carried out to assess the SoS priorities of business and industrial groups (e.g., Growitsch et al., 2015 for Germany and Manley et al., 2013 for the U.S.). However, only a few researchers have adopted a psychological or sociological perspective of private consumers' evaluation of SoS (cf. Demski et al., 2014). Aside from Demski et al.'s study, private consumers' preferences regarding SoS have mostly been studied by economists, who generally build up scenarios of costs for unplanned outages (“blackouts”) by estimating consumers' value of lost load (VoLL; e.g., for German households: Growitsch et al., 2015; Praktijnjo, 2014; Praktijnjo et al., 2011). Nevertheless, we question whether this rather narrow, neoclassical economic perspective is a good starting point for a political, societal, and scientific debate on the socially optimal level of SoS. Moreover, we think that the economic analysis is not sufficient to fully cover private consumers' perspective on SoS.

In Germany, the Bundesnetzagentur (Federal Network Agency) has the task of regulating the desired quality derived from the Energy Law and Incentive Regulation. Simple VoLL based models fail to successfully counterbalance the energy policy goals of sustainability and economic efficiency against the goal of security of supply. Some aspects of consumer preferences are more adequately addressed by sociological and psychological models, in particular the dependence on dominant social standards and context dependent, dynamically changing consumer preferences. Ignoring these, the Bundesnetzagentur risks to set inadequate SoS target levels and to waste public welfare. Policy makers should thus stimulate a debate on consumers' nonmonetary evaluation of SoS, that are influenced e.g. by environmental frames or social practices of SoS.

The purpose of this paper is to identify blind spots in the debate on SoS and to outline the consumer-centered perspectives on it. We will focus on Germany but numerous aspects of our analysis might apply to other industrialized countries as well. We contribute to the aim of deriving a socially desirable SoS level by challenging traditional neoclassical economic valuation methods with different options and extensions from sociological and psychological science. Thereby, we demonstrate the way ahead for politics to fulfill their legal goals of appropriate security of supply, e.g. sufficient reserve capacity, and adequate expected supply interruption and risk levels (see the German Energy Law and Network Incentive Regulation, “EnWG” and “ARegV”). Existing knowledge from the social sciences has to be applied to the specific case of SoS regulation and has to come to political practice.

The paper is organized as follows. Section 2 summarizes the theoretical and empirical economic state-of-the-art analysis of the consumer's perspective on SoS. Section 3 adopts a psychological perspective to show the drawbacks of the economic approach and applies goal framing theory to the topic of SoS. We also discuss the relative importance of monetary incentives versus environmental attitudes regarding energy-related behavior. Section 4 adopts a

practice theory perspective, explaining electricity consumption patterns as the mutual interdependence of social structures and practices, and discussing options for change. Section 5 elaborates policy implications. We identify target consumer groups who might accept lower levels of SoS and give recommendations under which conditions of framing this can most likely be the case. Section 6 concludes.

## 2. Building blocks of the current regulation of SoS

Market imperfections restrict the tradability of providing quality and thus hinder market-based solutions. Therefore, the value that customers attach to SoS is of great importance to policy makers with regard to market design. It matters, for example, for determining the desired capacity of the reserve/balancing markets and of the general system reserves (cf. the “German winter reserve”), and as part of a capacity mechanism. Given the difficulties in implementing market-based solutions, economists and policy makers will have to determine how to consider consumer preferences.

Economists have greatly changed their perception of consumer preferences, determinants of decision making, and revealed preferences over the past several decades. Trying to explain systematic aggregate behavior, economists built on the neoclassical homo economicus.<sup>2</sup> This model takes a rational and selfish decision maker as a starting point, because economic equilibrium theory could be set up in a market framework comprising a household and a firm. By explaining large shares of systematic market behavior, this basic model of individual behavior is realistic and empirically valid as the lion's share of empirical work in economics over the last decades in virtually all its disciplines has shown. However, it is not complete. Large parts of recent economics, such as context-dependent behavioral economics, are devoted to finding reasons for deviations from this old neoclassical model and extending it for psychological and social elements.<sup>3</sup> Human decision making is influenced by various situative factors such as hunger, fear, temporarily increased attention (salience), fixing budgets for certain expenditures (budgeting), or being confronted to the strategic, systematic use of signals (framing and nudging). To contrast the possible valuable avenues for future research in these areas, we give a brief overview of the theoretical and empirical background on the value of SoS and its social desirability.

### 2.1. Economic theory

#### 2.1.1. Electricity market and SoS: the optimal level of quality

2.1.1.1. What is quality?. Defining quality in an electricity system is not a trivial undertaking even from the viewpoint of neoclassical economics. The *homo economicus* typically chooses between several goods on the basis of her preferences, or, in other words, the value she attributes to these goods. The value she attributes to reliable electricity delivery is called the value of lost load (VoLL). Goods are scarce and thus have a price. The neoclassical individual can make a purchasing decision in accordance with her preferences, her budget and the costs. This constellation results in her desired level of individual SoS, i.e., a probabilistic (*ex ante*) statement about her expected outages and the risk of deviations from this level. SoS then typically means an aggregate level of system reliability that takes into account an individual's value for lost load. It can be understood as a measure of an electricity system's quality

<sup>2</sup> See standard textbooks such as Varian (2010) or Mas-Colell et al., (1995).

<sup>3</sup> See for example the recent special issues in the *Journal of Economic Perspectives*, volume 29(4), and *Review of Industrial Organization*, volume 47.

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