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The willingness to pay by households for improved reliability of electricity service in North Cyprus

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HIGHLIGHTS

- Measures households' WTP for improved reliability of electricity service.
- Households are willing to pay 13.8% more to improve reliability of service.
- WTP is greater than the cost of improving reliability of the electricity system.
- Some investments would save even more in system fuel costs.

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ABSTRACT

This research examines households' willingness to pay (WTP) for an improved electricity service. Households' WTP is estimated using the payment ladder contingent valuation (CV) data from 350 in-person interviews in North Cyprus. In order to avoid the cost of outages, households are willing to incur a 13.8% increase in their monthly electricity bill. A cost–benefit analysis (CBA) indicates that the annualized economic benefits of improved reliability of the electricity service would be approximately USD 35.6 million for the residential sector. This figure is more than enough to finance the investments needed to completely eradicate any electricity outages. In addition, the fuel savings from substituting the generation of the new plants for the old plants would yield about USD 32.9 million per year in fuel savings. Hence, a change from the current low-reliability policy to one of providing a high-quality service would yield an economic net present value to the residents of North Cyprus of twice the investment costs, or USD 173.3 million, within five years.

1. Introduction

The reliability of a power supply is crucial for small island countries that depend heavily on tourism for their economic prosperity. Power outages, especially in the summer months when air conditioners are in almost continuous use, can have a deleterious effect on the tourism sector and are therefore of great concern to these countries.[1] Cape Verde in the Atlantic Ocean, North Cyprus in the Mediterranean, and several islands in the Caribbean, such as the Dominican Republic, live with almost daily blackouts (World Bank, 2006; Clough, 2008). Often the reason behind these frequent interruptions in electricity supply is the lack of a coherent policy and investment planning framework to ensure that adequate and timely investments are being made in the electricity generation, transmission and distribution systems.

This study reports on an evaluation of the willingness to pay (WTP) for electricity reliability in North Cyprus, using the contingent valuation (CV) method. The economy of North Cyprus relies heavily on tourism and universities for its economic well-being. The results of this study are key inputs for decision making by regulators and the public electric utility in their recommendations for funding of electricity reliability improvement projects.

Economic cost–benefit analysis (CBA) has become the approach preferred by many utilities around the world in determining the optimal system capacity and reliability of electricity supply (Munasinghe and Gellerson, 1979; Sanghvi, 1983; Chowdhury et al., 2004; Sullivan, 2009). This method incorporates into the decision

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[1] When the term 'power outage' (or failure/interruption/blackout) is used in this paper, it refers to a complete interruption of electricity for a period lasting a few seconds or longer.

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making the customers' evaluation of the costs of shortages, which is reflected by the magnitude of the customers' WTP. Given the system's costs for enhanced reliability, it is the size of the consumers' WTP for electricity reliability that will determine the optimal policy rules for maintaining alternative levels of reliability of service.

1.1. North Cyprus and the electricity system

Cyprus, the third largest island in the Mediterranean, is characterized by mild winters and hot, dry summers. North Cyprus has a population of 265,100 (25.1% of the total population of Cyprus) and a gross domestic product (GDP) per capita of USD 13,354 (2009 estimate).[2,3] Its principal industries are tourism and the seven international universities it hosts.

In 2014 the total installed electricity generation capacity in North Cyprus was 376 MW (Kıb-Tek management, Personal communication).[4] All the thermal and diesel plants use heavy fuel oil (HFO) as their source of energy. At the present time, the public utility, Kıb-Tek, has generation capacity that includes two 60 MW steam turbine generators that are fully depreciated, but are still being used during the peak seasonal demand. The utility also has 105 MW of relatively new diesel generators that are used as peaking plants. Supplementing the generation capacity of Kıb-Tek is a private generator, Aksa Enerji, that has a power purchase agreement (PPA) to supply electricity using six diesel plants with a combined capacity of 120 MW (Aksa Enerji, 2014). Many of Aksa's plants are also near the end of their useful life. To date, the total installed renewable capacity is 7 MW, all of which is from private solar installations with net metering agreements with Kıb-Tek.

The system has suffered both from insufficient generation capacity and from generation plants that have been kept in service for longer than their planned life, thus causing frequent outages. Electricity outages have been chronic for two decades, largely as a result of the lack of a firm policy or set of regulations making electricity reliability a policy priority. Over this period an increase in the number of foreign students and tourists has worsened the power shortage problem.[5] There are power cuts throughout the year, the situation becoming worse during the summer months when the air conditioners and water pumps are working, and during the winter months when more people rely on electricity to heat their homes (Ilkan et al., 2005).

The official reason that has been given for the failure to maintain reliability is a lack of funds, or unwillingness on the part of consumers to pay sufficient amounts for the electricity they consume to enable the public utility to have a policy for maintaining adequate generation reserves and a strong transmission and distribution system. There has been a lack of information on how costly this dysfunctional policy environment has been for the residents of North Cyprus. The purpose of this study is to fill this information gap and to inform policy makers of consumers' WTP for improved reliability of electricity supply, provided the electric utility is able to deliver such a service.

Very few studies have been undertaken elsewhere in the world to estimate the WTP for improved electricity service reliability. Setting a price for a reliable electricity supply is challenging owing to the fact that electricity cannot be stored in an economical way while its demand varies throughout the day and year. Teblitz-Sembitzky (1992) noted that power generation is a multi-product industry in which the outputs can be indexed by time of use and priority of service, and in contrast with a single-product industry, the cost allocation and price setting across different outputs is analytically challenging.

2. Methods

There are many studies that survey the outage cost evaluation literature and categorize the interruption impact evaluation methods into various groups (Sanghvi, 1982; Andersson and Taylor, 1986; Caves et al., 1990; Lehtonen and Lemstrom, 1995; TERI, 2001; Lawton et al., 2003; Sullivan, 2009). The various methods of measuring the cost of unreliable electricity have also been widely discussed in the literature on optimal reliability assessment (Telson, 1975; Sanghvi, 1983; Tollefson et al., 1994; Billinton and Pandey, 1999; Chowdhury et al., 2004). Zachariadis and Poullikkas (2012) undertook three alternative approaches to the measurement of the economic cost of a major one-time outage that took place in South Cyprus in 2011.

Measuring the cost of unreliable electricity to consumers in the business sector is relatively straightforward, since these consumers produce an output that has a market value. Measuring the cost of unreliability to residential customers is more difficult owing to the intangible nature of the main losses. The models used for residential users are based on utility maximization subject to an income constraint (Sanghvi, 1982). Each household has a preferred order in which it performs certain activities in a day, each of which brings a certain benefit and increases the household's total utility. A power interruption disrupts this preferred order and results in a reduction in the utility enjoyed by the household. This reduction in utility expressed in monetary values is theoretically equal to the WTP to avoid the costs of the interruption, or alternatively, to the WTA (willingness to accept) the forgoing of benefits from the interrupted activities. In practice, it is measured by survey or market-based methods.

Valuation methodologies for WTP are generally studied under two main categories: revealed and stated preference. The revealed preference approach measures the WTP for a service using actual expenditure data on marketed goods related to the service concerned. The stated preference approach relies on survey-based methods and hypothetical scenarios to measure the consumers' WTP for an improvement in the service. The stated preference method includes the CV method and the choice experiment (CE) method. Sometimes this is one of the few ways of quantifying the benefits of a good or service that is not purchased in the market.

CV is a survey-based method often used in estimating the economic value of environmental services (Carson, 2000). Individuals are asked directly to state their WTP in a survey. Although CV has been widely used in the case of other infrastructure services such as transportation, there are fewer examples in which CV has been used in the valuation of electricity service improvements (Farhar, 1999; Rehn, 2003; Wiser, 2003; Atkinson et al., 2004; Layton and Moeltner, 2005; Carlsson and Martinsson, 2006; Carlsson and Martinsson, 2007; Kateregga, 2009).[6]

[2] ⟨http://devplan.org/Frame-eng.html⟩.

[3] ⟨http://nufussayimi.devplan.org/index-en.html⟩, 2006 Census and ⟨http://en.wikipedia.org/wiki/Demographics_of_Cyprus#Population⟩.

[4] Kıb-Tek (Cyprus Turkish Electricity Authority – Kıbris Türk Elektrik Kurumu in Turkish) is the electricity authority of North Cyprus that is responsible for the generation, transmission and distribution of electricity in the north.

[5] Annual average growth rates for the period 1979–2008. TRNC State Planning Organization, ⟨http://devplan.org/Frame-eng.html⟩.

[6] CV is also used to value a wide range of commodities in developing countries (FAO, 2000; Devicienti et al., 2004). Some of the studies conducted in developing countries using CV are: Alberini et al. (1997) – valuation of health effects of air pollution; Altaf and Hughes (1994) – measuring the demand for improved urban sanitation services; Whittington et al. (1990); and Montes de Oca and Bateman (2006) – estimating the WTP for water services.