The value of supply security: The costs of power outages to Austrian households, firms and the public sector

Johannes Reichl a,⁎, Michael Schmidthaler a, Friedrich Schneider b
a Energy Institute at the Johannes Kepler Universität Linz, Altenberger Strasse 69, A-4040 Linz, Austria
b Department of Economics, Johannes Kepler Universität Linz, Altenberger Strasse 69, A-4040 Linz, Austria

A R T I C L E   I N F O

Article history:
Received 10 November 2011
Received in revised form 7 August 2012
Accepted 24 August 2012
Available online 15 September 2012

JEL classification:
N74
Q43
Q43
Q13
P28

Keywords:
Power outage
Value of supply security
Empirical analysis
End-user survey

A B S T R A C T

This paper presents a model for assessing economic losses caused by electricity cuts as well as Willingness-to-Pay to avoid these power outages as an approximation to the value of supply security. The economic effects for simulated power cuts from 1 to 48 h, which take the affected provinces, the day of the week and the time of day into consideration, can be calculated using the assessment tool APOSTEL. The costs due to power cuts are computed separately for all sectors of the economy and for households. The average value of lost load for Austrian households and non-household consumers in the case of a power cut of 1 h on a summer workday morning was calculated to be 17.1 € per kWh of electricity not supplied.

© 2012 Elsevier B.V. All rights reserved.

1. Introduction

In the past decades, Europe has experienced an unprecedented degree of electricity supply security. Nevertheless, the current status of reliability should not distract from the fact that the future development of electricity supply security is uncertain as production as well as distribution experiences significant restructuring. This transformation is taking place at three levels potentially affecting security of supply:

Firstly, challenges arise due to changes in the market framework or as a consequence of deregulation and unbundling imposed by EU directive 2003/54/EC (European Commission, 2003). Secondly, the significant growth of electricity generation from renewable energy sources implies increasing levels of supply volatility thereby putting pressure on transmission and distribution systems (Borggreve and Nuessler, 2009; Boxberger, 2005, or BDEW, 2011). Thirdly, the current and anticipated growth of electricity consumption in developed countries such as Austria requires capacity enhancements and innovative solutions. From a technical and public acceptance perspective these infrastructure measures become increasingly difficult to implement (Netzentwicklungsplan, 2012).

Together, these developments represent significant challenges to the power infrastructure and to the preservation of the current level of electricity supply security in the future.

Selection and design of the appropriate measures for addressing these challenges require knowledge about their costs and their benefits. Hogan (2008) and Eto et al. (2001) discuss issues of the electricity market structure in the United States and find the necessity to assess the economic value of supply security enhancing...
measures as complement to the evaluation of their technological benefits. This is an essential prerequisite for regulatory policy and for the justification of investment decisions. While efficient decision making regarding security investments is hampered by the lack of precise knowledge of the benefits of potential enhancing measures, large scale failures of the power system are supposed to have increasingly serious consequences for the society. In the presence of near-perfect levels of supply reliability and increasing electricity dependence, societies are getting more vulnerable to power outages as preparation for prolonged outages becomes more difficult and less of a concern. This is known as the double paradox, researched in detail by Luijff and Klaver (2000) and De Hoo et al. (1994) for the Netherlands.

Despite their increasing dependence on uninterrupted electricity supply, consumers send hardly any signals about their valuation of energy supply security to suppliers, who thus misinterpret the benefits of reliability improvements and postpone infrastructure investments (Büske et al., 2007). In the special case of grid-bound supply systems, such as electricity, customers have for physical reasons no option of choosing an operator with a more adequate level of supply security. In addition to these specific economic aspects of electricity supply security, the short- and medium-term resilience of infrastructures in spite of security-preserving investments not being made creates incentives to further postpone investments. Precise knowledge of the importance of uninterrupted electricity supply to society is thus paramount. This research aims at providing an economic assessment of the value of electricity supply security which can be used – among others – for energy political decisions, benefit cost analyses, or the design of regulatory frameworks.6

Since electricity supply security constitutes a non-market good, which can only be purchased in combination with the physical product (electricity), its value cannot be elicited by market transactions (Kariuki and Allan, 1996a). That is why usually the effects of a failure of electricity supply are utilized for the value elicitation of service reliability (Baarsma and Hop, 2009; De Nooij et al., 2007, or Woo and Pupp, 1992, for instance). In this study the costs of power cuts to non-household consumers, which include businesses, public sector entities and non-government organizations (NGOs), along with the Willingness-to-Pay (WTP) of household consumers to avoid power cuts. Their approach served as base model for this study. It maps the lost value added for non-household consumers (Section 2.1), while CVM was used to elicit households’ WTP to avoid power cuts (Section 2.2).

2. Methodology

In this section we discuss different outage cost categories, our approach of modeling non-household consumers’ economic losses in the event of a power cut, and the methodology to assess households’ WTP to avoid them. As a starting point, three different loss categories which are relevant in the case of power outages are identified.

The first loss category, direct outage costs, includes the immediate consequences of a power cut. This includes – for instance – the repair costs for defective infrastructure facilities. They are usually limited and can be quantified with high precision (Munasinghe and Sanghvi, 1988).

The second category comprises indirect outage costs which arise subsequent to power cuts. They form part of the total losses, which are causally linked to the absence of electricity supply in the aftermath of a breakdown. The cost of production outages, expenditure on idle staff and other opportunity costs to non-household consumers such as lost value added represent indirect costs. They make up a significant proportion of the total costs (Centolella et al., 2006, or Wacker and Billinton, 1989).

The third category involves the macroeconomic consequences of a perceived long-term change in the level of electricity supply. This includes the influence of the level of electricity supply security on the choice of business locations, the potential rise of production costs due to the increased need for backup-systems, or customer churn due to unreliability regarding delivery deadlines. This outage cost category depends on the attributes of the power outages and is not included in the assessment of the value of electricity supply security in this study.

Based on these cost categories, Woo and Pupp (1992) suggest three approaches to assess electricity supply security in monetary terms: proxy, market-based and contingent valuation methods (CVM). As market based methods, which for instance quantify the costs of back-up generation and insurance purchases, only monitor individual cost factors, a different approach was chosen in this paper aiming at assessing the entire macroeconomic dimension of electricity supply security. In accordance with De Nooij et al. (2007) we applied a proxy method which takes into account the costs of idle staff capacity during the power outage. The costs for defective electrical infrastructure facilities. They are usually limited and can be quantified with high precision (Munasinghe and Sanghvi, 1988).

2.1. Non-household consumers

In line with Chen et al. (1995), we assume that non-household consumers experience exclusively monetary losses in the event of power cuts. The assessment of individual and aggregated outage-related costs is possible by a lost value-added regression model and data on economic activities. Losses have to be assessed depending on the time of the year the power cut occurs (summer vs. winter), the time of the day (working hours or non-working hours), the duration of the outage and other explanatory variables. Details of the regression and the estimation approach are in the Appendix A. An in-depth discussion of different assessment methods of non-household consumers’ outage costs can be found in Kariuki and Allan (1996b).

De Nooij et al. (2007) apply top-down methods for the elicitation of outage costs. Their approach served as base model for this study. It requires that all (key) activities of non-household consumers are analyzed with regard to their dependence on electricity and the impact of possible restrictions of power cuts on the value-adding process. Thus, the overall dependence on electricity of the non-household consumers in question can be inferred from the aggregated monetary losses due to the impossibility of certain activities in the case of a power outage. These economic losses are subsequently diminished by that portion of added value which can be recovered later (at certain costs, which have to be added). To the lost added value calculated in this way the costs of idle staff capacity during the power outage have to be added in another calculation step. The same applies to the value of inputs lost due to the power outage under consideration.

To quantify the value added as one major input for the outage-related loss function, the staff costs and input expenses of sector-typical non-household consumers were deducted from annual turnover. This approach allows for the use of data which are available in great detail in public statistic databases (Statistik Austria, 2011). In order to derive the daily value added from the available annual data, we made use of the

---

5 A detailed discussion on competition aspects, electricity markets and natural monopolies is found in Hogan (1993).

6 Additionally, beginning in 2011 all member states of the European Union (EU) are required to assess the economic consequences of an interruption of the electricity supply system (EU Commission, 2008).
دریافت فوری متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات