Willingness to Pay for Reliable Electricity Supply in Nigeria: Evidence from Residential Consumers

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Abstract

The problem of unreliable electricity supply is a barrier to good quality of life and economic productivity. Therefore, this study examines the drivers of residential consumers' willingness to pay (WTP) for improved electricity supply and the average monetary value they can accommodate on their current tariff for 70 percent improvement. The study used a 2022 contingent valuation household survey of 215 samples in Ekiti State, Nigeria. The analysis adopts a logistic regression to determine the drivers of household WTP for the improved electricity supply using a combination of socioeconomic characteristics, electricity supply profile, and maximum tariff bid. Household characteristics such as education, household size, income, expenditure on backup generator fuel, and bid are the likely determinants of WTP for reliable electricity supply. The derivation of mean WTP from the logistic estimation shows that the residential consumers could pay N164.81/kWh (~US$ 0.37/ kWh) for a 70 percent improved electricity supply. The mean willingness to pay represents an extra N108.93kWh (~U$0.25/kWh) over the current tariff and an increment of about 194.94 percent per kilowatt of electricity. The higher premium is acceptable by 85 percent of the households surveyed. These findings provide evidence about the WTP for reliable electricity supply and its determination, which is vital for policy direction on future tariff setting in Nigeria. The study recommends that the electricity sector regulator stipulate a minimum investment requirement for improved electricity supply.

Keywords: Residential; Willingness-to-pay; Improved electricity supply; Contingent Valuation approach; Nigeria

JEL Classification Codes: D01, D18, K32

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1. Introduction

Unreliable electricity has remained a challenge to the quality of living and economic productivity across all sectors, particularly in the residential sector (Maduka, et al. 2020). While average electricity generation hovers around 45000 Megawatt (MW) (Kashyap et al., 2022) for about 200 million population, there are concerns around final energy consumption, availability, and supply quality to consumers (Olanrele, 2023). Consistently, electricity generation has been above the available energy supply for final consumption, with high distribution and transmission losses accounting for the margin (Fig. 1). Power outages are frequent due to total and partial grid collapses. Between the 2020 first quarter and the 2023 third quarter, Nigeria recorded 15 events of total grid system collapses despite the period coinciding with the era of the electricity sector privatization[1]. While privatization in itself may not be an optimal framework for effectiveness, private ownership of Nigeria's electricity sector was expected to promote high efficiency in service delivery (Obadan, 2004).

One of the priorities of the Sustainable Development Goal 7 is providing access to reliable and clean energy (Kamanyire, et.al. 2024). While Nigeria has recorded an appreciable mark in terms of electricity access from 27.3 percent in 1990 to 59.5 percent in 2021 (WDI, 2023), estimates revealed that consumers have an average grid electricity supply of about 6.6 hours per day (Pelz et.al., 2023). Compared to other clans, the World Bank statistics linked Nigeria's per capita electricity consumption to about 142kWh per annum, lower than proximate countries like South Africa (4,183 KWh) and Brazil (2611kWh) (WDI,2023). Undoubtedly, Nigeria has improved connectivity rates, but improvements in the reliability and quality of electricity supply to residential consumers remain insignificant. Cut in this trap of frequent blackouts, an average Nigerian has resorted to self-generation through backup diesel and gasoline generators, with negative implications on climate sustainability and the associated economic losses. It is estimated that Nigerians spend an average of about US$ 3.8 billion on alternative electricity sources per annum (Ugwoke et. al., 2020).

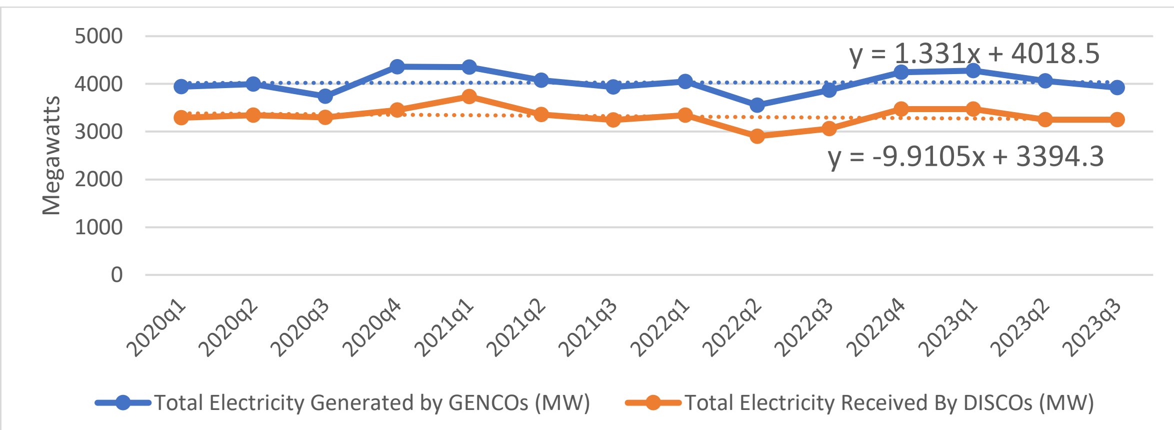

Fig. 1: Available Electricity Generation and Consumption, 2020-2023
Source: Data Compiled from NERC Quarterly Reports

[1] https://nerc.gov.ng/resources/

Sadly, persistent increments in electricity tariffs have not been in tandem with the quality of electricity supply. Nigeria has operated a service-based tariff regime since 2020 to foster electricity sector efficiency in revenue generation and supply reliability. The new pricing framework known as the 2020 Multi-Year Tariff Order (MYTO) is a supply-side mechanism that allows for payment of electricity tariff in tandem with the duration of energy consumed. This situation led to the classification of consumers along five electricity tariff Bands. Differential rates apply across the five Bands, with consumers at the highest Band, those presumably having 20 hours of electricity supply per day, paying higher tariffs than other classes of consumers. The guiding principles of this arrangement include considerations for macroeconomic dynamics, such as inflation rate, exchange rate, and gas price movements. While these remain the necessary conditions for tariff adjustment, sufficient conditions hinge on the improvement in electricity supply, without which adjustments may remain unfair.

The introduced 2020 MYTO framework has not led to a significant improvement in electricity supply as anticipated, but tariff reviews have been frequent. The latest increment of over 200 percent was announced in April 2024 by the Nigeria Electricity Regulatory Commission[2]. The implication is that the provision of the pricing framework seems favorable to the supply side of the industry to the detriment of the electricity consumers. The unpleasant price discrimination and poor quality of electricity supply have increased public dissatisfaction with growing concern about the effectiveness of the reforms. Under these circumstances, to what extent are the residential electricity consumers willing to pay for higher electricity tariffs if the electricity supply improves above the present levels? Specifically, the paper examined the drivers of residential consumers' willingness to pay for improved electricity supply and the premium they can afford for such improvement. The assessment is important for optimum service delivery.

While efforts have continuously skewed towards increasing the financial viability of the Nigerian Electricity Supply Industry (NESI), it is also necessary to ensure improvement in electricity supply for effective demand and supply-side management. Without improvement in electricity supply and the demand-side buy-in in the process of tariff adjustments, the sector's performance may worsen in terms of higher energy theft and non-payment of electricity bills, among others. Also, this may undermine government efforts regarding clean energy transition and energy access. Perpetual poor electricity supply may lead to low quality of life, low productivity, and economic backwardness (Momoh et. al. 2018).

Empirically, there is little knowledge on the subject matter, as existing studies do not consider the recent development in the Nigerian electricity sector. Specifically, studies that estimated grid tariff preference under the service-based tariff (SBT) regime introduced in 2020 are scarce. Relevant studies such as Oseni (2017) considered this subject under the old MYTO methodology, a demand-based tariff regime. The SBT regime aimed to enhance service delivery as encapsulated in the long-term electricity sector privatization plan; thus, the outcomes of studies under the old tariff methodology may not reflect the current realities facing electricity consumers. The situation may also mar future tariff settings and consumers' concerns about fairness vis-à-vis electricity supply reliability. In the context of the Nigerian electricity generation and distribution sub-sectors liberalization, it is germane to assess the willingness of residential consumers to pay for reliable

[2] https://nerc.gov.ng/resources/?doc_term=mytoandins=1#nerc-documents

electricity supply given periodic tariff adjustments, which favors the service providers despite inadequate and unreliable electricity supply.

The liberalization under private ownership was to improve the efficiency of electricity supply, a position strongly supported by the literature (Vlahinic, 2011). A perspective under the service-based tariff regime of the liberalized market may throw new insights into the determination of household willingness to pay for higher tariffs, especially with the classification across different tariff classes in the 2020 MYTO. Hence, this study provides the average amount households are willing to pay for improved electricity supply and a breakdown of the tariff preference by customers' tariff class. The latter analysis provides insights into what households would have offered without the 2024 electricity tariff revision by the Nigerian Electricity Regulatory Commission (NERC). Using recent data, this level of analysis captures nuances and developments in the electricity sector that were not considered in previous literature but are relevant for future tariff review.

The literature identified the revealed preference and stated preference as the two prominent frameworks for estimating willingness to pay vis-à-vis efficiency improvement in service delivery, including electricity supply. This study employs the stated preference approach based on the contingent valuation of consumers' preference for a good or service delivery, predicated on economic theory and survey (Mitchell and Carson, 1989; Kanninen, 1995). The stated preference method is the most suitable approach for estimating willingness to pay for goods or service delivery as it revolves around building attributes from survey scenarios rather than through observation of the cost associated with taking alternative actions to inefficient service delivery, as in the case of the revealed preference framework. The stated preference method has been applied in the contingent valuation of infrastructural services, including electricity services (Atkinson et.al. 2008; Carlsson and Martisson,2007). This makes the framework most suitable for evaluating the preference of residential consumers for reliable electricity services in Nigeria.

Specifically, this study examined the drivers of household willingness to pay (WTP) for improved electricity supply and the maximum tariff they are willing to offer for a reliable electricity supply. The study calculates the average price and the disaggregated prices along the tariff classes, using the stated preference Contingent Valuation Method (CVM) to elicit information about WTP and the underlying factors among residential electricity consumers through a cross-sectional survey. Although existing national surveys such as the household living standard survey of the Nigerian Bureau of Statistics provide information about household socioeconomic characteristics and sectoral dynamics, they do not cover information on electricity tariffs and related issues required for this analysis. Thus, a cross-sectional survey was conducted among 215 rural and urban households in 2022 to elicit information about their socioeconomic characteristics, grid electricity supply status, and scenarios around tariff preference. The sample size may be perceived as insufficient, but the challenge of electricity supply unreliability is of a national scale in Nigeria, and consumers' opinions may not differ significantly. Also, national-scale surveys are usually financially demanding and beyond individual sponsorship. Nevertheless, the findings from this research have national implications for the electricity sector governance framework on future tariff setting and infrastructural development.

The study is in six sections, including this introduction. Section 2 provides the literature review, including the theoretical and empirical perspectives. Section 3 discussed the dataset used and the analytical method. Section 4 presents the empirical findings. The results are discussed in section 5. The last section concludes with a summary of findings and some recommendations. The section also provides areas for further research and the study's limitations.

2. Literature

The rational choice theory presumes that individual behavior is influenced by personal characteristics, available resources, alternative attributes, and a decision rule. Given a fixed set of alternatives and their attributes, the individual choice may depend on the utility assessment of other options and the particular choice based on the decision rule of utility maximization. Based on the preposition of Friedman (1953), an individual will usually decide on outcomes that meet their preference subject to some constraints. In other words, preferences are optimized by weighing the costs and benefits. Abell (2000) sums the basis for the rational choice theory across the assumptions of individualism, self-maximization, structures, self-regarding interest, optimality, and rationality.

Explicitly, De Jonge (2012) describes the rational choice theory based on outcomes resulting from individual action. In this case, a rational individual will choose all feasible regions with all possibilities. The subsequent outcome depends on the first outcome, with choices based on some individual constraints such as financial, legal, social, physical, or emotional restrictions. In the final analysis, a rational agent settles for choices with higher pay-offs. The theory has been applied to the set of actions or objects relating to utility maximization, making the theory a suitable framework for evaluating preferences for higher efficiency gains, such as the preference for improved electricity supply.

A plethora of studies in the literature have provided empirical evidence along this framework. For instance, Afriyie et. al. (2024) examined households' willingness to pay for alternative energy sources based on a discrete choice model. The analysis depends on household survey data in Kumasi, Ghana, and the findings show that the WTP for solar PV was the highest. However, households have a higher preference for biomass where solar PVs are inaccessible. A study by Wen et.al. (2022) also conducted a choice experiment analysis in Sumba, Indonesia. The study assessed households' preference for attributes of electricity access such as daily supply hours, capacity of using medium or high electric appliances, power-cuts reduction, and unplanned power cuts. Their findings show higher WTP for improved electricity supply among grid-connected households than off-grid households. Specifically, households are WTP 7,480 Rp/month for improved power supply. This price is compared to 4,480 Rp/month to be paid by the off-grid households. The study used the household survey data collected from the Iconic Island of Sumba in 2019.

Further, Duetschmann et al. (2021) measured willingness to pay for reliable electricity supply in Senegal using a national survey of 2775 households and 1072 enterprises. Their findings revealed households' willingness to pay for a premium of 24–35 percent higher than the current average tariff of $0.17 per kWh. Among firms, even though the price they reported is almost 50 percent more per kWh than households, more than 70 percent of formal firms and 45 percent of informal firms are willing to pay a higher price for service improvement. Likewise, formal and informal firms are willing to pay 70 percent and 45 percent more than the current price for improved electricity supply. The willingness to pay for marginal service improvement is lower than that of an uninterrupted power supply. In a study by Abdullah and Jeanty, (2011), households are willing to pay a higher premium for grid electricity than off-grid renewable solar PVs and favored monthly tariff payments. The study assesses the possibility of households paying for off-grid renewable energy using the Contingent Valuation Method (CVM).

Ayodele et al. (2021) investigate the determinants of WTP for renewable energy sources in Oyo State, Nigeria. The study employed a descriptive statistics analysis. The findings showed that education, age, knowledge of renewable energy, employment status, and marital status determine WTP for renewable energy. Households are WTP 5 to 10 percent more for renewable energy integration. Likewise, Oseni (2017) studied households' WTP for reliable electricity services in Nigeria using a survey method with an interval data model and a regression analysis. The study finds that households are willing to pay for improved reliability of electricity supply ranging from N24.47/kWh to N26.1/kWh, which was less than the marginal costs of reliability from self-generation within the price range of N44.04/kWh and N66.88/kWh. Among other factors, the high cost of self-generation influences the decision to pay higher tariffs for reliable electricity supply, especially among backup households. In a different study by Magazzino et.al. (2023), they find that demographic effects account for an increase in electricity demand in Nigeria. The study analyzed the Nigerian electricity supply security and sustainability issues using five decades of historical data. Their evidence revealed that population growth engenders long-run electricity demand in Nigeria. Similar studies like Byaro and Mbaga (2022) find that food production and access to credit are the main drivers of electricity access in 48 sub-Saharan African countries.

In Pakistan, Naz and Ahmed (2024) examined the determinants of household WTP for improved electricity supply in Nowshera, Pakistan. They find that education, household size, income, electricity bill, and service reliability determine WTP for electricity service. The findings also align with the conclusion of Dumga and Goswami (2025) that income, main road distance, cooking stove type, and number of power outages per day determine household WTP in Ethiopia. Wakjira and Kefale's (2022) result corroborated the assertion that reliability attributes such as frequency and duration of power outages determine household WTP for reliable electricity service.

From the literature, empirical evidence exists on willingness to pay for reliable electricity supply at the residential level, even in Nigeria (see summary in Table 1). However, evidence is sparse on disaggregated analysis across tariff classes. While this situation may not be applicable in some contexts, the Nigerian electricity market presents a peculiar case for a disaggregated analysis. Specifically, the commencement of the Nigerian service-based tariff regime in 2020 makes it pertinent to reexamine the willingness to pay for improved electricity supply. The tariff regime has become discriminatory due to end-user classification across five service areas. As mentioned earlier, the regime has not brought about the desired level of service delivery based on the electricity supply of about 4500MW. This situation, among others, highlights the need for this assessment by providing insights from recent data to fill the gap in the literature and policy space.

Table 1: Determinants and Household WTP for Reliable Electricity Supply in Empirical Literature

S/N	Authors	Country	Time period	Methodology	Key findings
1	Afriyie et. al. (2024)	Ghana	2022	Logit regression	WTP for solar PV was high, however, households have a higher preference for biomass where solar PVs are inaccessible
2	Wen, et.al. (2022),	Indonesia	2019	Latent and Logit analysis	Households are WTP 7,480 Rp/month for improved power supply compared to 4,480 Rp/month
3	Duetschmann, et al. (2021)	Senegal	2018	Probit regression	Households are WTP a higher premium of 24–35 percent higher than the current average tariff of $0.17 per kWh
4	Ayodele et al. (2021)	Nigeria	2019	Descriptive Statistics	Education, age, knowledge of renewable energy, employment status, and marital status determine WTP for renewable energy
5	Byaro and Mbaga (2022)	48 SSA	1995-2019	System GMM	Food production and access to credits are key drivers of electricity access in SSA
6	Oseni (2017)	Nigeria	2016	Logistic regression	Households WTP for reliable electricity supply ranges from N24.47/kWh to N26.1/kWh
7	Dumga and Goswami (2025)	Ethiopia	2022	Probit regression	Total family income, main road distance, cooking stove type, and number of outages per day determines household WTP
8	Naz and Ahmed (2024)	Pakistan	2020	Logit regression	Education level, household size, monthly income, monthly electricity bill, and service reliability determines WTP for electricity service

3. Data and Methodology

3.1 Data

The study used primary data from a 2022 Nigerian Institute of Social and Economic Research (NISER) household survey in Ekiti State, South West Nigeria. Ekiti state is one of the 36 statutory states with an estimated population of 3.5 million and the 13th in human development index ranking in Nigeria. There are eleven electricity distribution companies (DISCOs) supplying electricity to consumers across the 36 states in Nigeria. Two companies, Benin and Ibadan DISCOs, supply electricity to Ekiti State. The selection of a State within the jurisdiction of these two DISCOs is due to their performance in revenue collection efficiency and infrastructural development. For instance, Ibadan DISCO is among the top companies with high revenue and electricity tariff collection inefficiencies (NERC Quarterly Reports). Also, the Benin DISCO has a record of low power uptake from generation companies due to weak distribution networks (NERC Quarterly Reports). These situations may have implications for the reliability of electricity supply for Ekiti State and others covered by the two DISCOs; hence, the purposive selection of the State. The study also focuses on urban and rural electrified households in the three senatorial districts of the State. The electrified households are those under the national grid with tariff obligations through prepayment or post-payment plans.

A multistage sampling technique is adopted in the household selection. The first stage is the purposive selection of a State connected to the national grid where residential consumers pay monthly electricity tariffs. The second stage entails a selection of three Local Governments Areas (LGAs) from each senatorial district. The third stage involves the selection of rural and urban areas in the LGAs. The last stage is the systematic random selection of households in the selected rural and urban areas. Hence, a sample of 215 households, randomly selected, across rural and urban locations in the three senatorial districts of the State was employed for the analysis.

The basic data collection instrument is the structured questionnaire. This method was used to elicit information about the willingness to pay for reliable electricity supply and its determinants using the Contingent Valuation Method (CVM). The CVM is an appropriate technique for scenario building where respondents are offered bids of questions, with the second bids contingent upon the first (Hanemann et al.1991). This approach leads to the determination of the amount households are willing to pay for an improved electricity supply. The questionnaire was structured into three parts: household socioeconomic characteristics, household grid electricity supply status, and a hypothetical scenario of reliable electricity supply vis-à-vis a maximum tariff premium a household is willing to offer. Three scenarios of improvement in power supply around 50%, 70%, and 90% were proposed to guarantee households' willingness to accommodate a higher tariff. The indicators are presented in Table 2.

Appendix C presents the summary statistics of the dataset used. Although the selected sample size was 270, the retrieval rate was about 80 percent (215) due to a lack of public trust in the government's commitment to electricity sector transformation. There were variations in the subsamples due to missing data in some variables and responses. However, this does not affect the validity of the data.

Table 2: Data Description

Variable	Description	Classification	Variable Type
WTP	Household willingness to pay for higher tariff, 1 if yes and 0 otherwise	Dummy	Dependent
Bid	Maximum price households are willing to pay for an improved service in Niara per kilowatt hour	Continuous	Independent
Gender	Gender of the household head, taking a binary value of 1 if female and 2 Male	Dummy	Independent
Age	Age of the household head	Categorical	Independent
Education	Household head education level, categorized along five levels- no education, primary, secondary, vocation, and tertiary education)	Categorical	Independent
Household Size	Number of a household members	Categorical	Independent
Income	Household average monthly income in Naira	Categorical	Independent
Metering Status	Household meter type such as a postpaid and prepaid meter	Categorical	Independent
Outage attribute of electricity supply	Duration (in hours and days) and frequency of power supply to a household	Continuous	Independent
Satisfaction with current supply	Household satisfaction with current state of electricity supply in a neighborhood on a binary scale of 1 if not satisfied and 2 if otherwise	Dummy	Independent
Backup Generator Fuel Expenditure	Household average monthly expenditure on energy fuel for back-up stand-alone electricity generator in Naira	Categorical	Independent
Household Work Depends on Electricity Supply	A variable indicating if household work dependent on availability of electricity supply on a scale of 1, if highly dependent, 2 if partially dependent, and 3 if not dependent	Categorical	Independent

Source: Author's compilation based on variable definitions in 2022 NISER Survey

3.2 Methodology

The conceptual design herein hinges on the utility maximization framework of the rational choice theory. In the context of this analysis, a household may choose a higher premium for reliable electricity supply provided the benefits outweigh the additional costs. Thus, the willingness to pay for the improvement is subject to the perceived utility derived from the service. The choice for the utility improvement is usually more discrete than the choice of the alternative, and there are also specific factors influencing preferences, thus, accounting for variation and random individual behavior. The random utility model is specified as follows (Twerefou, 2014):

$$U_i = X_i'\beta + \varepsilon_i \qquad (1)$$

U_i is the derived utility from the i-th alternative, X_i' are the specific factors affecting individual preferences, β is the parameter coefficient, and ε_i is the random error. Household may decide to choose the i-th alternative if utility from higher electricity tariff is positive, otherwise the utility becomes negative. In this study, the alternatives revolve around individual response to a new price with improved service or the current state with no improvement. The utility for a reliable electricity supply, which is consequent upon household willingness to pay depends on the deterministic and the random error re-specified as:

$$WTP = X'\beta + \varepsilon \qquad (2)$$

Where, $X' = X_i - X_j$ and $\varepsilon = \varepsilon_i - \varepsilon_j$

From equation (2), household willingness to pay is driven by the degree of utility variation vis-à-vis the choice for electricity supply improvement. The higher the utility preference, the higher the electricity tariff, although based on individual heterogeneity along specific or context characteristics. From equation (2), the probability of the WTP for a reliable electricity supply can be determined within a choice of maximum or minimum premium such as defined in equation (3)

$$Pr(WTP_L < WTP < WTP_H = Pr(X'\beta + \varepsilon \leq \theta_H) - Pr(X'\beta + \varepsilon \leq \theta_L) \qquad (3)$$

WTP_L and WTP_H are the minimum and maximum amount households would pay along the threshold consistent with the minimum θ_L and maximum θ_H utility. The probability of a household settling within a threshold depends on the factors that may alter individual preferences, which are usually modeled within a binary regression framework.

In this study, the analytical strategy for determining WTP for reliable electricity supply follows the model choice of Taale and Kyeremeh (2015), who adopt a binary model in their analysis. The study adopted a Tobit regression technique, a form of a binary regression technique. This technique is assumed inappropriate for the nature of the response elicited on household WTP in this study. The binary responses of positive and negative values of 0 and 1 were collected to ascertain household WTP for a reliable supply. Thus, a Tobit model is only suitable if there is censoring in the dependent variable, making it restrictive in this case. The logit regression technique is most appropriate since the dependent variable in this study takes the form of non-censored binary values (Afriyie et. al., 2024 and Naz and Ahmed, 2024)

The explicit form of the probability model is:

$$P\,r(WTP_i = 1) = (\emptyset(\beta_0 + Outages)_i + \beta Z_i) + \varepsilon_i \quad (4)$$

$$P\,r(WTP_i = 1) = \emptyset(\beta_0 + (\beta_1 Bid)_i + Outages_i + (\beta_n X)_i + \varepsilon_i \quad (5)$$

WTP_i is the household WTP for improved electricity supply or otherwise, Bid is the average price households are WTP for an improved service, Outages is the frequency of power outages measured by duration and frequency, Xi include other controls such as household characteristics (gender of household head, age, education, household size, income), metering status (postpaid or prepaid), household work depends on electricity supply, satisfaction with the level of electricity supply, monthly expenditure on backup electricity generator, μ_i is the error term, and β is the vector of parameters. The control variables in the analysis are aligned with similar studies. For instance, Özbafli (2011) estimated the roles of socioeconomic demographics such as age, gender, income, and education on WTP for reliable electricity service. Likewise, Oseni (2017) considers factors such as the dependency of household work on electricity, metering status, and cost of backup alternatives. This prior knowledge justifies the choice of the control variables in this analysis.

Following from Cooper and Loomis (1992), the calculation of the WTP is the mean estimate of the absolute value generated from the derivation in equation (5), given as:

$$(WTP)' = \frac{\beta_0}{\beta_1} \quad (6)$$

Where $(WTP)'$is the maximum monetary value, a household is WTP for an improved electricity supply. β_0 is the constant and β_1 is the Bid coefficient.

4. Empirical Results

This section discusses the empirical findings of drivers of household willingness to pay for improved electricity supply and the determination of the premium for the improvement. Table 4 presents the estimates of the logistic regression analysis of the determinants of WTP based on STATA 15 software. The result shows that residential consumers are willing to pay a higher bid for a reliable electricity supply. Specifically, there is a 0.006 percent likelihood of consumers paying a higher tariff for the improvement. The coefficient is statistically significant.

Increased awareness due to a higher level of education likely propel households' willingness to pay for improved electricity supply. Specifically, a higher level of education may increase households' chances to pay for higher electricity supply by 0.04 percent, at a 10 percent level of statistical significance. Also, the larger the household size, the more willing a household is to pay for a reliable grid electricity supply by about 0.2 percent. The coefficient is statistically significant at 1 percent, indicating the strong positive correlation between the household size and the WTP for improved services. A rise in household monthly expenditure on backup generator fuel engenders households' preference for reliable electricity supply. As expenditure on backup generator fuel increases by 1 percent, the WTP for reliability increases by about 0.07 percent. The coefficient is an important determinant due to its 5 percent level of statistical significance.

The reliability attributes (outage duration and frequency of power outages) exert negative relationships with the WTP for reliable supply. Except for the frequency of power outages, the duration attribute is statistically insignificant. While the duration of power outages is not a significant factor, a decrease in the frequency of power supply outages may encourage the acceptance of a higher tariff by about 0.02 percent at a 1 percent level of statistical significance.
Other variables have an insignificant impact on WTP for a reliable electricity supply. For instance, income has a negative and insignificant relationship with household WTP for improved electricity supply. The relationship is counterintuitive to theoretical expectations. An increase in income will engender less preference for a reliable electricity supply by about 0.057, although the coefficient is statistically insignificant. On the flip side, bid, education, household size, frequency of power outages, and monthly expenditure on backup generator fuel are the significant determinants of residential WTP for reliable electricity supply. The analysis of average marginal effects also validates the probit estimation.

The result in Table 5 is based on the sensitivity analysis of the model in equation (5) to parameter changes. The estimation excluded one of the insignificant variables. Specifically, the indicator that measured metering status (postpaid and prepaid) was dropped. All variable coefficients remained unchanged in sign and by level of statistical significance, except that the coefficient of income became statistically significant and with a negative sign. The persistent negative sign of income further reinforces the finding that income may not be a strong determinant of WTP for reliable electricity supply, possibly due to the nature of this commodity as a basic necessity. Households may not necessarily substitute electricity consumption if price or income changes, but may adjust their consumption behavior through energy-saving practices to reduce energy expenditure. Overall, the findings in Table 5 established the robustness of the model in the determination of residential consumers' WTP for reliable electricity supply.

Table 4: Estimation of Determinants of Household WTP for Improved Electricity Supply

Variable	Coef.	Std. error	**P>|z|**	Average Marginal Effects	**P>|z|**
Bid	0.101***	0.037	0.006	0.006***	0.000
HH Sex_Female	0.317	0.811	0.695	0.019	0.695
HH_Age	-0.071	0.431	0.870	-0.004	0.870
HH_Education	0.682*	0.391	0.081	0.042*	0.060
HH Size	2.485***	0.965	0.010	0.154***	0.003
Income	-0.922	0.717	0.198	-0.057	0.184
Metering Status (Reference attribute_ None)					
Postpaid	2.303	4.775	0.630	0.110	0.491
Prepaid Meter	0.951	1.371	0.488	0.052	0.441
Power Outage Duration/hours	-0.738	0.628	0.240	-0.046	0.231
Frequency of Power Supply outages	-0.284*	0.162	0.080	-0.018***	0.066
Satisfaction with current supply	1.337	4.799	0.780	0.083	0.780
Backup Generator Fuel Expenditure	1.103**	0.518	0.033	0.069**	0.015
Household Work Depends on Electricity Supply	0.662	0.752	0.378	0.041	0.372
Constant	-16.646	14.944	0.265		
Prob > chi2	60.23				
Pseudo r-squared	0.5589				
Prob > chi2	0.0000				

Source: Author’s Estimation with Stata 15

Note: *=significant at 10%, **=significant at 5%, ***=significant at 1%

Table 5: Sensitivity Analysis to Parameter Exclusion

Variable	Coef.	Std. error	**P>|z|**	Average Marginal Effects	**P>|z|**
Bid	0.09***	.0310	0.002	0.007***	0.000
HH Sex_Female	0.364	0.698	0.602	0.027	0.601
HH_Age	-0.345	0.384	0.387	-0.025	0.378
HH_Education	0.595*	0.344	0.084	0.044*	0.067
HH Size	2.411***	0.817	0.003	0.181***	0.001
Income	-1.039*	0.620	0.094	-0.078*	0.079
Power Outage Duration/hours	-0.228*	0.134	0.090	-0.017*	0.079
Frequency of Power Supply outages	-0.605	0.503	0.229	-0.045	0.219
Satisfaction with current supply	-0.749	1.623	0.644	-0.056	0.643
Backup Generator Fuel Expenditure	0.807*	0.449	0.073	0.060*	0.058
Household Work Depends on Electricity Supply	0.695	0.683	0.309	0.052	0.303
Constant	-8.847	6.701	0.187		
Prob > chi2	61.99				
Pseudo r-squared	0.498				
Prob > chi2	0.000				

Source: Author's Estimation with Stata 15

Note: *=significant at 10%, **=significant at 5%, ***=significant at 1%

Increased awareness due to a higher level of education likely drive households' willingness to pay for improved electricity supply. The mean willingness-to-pay estimates derived from Table 4, based on equation (6), are in Table 6. On average, residential consumers are willing to pay up to N164.81/kWh (~US$ 0.37/ kWh[3]) for a 70 percent improved electricity supply. The new service-based electricity tariff designed by the Nigerian Electricity Regulatory Commission (NERC) categorizes residential customers into five different Bands based on the daily hours of electricity supply to a domain and the distribution company (NERC, 2020). The study location is under the Ibadan and Benin distribution companies; however, 99.03 percent (205) of households surveyed fall under the Benin Distribution company. As such, the study adopts the average tariff rate across the service Bands of the Benin distribution company as a reference benchmark for the current electricity tariff in Ekiti State. The survey was in December 2022; the average electricity tariff, as of then, across the five service Bands for the residential consumers of the State was N55.88kWh (~US$0.13/kWh) under the Benin DISCO (MYTO, 2022)[4]. This suggests that households are willing to pay an extra premium of N108.93/kWh (~U$0.25/kWh) for an improved electricity service.

Based on a disaggregated analysis, the results of the extra premium households are willing to pay on their current tariff are in Table 6. The results differ across the tariff classes. The estimates are based on the approved 2024 January to March MYTO for Benin Electricity Distribution Company as provided by NERC[5]. The computation assumed no tariff review occurred in the Band A tariff class; thus, the residential consumers on the Band will pay an extra premium of N92.62/KWh (~US$0.07/KWh)[6], on average. This cost for desired service improvement accounts for about a 128.3 percent increment above the baseline. The increment is 83.7 percentage points lower than the 212 percent increase brought about by the provision of the 2024 April to December supplementary MYTO review, which pegged the tariff at N225/kWh (US$ 0.17/kWh[7]) for the Band A electricity tariff class. The implication is that the recent tariff hike is not justifiable and outrageous in light of end users' perception of the current level of electricity supply. Overall, most households surveyed (85 percent) are willing to spend more on the tariff due to the importance of electricity in enhancing productivity gains and higher quality of life. The remaining households lack trust in the government to improve the quality of the electricity supply, hence their unwillingness to accommodate the increase in the electricity tariff, including the rejection of the recent tariff hike. These results align with other literature that shows households' preference for increased tariffs on the backdrop that the benefits of improved grid electricity always outweigh the cost of the extra premium (Wen et, al. 2022; Duetschmann et al., 2021; Niroomand and Jenkins, 2021; Batidzirai et.al. 2017; Ozbafli and Jenkins, 2016).

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[3] This calculation is based on the central official exchange rate of N448.6/ US$ for Dec 2022, which was the rate at the period of the survey. (https://www.cbn.gov.ng/rates/ExchRateByCurrency.html?

[4] The tariff value is an average amount computed across the Band A, B, and C tariff class for February to December 2022 MYTO, excluding others that do not qualify for the periodic minor tariff review based on the minimum threshold of 12 hours of electricity supply (see https://www.olaniwunajayi.net/wp-content/uploads/2020/09/NERCS-Multi-Year-Tariff-Order-MYTO-2020.pdf.

[5] https://beninelectric.com/april-2024-supplementary-order/

[6] This calculation is based on the average central official exchange of N1322.5/US$ for the 2024 January to March based on the tariff review period.

[7] This calculation is based on the April 2024 central official exchange rate of N1329.705/US$ https://www.cbn.gov.ng/rates/ExchRateByCurrency.html

Table 6: Calculation of Mean Willingness to Pay for Improved Electricity Supply

		Mean WTP (Naira/ kWh)	Mean WTP (US$ / kWh
Household mean willingness-to -pay per kilowatt		164.81	0.37
Average extra premium households are WTP on the current tariff [8]		108.93	0.25
Tariff Class for Residential End Users	**Approved Tariff, Jan to March 2024 (Naira/** kWh)[9]	**Extra amount households are WTP across tariff class[10] (Naira/**kWh)	**Extra amount households are WTP across tariff class (US$/** kWh)
A	72.19	92.62	0.070
B	68.56	96.26	0.073
C	56.91	107.9	0.082

Source: Author's calculation based on equation (6)

Note: The calculation excludes tariff classes D and E, see footnote 2 and 3 for details.

[8] For socioeconomic concerns, the 2020 MYTO regime takes cognizance of vulnerable populations, individuals who cannot afford to pay high electricity tariffs. This category falls within the lifeline/underprivileged end-users, consuming less than 50kWh of energy monthly. Hence, the calculation did not capture those categories in the WTP estimation. The calculation is for households within band A to C in the Benin Electricity Distribution Company only, subject to minor revisions due to environmental factors. In the 2020 MYTO, households in bands D and E enjoy less than 12 hours of energy supply daily and are excluded from short-term tariff adjustment unless otherwise stated. Also, the tariff review applies to metered customers in the referenced category.

[9] Rates are for the upper bound of each tariff class

[10] This calculation does not take cognizance of the recent electricity tariff adjustment that affects only the Band A tariff class due to the public outcry associated with the review.

5. Discussion of Results

The empirical results show that residential households have WTP higher electricity tariffs for electricity supply reliability. The positive and significant relationship between the bid and the likelihood of WTP for higher tariffs indicates that improvement in grid electricity supply can engender higher tariff acceptance by residential consumers. This situation may stem from the role of electricity in enhancing quality of life and livelihood strategies, among others. Although the theory of demand stipulates an inverse relationship between price and the quantity demanded, in some exceptions where the commodity has no close substitutes, like electricity, the relationship may be direct. Thus, households' preference for higher prices for improved service delivery is well justified. The residential consumers' stated preference may stem from the undesirable effects of poor quality of electricity supply on household electric appliances. The result aligns with similar studies, which established that the need for higher utility maximization in electricity supply may lead to the acceptance of higher tariffs (Twerefou, 2014).

A positive and statistical relationship is established between a higher level of education and the WTP for improved service delivery, suggesting that highly knowledgeable persons are likely to seek service improvement towards utility maximization. This result conforms with the literature (Ayodele et al.,2021, Gunatilake et.al. 2012; Aklin et al., 2014) that asserts positive roles of education in WTP for reliable electricity supply.

A residential consumer with a large family size will accept a higher electricity tariff to improve service delivery. The outcome is due to the positive relationship between large family size and the WTP for improved reliability. This situation is possible where a household has to spend double or more of its income as a cost of power outages on expensive alternative backup generators. In this case, the extra income spent by the household on alternative sources becomes an opportunity cost for other consumption needs. Thus, a large household is willing to pay a higher premium for an improved grid electricity supply, which is cheaper and has higher utility than alternative energy sources. The finding conforms with Abdullah and Mariel's (2010).

The results revealed that an increase in backup generator fuel expenditure has a positive relationship with a preference for reliability in electricity supply. This outcome implies that the preference for a stable grid electricity supply supersedes that of the alternative backups, partly due to the higher utility derived from the functionality and large-scale usability of the grid electricity supply. This satisfaction, which has widespread positive effects may explain the relationship. Also, grid electrification is cheaper and exerts less financial burden on household expenditure than the cost of backup generators. The finding corroborates other literature that ascertained the direct relationship between backup fuel expenditure and the WTP for improving service to reduce the cost of power outages (Oseni, 2017).

Also, the reliability attributes (duration and frequency of power outages) have a negative relationship with household WTP for improved electricity supply, although only high frequency of power outages is a significant determinant. This suggests that the frequency of power outages, not the duration, affects households' decisions about improved service delivery. The result confirms the outcome by Oseni (2017), who shows that a decline in the duration of power outages engenders WTP for reliable electricity supply. While most residential consumers are uncertain about further improvement in electricity supply, a situation echoed by the insignificant improvement of the sector since its liberalization in 2013 and the commencement of the service-based tariff regime (see Appendix B), an improvement in reliability attributes may build trust towards the acceptance of higher tariff.

Further, the results show that the residential consumers are WTP higher tariff for improvement in electricity supply. The consumers are willing to accept up to 194.94 percent tariff increase for a kilowatt of electricity supply over the current level, on average. The 70 percent level of improvement was the desirable level gathered from the field survey. The disaggregated analysis by the MYTO tariff classes indicates that residential households are willing to pay a higher premium if there is no upward tariff review in 2024. For instance, customers in Bands A, B, and C will accept about 128.3 percent, 140.4 percent, and 189.6 on their tariff rates, respectively. These rates are lower than what should be with the tariff revision, especially for the Band A customers who pay the new tariff rate. The increment that can be accommodated above the baseline by the Band A customers is 83.7 percentage points, which is lower than the 212 percent hike brought about by the higher tariff through the MYTO review. The implication is that the recent tariff hike is beyond the acceptance threshold for service improvement. The households are open to tariff review, but not as outrageous as the imposition by the NERC. A modest tariff adjustment in tandem with considerable improvement in electricity supply is preferred.

6. Conclusion and Recommendation

This study examines the drivers of residential electricity end-users' willingness to pay for reliable electricity supply and the extra tariff they can accommodate for the higher utility. The study used a household survey designed within the contingent valuation framework to elicit information from the selected respondents. Specifically, the study considered the roles of socioeconomic characteristics such as household size, income, education, gender, and age on household willingness to pay for improved electricity supply. Also, the implications of household electricity supply profile, such as the price of electricity, power outage attributes in frequency and duration, metering status, and the average monthly expenditure on backup generator fuel, were examined. The calculation of the maximum tariff the household is willing to pay for improved electricity supply was a derivation from the estimates of the drivers of the WTP.

The empirical analysis finds that the price bid, education, household size, frequency of power outages, and monthly expenditure on backup generator fuel are the significant drivers of household willingness to pay for improved electricity supply. On average, households are willing to pay N164.81/kWh (~US$ 0.37/ kWh) for a 70 percent improvement in electricity supply. The amount represents an increment of about 194.94 percent above the current average rate of N55.88kWh (~US$0.13/kWh) as of the survey time. Using the 2024 January to March MYTO as a baseline for a disaggregated analysis, the analysis shows that residential consumers across the Bands A, B, and C tariff classes can accommodate a lower tariff rate than the higher rates imposed by the NERC, especially among the Band A customers. Without the 2024 MYTO review by NERC, the Band A customers are willing to accommodate 83.7 percent tariff increment compared to the 212 percent hike experienced due to the MYTO review.

The findings underscore the need for demand-side consideration in the tariff setting. Thus, the study recommends more investment in electricity infrastructure to enhance electricity supply. The

NERC may stipulate minimum infrastructural investment in the electricity sector to guarantee a 70 percent improvement in service delivery. Otherwise, there should be sanctions on erring supply companies to build consumers' trust regarding the acceptance of upward tariff review for higher efficiency. This option may lead to a win-win situation in terms of increased reliability in electricity supply while bolstering cost-reflective tariffs.

Further research should consider other electricity-consuming units such as the micro, small, and medium enterprises (MSMEs). The MSME sector is suitable as it accounts for about 48 percent of the economic growth while propelling job creation and revenue generation for the government. Unreliable electricity supply is one of the factors undermining the sector's performance, making it suitable for the type of assessment in this study. The outcome may provide insights about equitable tariff review vis-a-vis efficient service delivery.

While the sample adopted for this analysis may seem insufficient, the empirical findings have national policy implications in future price setting and infrastructural development because the problem of unreliable electricity supply is of a national scale. Also, a nationwide survey is financially demanding; hence, the study adapted to available resources. While the adopted sample used in the analysis varies from the initial selected sample size and by variables due to missing data, the overall validity of the findings was preserved.

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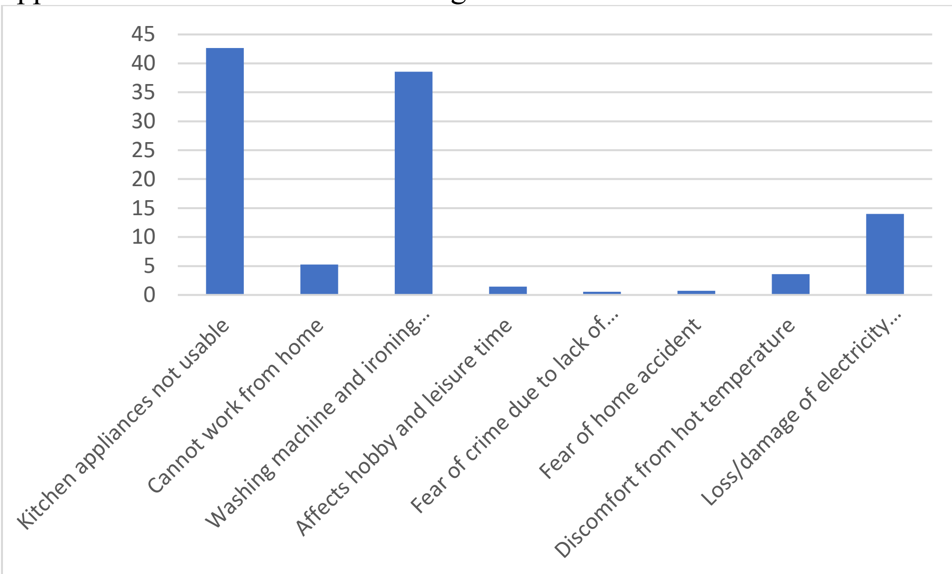
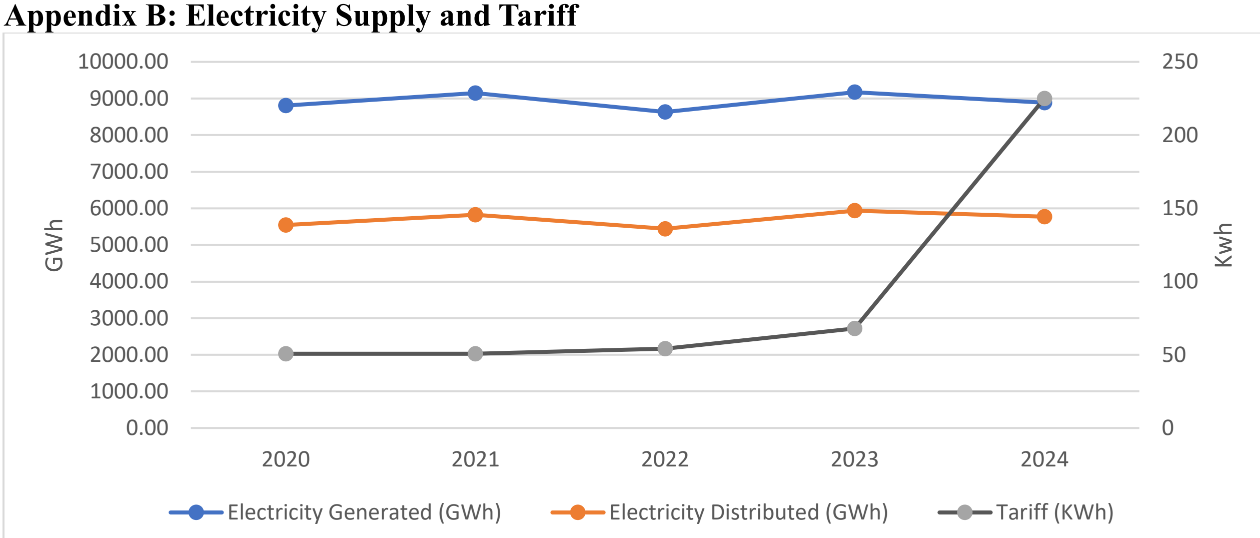
Appendices

Appendix A: Effects of Power Outages



Source: Computation from 2022 NISER's Survey Data

Appendix B: Electricity Supply and Tariff



Source: Computation with Data from the Nigeria Electricity Regulatory Commission, Various Report

Appendix C: Summary Statistics

	Obs	Mean	Std.Dev	Min	Max
WTP	206	0.150	0.358	0	1
Bid	211	173.88	900.97	50	13196
HH Sex_Female	204	1.456	0.556	1	2
HH_Age	208	3.379	1.153	1	5
HH_Education	200	2.945	1.261	1	5
HH Size	205	2.332	1.529	1	22
Income	209	2.100	0.782	1	4
Metering Status	189	1.169	0.498	1	2
Power Outage Duration/hours	209	3.421	1.062	1	5
Power Outage Duration/ days	209	15.086	10.126	6	141
Frequency of Power Supply	154	6.825	4.954	0	14
Satisfaction with current supply	209	2.952	0.213	1	2
Backup Generator Fuel Expenditure	211	2.118	0.730	1	4
Household Work Depends on Electricity Supply	208	1.817	0.633	1	3

Source: Author's Computation using Stata 15