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Households' willingness to pay electricity in northern Nigeria

Ibrahim Gerarh Umaru
Department of Economics
Kaduna State University
Kaduna-Nigeria
Corresponding author's mail: umaru8@gmail.com

Abstract

The 45 per cent hike of electricity tariff introduced in February 2016 in Nigeria generated mixed reactions. Official explanation was that the increase would encourage the electricity distribution companies (DISCOs) to inject new investments into the electricity sub-sector thereby ensuring better service delivery to consumers. Claiming to represent the interest of the general public, consumer associations, trade and civil rights groups described the hike as exploitative, unrealistic considering the fact that its implementation came at the backdrop of incessant power outages, lack of prepaid meters and ageing equipment often associated with DISCOs and difficult economic times occasioned by the dwindling government oil revenues. All this has serious implication not only for further investment to upgrade electric power by DISCOs in the country, but future investments in the universally trending switch to green power by the private sector. A double-bounded dichotomous choice bidding experiment approach was adopted in the study. Through extensive in-person interviews, data from 1,194 households in three geopolitical zones of the region were collected and the Tobit regression technique used to analyse the data. Results from the survey show that monthly income, prior notice to power outages, cost of traditional alternative sources of energy, business ownership, separate electric billing system and formal education significantly influence willingness to pay for improved and reliable electricity. Households revealed that they were, on the average, prepared to pay ₦7.21 (35.45 per cent) and ₦7.36 (35.56 per cent) over and above the minimum KW/h per month for improved electricity services and electricity from renewable sources respectively. It is envisaged that the findings would promote design of policy to promote appropriate investments in the energy sector, leading to the generation and distribution of efficient and uninterrupted electricity in the region.

Keywords: Electricity, Households, *WTP*, OBDC, Tobit, northern Nigeria, Renewables

1.0 Introduction

On 1st of February 2016 a new electricity tariff was introduced by the Nigerian Electricity Regulatory Commission (NERC) under the Multi-Year Tariff Order (MYTO) 2015. Under the new tariff, customers of residential customer category (R2) across the country were to pay between N11.05 and N23.60 per kilowatt/hour, representing an overall 45 per cent increase in their electricity charge.

While the Federal Ministry of Power, electricity distribution companies (DISCOs) and NERC defended the introduction of the new tariff by arguing that aside from reflecting appropriate energy pricing which is component of the on-going energy reforms the hike will encourage the *DISCOs* to inject new investments into the electricity sub-sector thereby ensuring better service delivery to consumers, some segments of the general public saw it differently. Newspaper reports indicated many Nigerians, the civil rights and the organized labour groups described the increase in tariff as exploitative, unrealistic considering the fact that its implementation came at the backdrop of huge estimated bills, incessant power outage, lack of prepaid meters and ageing equipment often associated with the DISCOs [1,2,3].

2. Problem identification and basic principle

This policy action has set the stage for the implementation of the new energy policy (NESP) which started with the adoption of the National Electric Power Policy (NEPP) in 2001, and is at the current stage of full privatisation of the generation and distribution subsectors, retaining the management of the remaining subsector to the government through concessional arrangements with the private sector. However, the policy is

undoubtedly likely to have significant impact on households' consumption of electricity and their overall welfare.

The critical question is how will the 'benefits' and 'costs' of the reforms affect the welfare of individual households and the economy at large depends on the socio-economic and demographic peculiarities of the consumers in the various regions that constitute the country? This question is even more relevant when it is considered that national socio-economic data, especially on poverty, unemployment, electricity consumption suggesting that people and the economy of some region especially the northern region are lagging behind. What is more, a substantial part of the region has been ravaged by the scourge of terrorism and insurgency for almost a decade now. If the economy is to make a head-start, therefore, these issues will have to be addressed sooner than later.

In addition to special emphasis placed on renewable energy, energy efficiency and rural electrification, increased electricity generation and ultimately consumption by both the households and industry in the region are considered by many as key requirements for the economic development in the country. However, a good understanding of households' knowledge and perceptions, as well as how the reforms in the energy sector will likely impact on their consumption patterns are essential to good policy formulation and implementation.

This study therefore set out to estimate the consumer's willingness to pay (*WTP*) for improved and reliable electricity and also 'green' power in the northern region of the country. It is intended to contribute to the debate on determining realistic and affordable market prices for electric services in the country and to help to bridge the gap between the private and social costs associated with the pre-reform electricity generation, transmission and distribution. It is equally aimed at shedding light on the potential of renewable sources in the electric power generation matrix of the country.

3. Methodology

Though there are several ways to model the relationship between *WTP* and household characteristics, the double-bounded dichotomous choice (*DBDC*)-Tobit model was chosen this study. The choice is deliberate and informed by the fact that the model has some attractive qualities - it combines its superiority of *DBDC* over its single bounded counterparts as highlighted above with the advantage of Tobit specification originally suggested by [3]. *DBDC*-Tobit specification seemed more appropriate for the study because it allows the individual effects of the various socio-economic and demographic variables to be isolated and quantified, yet permits the non-normal (truncated) distribution of the dependent variables.

The study was based on the survey conducted in three (northern) of the six geopolitical zones of the country, using questionnaire method as research instrument of choice between January 2015 and June 2016. Out of a total number of sixteen states in the three zones (six from the North-central, five each from North-east and North-west), six were randomly selected for the survey, using the sample-size formula suggested by [4] as a basis. Then using the projected population of the each of the zones as sampling frame, the total number of households was obtained. In this regard, a simple stratified random sampling method was employed to select required sample size of 1,194.

Like in similar surveys, each respondent was treated to a number of issues such as the state of electricity in the country; general questions and the debate on the merits and demerits of current national energy reforms (*NER*); improved electricity supply and energy efficiency as well as the potential of alternative sources such as renewables (*E&AS*); questions on knowledge about Nigerian energy system; money amounts (bids), using the 2016 general review of electricity tariff with ₦20.26 Kw/h per month serving as benchmark; and increment over the current mean monthly bill as *WTP* in support of the

development of reliable supply of electricity in the region.

The survey instrument included questions on attitude, behaviour and socio-demographic characteristics of the household. Like was in [5], *DBD* hypothetical prices (bids) was based on the questionnaire pretest and starting with N20.26 as the lowest bound and working way up to 100 per cent of that amount as the highest bid. ₦20.26 was selected because it represents the least charged for electricity bills approved for distribution companies (*DISCOs*) in the zone by the Nigerian electricity regulation agency. Each respondent was then required to answer one of the four random bid questions to minimize the bias of starting bids.

Two statistical packages, the statistical package for social science (SPSS) version 17 and E-views version 8.0 were used to process/analyse the survey data and to estimate the *DBDC*-Tobit models, respectively.

An internal consistency (reliability) test using the Cronbach's alpha was carried. The result of the test (α = 0.731) indicated acceptable reliability of the instrument.

4. Results and discussions

The results of the study reveal that majority of respondents are willing to pay an average of about 33 per cent (₦7.21) over and above the unit monthly electric charge to enjoy improved and reliable supply of electric power from their utility companies. Similarly, the same majority of respondents are prepared to allow a 35.6 per cent above their mean monthly charge of N20.26 Kw/h for electricity supplied from renewable sources by their utility companies.

To describe the aggregate household *WTP* for improved and reliable electricity and the *WTP* for electricity from renewable sources, best-fit curves were developed for scatterplots of the averaged values of incremental amounts per monthly unit of charge. An average 0f 17 per cent and 15 per cent of respondents indicated their willingness to pay at least ₦3.00 KW/h per month more, respectively. Less than 5 per cent of them stated that they are not willing to pay between 20 to 100 per cent more per month for improved and reliable electricity from either conventional source or from renewables.

Except for ownership of residence and education below primary school level, all the variables included had the right signs attached to them. House income, prior knowledge of *NER*, type of electric billing the respondent uses, ownership of enterprise, education level above primary school, household size and notification of outage were significant at 5 per cent level; while the relative price of existing conventional alternative sources, educational level above secondary school and location of residence were significant at 10 per cent level. Who pays the bills, ownership of residence, education at primary school level or below were neither significant at 5 per cent nor at 10 per cent levels. The summary of the marginal effect of changes in household characteristics on WTP for improved and reliable electricity and electricity from renewable sources are shown in Table 1.

Table 1: Marginal effects of changes in household characteristics on WTP for improved and reliable electricity and electricity from renewable sources

VARIABLE	**W_{EI} (₦ KW/h)**	**W_{ER} (₦ KW/h)**
INCOME	22.65914	14.22604
KNOW	8.446577	1.507567
P_ALTER	5.351568	5.035357
BILLING	4.83023	2.9838
BUS_OWN	7.606732	1.0156
EDUC2	0.927628	11.15767
EDUC3	3.762711	7.502191
HHSIZE	-1.167478	-0.790245
N_OUTAGE	53.28595	-6.093969

Source: Survey (2015)

The table indicates that three factors that significantly influence WTP for improved and reliable electricity are power outage, household income and business ownership in the study area. The coefficient of *N_OUTAGE* gives an indication

of the sensitivity of households to power outage in the region. As a matter of fact, households seem to be willing to pay up to ₦53.26 KW/h in addition to their monthly unit charge to avoid power outage. If anything, this result is an indication of the importance household in the region attached to uninterrupted supply of electricity. With about 54 per cent of the population in this region yet to have access to electricity either from conventional or renewable sources [6], this may an indication of potential for business and the need for more investment, especially by the private sector, in the generation and distribution of regular and steady electricity.

The results also suggest that the average household in the region is prepared to part with a percentage of his monthly income for an improvement in the supply of electricity. In fact, for every ₦1,000 increase in income, an average household in the region is prepared to pay ₦22.659 KW/h over and above existing rate to enjoy improvement in electricity. Households which admitted owning business enterprises indicated their willingness to pay ₦8.45 KW/h over and above their existing monthly per unit bill to have regular supply of electricity. This is in spite of the fact that the region has some of the poorest households in the country. As a matter of fact, the 2011 poverty profile of Nigeria's National Bureau of Statistics reveals that while the national average of relative poverty rate was 71.5 per cent, north-central, north-east and north-west zones of the region recorded 67.5 per cent, 76.3 per cent and 77.7 per cent respectively [6].

Perhaps the importance of the income and avoiding power outage in influencing *WTP* for reliable electricity may have been undermined by the level of formal education and knowledge of *NER* and *E&AS* as well as enlightenment on the potential of the current energy reforms to deliver uninterrupted electric power to the region. The relative values of the coefficients of *KNOW, EDUC3* and *EDUC4* can be interpreted to mean that there is strong indication of the role formal education, knowledge and enlightenment in future plans to make more reliable and efficient electricity available in the region.

Similar pattern is observable in the relationship between *WTP* for electricity from renewable energy sources. For instance, for every N1,000 increase in income, the average household in the study area is willing to pay an additional ₦14.23 KW/h per month. Similarly, the results of the survey also show that an average household is prepared to pay ₦5.03 KW/h with additional increase in the cost of using conventional sources relative to monthly electric bills

Conclusions

This study estimated the WTP for improved and reliable electric power supply as well as electricity from renewable sources by residential consumers in northern region of Nigeria. The results show that while about 34 per cent of electricity consumers are prepared to pay anything above the current unit charge, only roughly one-third of respondents in the survey indicated that they are prepared to pay more than the existing minimum of the 2016 reviewed increase in the unit charge (₦20. 26) for improvement in the efficient delivery and the promotion/development of electricity from renewable sources. The rest of the respondents indicated their likelihood to pay different amounts over and above the minimum charge per month in the region. The mean *WTP* for improved/reliable electricity and electricity from renewables were found to be ₦7.21 KW/h per month and ₦7.36 KW/h per month, or 35.45 per cent and 35.56 per cent increase respectively over and above the current minimum unit charge of electric power for residential consumers in the region. The median *WTP* was 30.00 per cent increase for both energy efficiency and electricity from renewables. Like in most past studies, the additional number of whose willing to pay more for either improved electricity or renewable power in the study area drops very rapidly as the incremental monthly amount per unit charge increases.

Regarding household characteristics influencing the *WTP* for electricity both from conventional and renewable sources, the factors found to be significant were power outage, income, prior knowledge of current national energy reforms and the potentials and technologies of renewable sources, formal education, ownership of enterprise, cost of traditional alternatives to conventional electricity and billing system. As would be expected of *WTP* for improved and reliable electricity, power outage, household income and knowledge of *NER* and *E&AS* stood out as the most significant factors. In the case of the *WTP* for electricity from renewable sources, household income, level of formal education of cost of traditional alternatives were found to dominate.

The above findings have serious implications for the current economic modernization agenda aimed at bringing to speed critical sectors of the economy, improving living standards and promoting sustainable development. In view of the following are recommended:

1. DISCOs should be encouraged to invest in better technologies that will help to reduce the persistent power outages in the region.
2. There should be synergy between federal, state and local authorities in putting in place economic strategies that will assist in reducing the current level of poverty in the region, so that household incomes will be enhanced and the per capita electricity consumption can be improved. The current statistics on the population without access to electricity in the region is not acceptable for an economy that aims to modernize and promote diversification away from heavy dependence on oil.

The need by policy makers to promote sound knowledge among the general public on the potential of renewable sources (especially solar and wind) and existence of technologies to generate efficient and reliable electricity as well as provide viable opportunities for profitable business in the region.

References

[1] Anaba, I., V. Ahiuma-Young and J. Agbakwuru (2016). Court annuls 45% electricity tariff hike. Vanguard newspaper online. Avaialble: http://www.vanguardngr.com/2016/07/court-annuls-45-electricity-tariff-hike/. Accessed: 9/4/2016.

[2] Opeyemi, D. (2016). Here' what you should know about Nigeria's new electricity tariff. Venturesafrica.com. Available: http://venturesafrica.com/is-the-new-electricity-tariff-justifiable/. Accessed: 9/3/2016.

[3] Akinwale, Y.O., I.O. Ogundare Ilevbare,O.E. and A.O. Adepoju (2014). A descriptive analysis of public understanding and attitudes of renewable energy resources towards energy access and development in Nigeria. International journal of energy and policy 4(4): 636 - 646.

[4] Tobin, J. (1958). Estimation of relationships for limited dependent variables. Econometrica 26: 24 - 36.

[5] Adekunle, C.P., D. Akerele, A.K. Adekunle and T.S. Amodemaja (2016). Consumers' willingness to pay for organic leafy vegetables in Abeokuta southwest Nigeria: evidence from double bounded dichotomous choice approach. Nigerian journal of agriculture, food and environment 12(1), 17 - 23.

[6] Yamane, H. (1973) cited in Umaru, I.G. (2013). Research methodology for social and behavioural sciences: principles and application. Abuja: Olive de l'afrique consult.

[7] NBS (2012). Nigerian poverty profile. Abuja: National bureau of statistics. Available: www.nigeriastat.gov.nf>pdfuploads. Accessed: 02/08/2016.

Commonwealth Energy and Sustainable Development Network (CESD-Net)

CESD-Net is a major global initiative in energy and sustainable development. The objective of network is to promote energy and sustainable development in commonwealth countries.
Focussing on Multidisciplinary Research, Promoting Future Low Carbon Innovations, Transferring Knowledge and Stimulating Networking among Stakeholders to Ensure the UK Achieves World Leading Status in Energy and Sustainable Development. https://www.weentech.co.uk/cesd-net/

The 1st International Conference on Energy, Environment and Economics (ICEEE 2016) was held at Heriot-Watt University, Edinburgh, EH14 4AS, UK, 16-18 August 2016. ICEEE2016 focused on energy, environment and economics of energy systems and their applications. More than fifty eight delegates from 31 countries with diverse expertise ranging from energy economics, solar thermal, water engineering, automotive, energy, economics and policy, sustainable development, bio fuels, Nano technologies, climate change, life cycle analysis etc. made conference true to its name and completely international. During conference total 51 oral presentations and six posters were shared between delegates. The presentations showed the depth and breadth of research across different research areas ranging from diverse background. ICEEE2016 aimed:

- To identify and share experiences, challenges and technical expertise on how to tackle growing energy use and greenhouse gas emissions and how to promote sustainability and economical, cost effective energy efficiency measures.

In total 11 technical sessions and two invited talks both from academia and industry provided insight into the recent development on the proposed theme of the conference. Preparation, organisation and delivery of the conference started from July 2015 and further co-ordinated by vibrant team of Conference Centre, Heriot Watt University. Conference organisers would like to acknowledge support from the sponsors particularly World Scientific Publication ltd and its team members for the delivery of the conference. Organisers are also thankful to all reviewers who contributed during peer review process and their contributions are well appreciated. At the end and during vote of thanks following awards have been announced and we would like to congratulate all well deserving delegates.

- Best Paper –Academia: Amela Ajanovic, EEG, TU Vienna, Austria
- Best Paper – Student : Christian Jenne,University of Duisburg-Essen, Germany
- Best Poster – Student: Yoann Guinard, University of New South Wales, Sydney, Australia
- Best Poster – Academia: E. Salleh, Universiti Kebangsaan Malaysia, Malaysia
- Active Participation Award - Yoann Guinard, University of New South Wales, Sydney, Australia

At the end we would like to extend our gratitude to all of you for your participation and hopefully welcome you again during ICEEE2017.

Editors:
Dr. Singh is Senior Scientist at Indian Agricultural Research Institute, New Delhi, India. Her area of expertise are bio energy and bio fuels, environmental engineering, carbon accounting and renewable energy integration for rural development.
Dr. Kumar is visiting faculty at Prince of Songkla University, Thailand. He have 16 years of research and teaching experience in the field of solar energy, drying and energy efficiency.

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