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Get rid of it: To what extent might improved reliability reduce self-generation in Nigeria?

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HIGHLIGHTS

- We study how improved electricity supply might reduce self-generation in Nigeria.
- Households use their generators less than 40% of times they suffer outages.
- Improved service quality would significantly reduce self-generation.
- However, self-generation would continue among rich and educated households.
- Import tariff and pollution tax can be used to further reduce self-generation.

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ABSTRACT

Despite the global concerns surrounding the threats of climate change to both human health and sustainable environments, gasoline- or diesel-powered generators with non-negligible emissions have become a popular choice among Nigerian households due to the poor publicly provided electricity. This study examines the extent to which an improvement in publicly supplied electricity may reduce backup generation and, by implication, reduce emissions from Nigerian homes. The results from a random-effects probit analysis reveal that, although improved electricity service quality would significantly reduce self-generation, self-generation would continue in the country, especially among rich and educated households. The study concludes by highlighting the policy implications of the findings.

1. Introduction

The benefits of reliable energy services cannot be overemphasised, as lack of access to quality electricity supply can reduce people's quality of life and limit growth on a range of socioeconomic fronts. Poor-quality electricity could reduce household income and employment opportunities, and affect school-going children's performance by limiting their ability to read during evening hours (see Khandker et al., 2012, 2014). Electricity stimulates income growth by enabling businesses to stay open for longer, promoting productivity, and allowing the members of a household to be engaged in income-generating activities, including sewing and/or making headcrafts for women (World Bank, 2002). All these benefits are either completely lost or significantly reduced when electricity is not accessible or the quality of the service is low.

Despite the significant costs associated with unreliable electricity services, poor electricity supply is what households in many developing countries face on a daily basis. For instance, the average daily power outage in Zambia currently lasts eight hours (Engineering Institution of Zambia, 2015). The average Nigerian household enjoys electricity for just five hours daily National Bureau of Statistics (NBS) (2012). This poor provision has resulted from underinvestment in new generation capacity and a lack of adequate maintenance for existing facilities. Since 1995, for instance, less than 300 MW of generation capacity has been added to the Nigerian electricity grid. The country's per capita electricity consumption remains less than 150 kWh per annum (Fig. 1).

For most Nigerians, tackling the electricity supply deficit means the procurement and installation of private gasoline- or diesel-powered generators. Current estimates indicate that over 86% of businesses and almost a quarter of homes have gasoline- or diesel-powered generators generators in use in Nigerian homes (National Bureau of Statistics (NBS), 2012; World Bank, 2012). Moreover, about 3% of Nigerian homes (a little under 1 million homes) rely solely on a generator as their only source of electricity National

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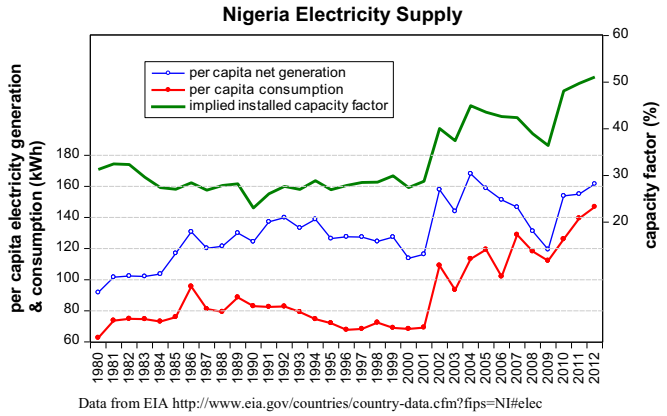

Fig. 1. Nigeria Electricity Supply. Data from EIA http://www.eia.gov/countries/country-data.cfm?fips=NI#elec.

Bureau of Statistics (NBS) (2012), a decision necessitated by people's dissatisfaction with the unreliable public power supply.

Generators installed for backup power during blackouts could help to reduce the losses (e.g. food spoilage, etc.) associated with unreliable electricity service, encourage children to study more during evening hours, reduce the time allocated to fuelwood collection, allow people to keep their businesses open for longer hours, and reduce the overall impacts of unreliability on consumer welfare. However, many of these generators are diesel-powered and produce non-negligible air emissions that may damage air quality and human health. In Nigeria, carbon emissions from domestic generation are greater than those from workplaces, buses and trucks, and pose potentially risky challenges to people's health and the environment due to long-time exposure and proximity (Awofeso, 2011).

Diesel exhaust contains many toxic contaminants, which result in irritation of the eyes and nose, asthma, chronic bronchitis and respiratory changes, and cancer-inducing substances such as benzene, arsenic, and formaldehyde. It also contains other harmful environmental pollutants that contribute in no small amount to ozone depletion and climate change. Several studies have found a link between diesel exhausts and health-related problems (Kagawa, 2002; Kenyon and Liu, 2011; Sydbom et al., 2001). Estimates are that up to 70% of the cancer risks attributable to the inhalation of toxic air pollutants in the United States stem from diesel exhaust (Loh et al., 2007). Empirical evidence has also suggested a link between occupational exposure to diesel exhaust and lung cancer in Europe and Canada (Olsson et al., 2011). Indirect evidence of the effect of diesel exhaust on lung cancer in Nigeria is indicative of its rising incidence among urban-based non-smoker adults (Salami et al., 2010), most of whom are generator users.

Furthermore, there have been several cases of deaths attributed to the inhalation of fumes released by generators in Nigerian homes. A family of five reportedly died after being poisoned by carbon monoxide from generator fumes at Urum in Anambra State in April 2012.[1] In October 2013, a newly married couple was reported to have died from generator fumes in their new home on the outskirts of Calabar, Cross River State. Similar cases of generator-related deaths have been recorded in many other Nigerian cities, including Ibadan, Lagos and Abuja (the Nigerian capital city), among others (Ogundipe, 2013).[2] Moreover, backup generation tends to be more expensive than publicly provided electricity due to the diseconomies of scale in self-generation (Oseni, 2015b); therefore, self-generation reduces consumers' ability to spend on other needs.

Considering the negative effects of self-generation and the view that the importers of generators strategically contribute to the underdevelopment of the Nigerian power sector, the debates on whether the importation and use of backup generators should be banned in Nigeria have gained increasing momentum, especially among non-users. A policy question from this debate is: should the government discourage or encourage self-generation? Formulating laws or imposing tougher restrictions on the use of backup generators may well be acceptable to consumers, and non-users in particular, considering the level of negative externality (e.g. noise and air pollution) they suffer from the use of generators in their neighbourhoods. However, many users would consider such a policy too harsh and may oppose it unless it is preceded by improved reliability. For such a policy to be considered fair, it would therefore be beneficial to investigate what level of reliability backup households would be willing to accept for them to dispose of their generators. Therefore, the main questions addressed in this study are: to what extent might improvements in electricity supply reduce self-generation? How do the socio-economic characteristics of households affect their decision to dispose of their backup generators? What level of reliability would make households dispose of their generators? Answering the aforementioned questions would serve as a useful guide in power planning expansion strategies aimed at achieving the appropriate level of strategic reliability and environmental sustainability.

Given the problems associated with self-generation, this study examines the ownership and use intensity of backup generators in Nigerian homes, and the extent to which improvements in reliability might motivate users to dispose of their generators. To the best of author's knowledge, this study is the first attempt to differentiate between the factors determining households' ownership of backup generators and their use patterns. Moreover, the study marks the first attempt to investigate the extent to which improved reliability might affect users' willingness to dispose of their backup generators. The paper is organised as follows: the next section discusses the methodology; Section 3 presents the data; Section 4 deals with the presentation and discussion of the results; and the last section concludes and discusses the policy implications of the findings.

2. Methodology

2.1. Generator adoption and usage

The running of a generator by a household involves a two-stage decision process. At the first stage, the household has to decide whether to buy a generator, and, in the second stage, it decides the use intensity (i.e. the duration of its use).[3] These decisions may be affected by different factors, or by the same factors in different ways. For instance, while the decision to procure a generator might be affected by unreliable power supply and fixed capital costs, its intensity of use might be affected by fuel costs. In this section, we start by presenting a model of what motivates the uptake and use intensity of a generator using a two-stage decision process.

By defining U_i^0 as the individual household i's utility given the current state of (un)reliability in electricity supply and U_i^g as the expected utility they could gain by investing in a backup generator,

[1] See Generator tragedy: Family rules out autopsy. http://www.gbooza.com/group/crime/forum/topics/generator-tragedy-family-rules-out-autopsy.

[2] http://www.vanguardngr.com/2013/10/portable-generators-standby-power-standby-death/.

[3] 'Generator usage', 'use intensity', and 'degree of use' are used interchangeably.