



Factors Affecting Solar Energy Satisfaction among Households in Maiduguri, Borno State, Nigeria

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Abstract

The importance of solar electrification cannot be overemphasized because of its enormous contributions to clean energy supply. However, several problems that affect its use exist. Thus, this paper examined the factors affecting solar energy satisfaction among households in Maiduguri, Borno State, Nigeria. The study utilized mainly 109 primary data obtained through snowball sampling technique and applied pie charts and a binary logistic regression model as tools for analyses. Results showed that about 85% of those using solar energy had encountered one problem or the other. About 76.9% lacked proper guidance by their solar installers on how to maintain it, 21.3% bought equipment with defects, 84.3% had no technical know-how on maintaining it, while 53.7% complained of the inefficiency of the already installed energy capacity. On the extent of households' problems, all the variables were positive although buying a piece of defective equipment and the already installed capacity's inefficiency was significant at $p < 0.001$. In comparison, lack of proper guidance by the solar power installers and lack of technical know-how on the consumers' part on maintaining their solar equipment were both significant at $p < 0.05$. In conclusion, the elasticity of the coefficient shows that a unit increase in defective equipment affected the consumers much more than the other problems. The study recommends that awareness should be created on the part of the consumers about the right place to buy their solar equipment and on how to maintain it. On the part of the installers, government and NGOs should make provisions for programs that provide skill acquisition on solar energy installation.

Keywords: Affecting, Energy, Factors, Households Satisfaction, Solar,

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INTRODUCTION

The type of energy utilized determines the populace's economic prosperity and quality of life as they are the economic development indicators. The use of clean energy such as LPG and electricity that emit less emission is an essential means of increasing household welfare. However, in Nigeria, access to electricity for urban households stood at 86%, while only 41% was for rural areas in the year 2016 (World Bank, 2016). Similarly, due to the increasing prices of fossil fuels and taxes on

energy sources, finding alternative, clean, and economical energy sources have been a significant concern for households and the nations' economy (Omolade, Nwosa, & Amassom, 2019). These reasons had resulted in several problems which constrained development and induce various environmental problems such as land degradation, among others as a result of excessive felling of trees for fuelwood purposes.

Households in Nigeria had been depending highly on dirty fuels such as fuelwood, charcoal, diesel and petrol that are environmentally unsustainable (WHO, 2016). This has been because modern fuels' retail prices have been relatively expensive due to factors such as high transportation costs and middlemen's activities. Thus, forcing them to resort to other cheap alternative dirty resources (Olaleye and Akinbode, 2012). The most used energy sources for cooking and lighting among the rural and poor urban households in Maiduguri has been wood (firewood, charcoal, dung, and crop residues), while the middle and high-income households used kerosene and LPG for cooking. Also, due to the epileptic electricity supply experienced, some households used power generating plants that work on petrol and diesel (Maina, Kyari & Dori, 2020), and to a smaller extent the use of solar energy has been reported (Maina, 2020).

The prospect of solar electrification cannot be overemphasized because of its enormous contribution to supply of clean energy, thereby contributing to poverty alleviation and sustainable socio-economic development, particularly at the household level where a more significant number of them rely heavily on dirty fuels due to lack of access to electricity (Mohammed, Mustafa & Mokhtar, 2013). Hence, improved access to solar energy would improve the environment through reduced CO₂ emission and climate change impact. Thus, it would improve access to other critical resources such as food and health (Rajendran, Aslanzadeh, & Taherzadeh, 2012).

A lot of studies (Maina, 2020, Mishra & Behera, 2016; Omolade, Nwosa, & Amassoma, 2019) have also shown that solar electrification is environmentally sustainable in lighting houses. Thus, solar light energy is considered environmentally clean and economically and socially beneficial to households (Maina, 2020). However, many constraints limit the use of solar electrification by households. These include the lack of financial capabilities to install it, inadequate access to institutional credit/subsidy for low-income families, lack of awareness, lack of technical know-how to maintain the equipment and, lack of government policy towards alternative sources like conventional grid electricity (Mishra & Behera, 2016).

Therefore, toward this end, this paper attempted to explore the above-raised issues as it affects the households that use solar energy in Maiduguri, Borno State, Nigeria. The rationale for such an attempt lies in bridging the gap in the demand side and proffer ways to achieve sustainable consumption and boasts its satisfaction and consequently demand in the long run. This paper considered two objectives. The first one identified the various problems associated with using solar energy and the second objective analysed how these problems affected the households in the study area.

MATERIALS AND METHOD

Study Area

Maiduguri, Borno State Nigeria, is the study area that lies between latitudes $11^{\circ}.83^1$ - $13^{\circ}.15^1$ North of the equator and longitudes $11^{\circ}50^1$ - $13^{\circ}09^1$ east of the Greenwich Meridian. In 2006, the area had 290,449 males and 231,043 females, totaling 521,492 (NPC, 2006). It is projected to increase to 890382 people at the end of 2022, based on the annual growth rate of 3.4%. The sources of energy available for cooking and lighting homes in the study area include electricity, fuelwood, charcoal, LPG, kerosene, diesel/petrol used in power generating plants, and solar (NBS, 2019 & Maina, 2020).

Sources of Data

The primary data used for the study were obtained via the snowball method. The data were collected between the months of June and July 2022. The justification for using the snowball sampling method was to make sure only the households that used solar were included in the study. To select the sample size, few solar installers were identified, and they made referrals to their consumers. A total of 110 questionnaire were distributed; however, only 109 were retrieved; thus, the sample size considered.

Variables Measurement

Table 1: Variables measurement

The problem of solar energy	It is the dependent variable, measured as dummy 1 for households with one problem or the other with solar energy and 0 if otherwise.
Lack of proper guidance by the installer on best practice of using solar	Is measured by the number of hours of light a household gets in a day.
Defects of solar equipment	Is determined by the households that had such problems are measured in dummy 1 for yes and 0 otherwise.
Lack of technical know-how on maintaining solar equipment	It is a dummy 1 for those who had such problem and 0 if otherwise.
The inefficiency of the already installed capacity	Is determined by the households who faced such problems is measured in dummy 1 for yes and 0 otherwise.
	It is a dummy 1 for those who had such a problem and 0 if otherwise.

Independent Variables Coined and Adopted by the author (2022).

Method of Estimation

Descriptive Statistics

Objective I was presented with pie charts to show the frequencies of the various problems encountered by the households using solar, in the study area.

Logistic Model

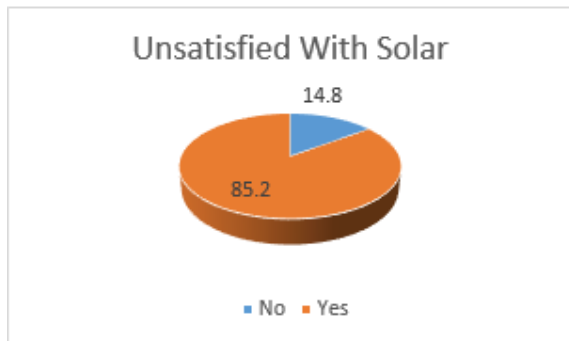
The binary logistic regression model was used to determine the level of a household's dissatisfaction with solar energy use. The model is appropriate because the dependent variable is dichotomous. It is given as $\ln [p/(1-p)] = \alpha + \sum (\beta_k) (X_k)$, where p is the probability that a household is dissatisfied with solar energy due to a problem encountered, $p/(1-p)$ is the odds that a household is satisfied (did not have any problem), α is a constant term, β_k represents the effects of parameters of the explanatory variables, and X_k represents the explanatory variables in the model. Coefficients

in a logit model give the change in the log-odds of being dissatisfied for a unit change in the explanatory variables.

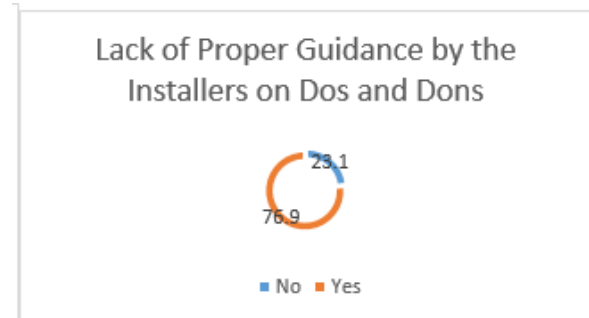
RESULTS AND DISCUSSION

The Major Problems Affecting Solar Energy Satisfaction among Households in Maiduguri, Borno State.

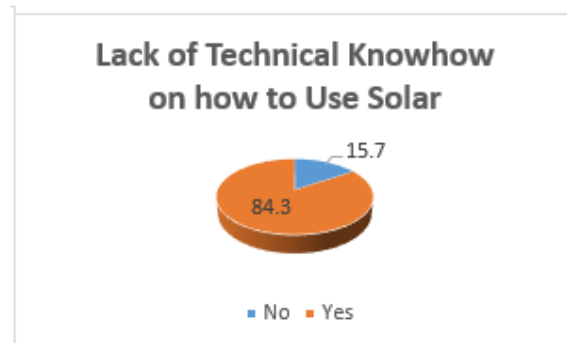
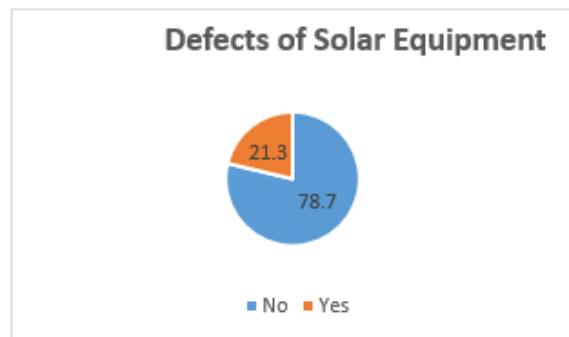
This objective is presented using a pie chart (virtual explanations) for better understanding. Figures 1A, 1B, 1C, 1D, and 1E present the results.



Sample 1A: Source Field Survey 2022
2022

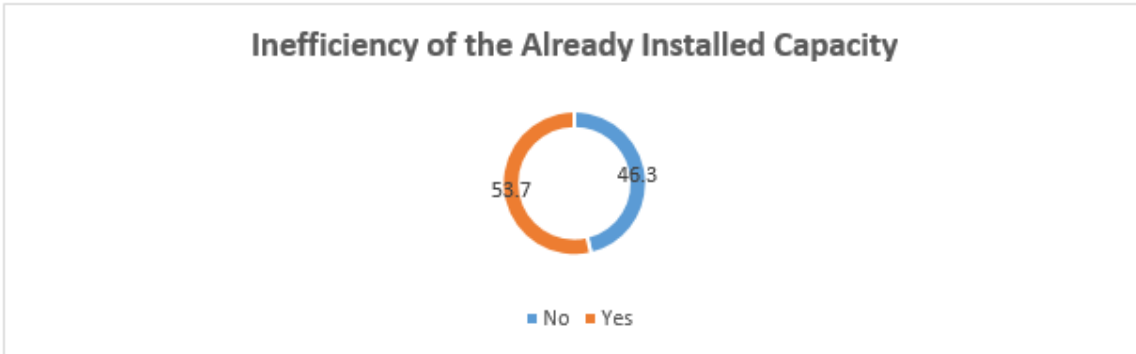


Sample 1B: Source Field Survey



Sample 1C: Source Field Survey 2022

Sample 1D: Source Field Survey 2022



Sample 1E: Source Field Survey 2022

It can be observed from Figure 1A that about 85% of the households using solar energy had encountered one problem or the other; thus, they were unsatisfied with it. For a further breakdown of the problems, Figure 1B to 1E are presented. The problems examined include lack of proper guidance by the solar installers/sellers on the best practice of using solar appliances for greater energy efficiency, which revealed that 76.9% of the households have had the problem. In addition, about 21.3% bought equipment with defects, and 84.3% had no technical expertise on maintaining their solar energy equipment, while 53.7% complained of the inefficiency of the already installed energy capacity. These problems as reported by the respondents emanated firstly, due to the lack of interest on the part of the sellers/installers on given proper guidance to their consumers to achieve maximum utility and consequently induce high demand in the long run. Instead, all they are interested in is to sell their products and gain profit. On the other hand, the consumers lack prior knowledge of the required capacity and the equipment needed before solar installation. This is because they do not involve professionals in determining the inverter's capacity based on load analysis; instead, they involve quacks in taking such a decision based on cost implication. Secondly, after the installation is done, most installers leave the consumers with lack of proper guidance as shown in sample 1B.

Thirdly, most of the consumers who complained of solar equipment defects end up at the receiving end because some of them bought from third-party marketers who do not give a warranty or only for a short period. Therefore, in such a situation, when a defect is detected after the warranty period, the consumer ends up bearing the financial burden of repairing or replacing it. In addition, about 84% sample lack the technical expertise on maintaining their solar equipment on the

consumer's side. For instance those who use tabular batteries, problems arise due to the consumers' lack of knowledge to check the level of mineral-free distil water regularly to see if they require a refill. Also, due to the lack of frequent checking and the possible soda cleaning of corrosion deposit on the battery terminals, it affects the rate of charge the batteries required.

Another problem is most of the consumers are not adequately guided by the professional solar installers on the right appliances to use with a given level of inverter and battery capacities. They neither know the adverse effects of using certain appliances, especially those with compressors such as air-condition, fridge and water pump nor how it affects the efficiency of the solar equipment in the long-run. Similarly, a problem is also encountered when the consumers do not frequently check the solar panels to when there are dirty and need cleaning in order to absorb the right amount of solar radiation.

Factors Affecting Solar Energy Satisfaction among the Households in Maiduguri, Borno State

Objective two analysed the degree of the marginal effect of how an increase in one problem could affect the household. Table 1 presents the results.

Table 1: Factors Affecting Solar Energy Satisfaction among the Households in Maiduguri, Borno State.

Variable	Coefficient	Standard error	T value	p>[t]
Constant	0.3277631	0.765276	4.28	0.000* *
Lack of proper guidance by the installer on the best practice of using solar	0.205921	0.101598	2.03	0.043*
Defects of solar equipment	0.097164	0.0185285	5.24	0.000* *
Lack of technical know-how on maintaining solar equipment	0.0559711	0.027296	2.05	0.041*
The inefficiency of the already installed capacity	0.3277631	0.765276	4.28	0.000* *
Log-Likelihood	-	33.648213		
Chi2 value	33.18			
Prob Chi2	0.0000			

Source: Field Survey (2022) Note ** = Significant at 1%; * = Significant at 5%

Table 1 shows the marginal effects of a unit change in a given problem (explanatory variable) on the probability of affecting the households using solar energy. Hence each marginal effect represents the extent to which a given problem affects the consumers. The log-likelihood value irrespective of its sign is greater than one and is significant at $p < 0.001$. This implies that the regression is fit for the model. The first variable considered is the lack of proper guidance by the solar power installers. The result is positive and significant at $p < 0.05$, while the marginal effect shows that a 1% increase or a persistent in the lack of proper guidance by the installers would affect the consumers by 203%. This shows that the more an installer does not guide the solar consumer on the right capacity of the equipment to be bought, the type of appliances to use with

their solar power and the best way to maintain their solar, the more the problem keeps persisting. Secondly, the result revealed that buying a defective product causes a consumer's problem at a $p < 0.001$ significant level. Thus, one unit of defective equipment would cause a problem to the consumers by 524%. Thirdly, lack of technical know-how on the consumers' part on maintaining their solar equipment also aggravates the problem at $p < 0.05$ level. This indicates that a 1% increase in lack of awareness of maintaining the solar equipment would aggravate the problem by 205%. Finally, the result of the already installed capacity's inefficiency shows it is significant at $p < 0.001$. Thus, the more the consumer does not have a prior knowledge on the right capacity of solar equipment to be installed the more he/she faces problems after the installation, which shows the marginal effect of 428%. The result on lack of technical know-how on the consumers' part on maintaining their solar equipment the obtained agree with findings of Mishra and Behera (2016) for a rural household in India, which show that there is non-availability of maintenance and repair facilities. In general, a unit increase in a piece of defective equipment affects the consumer much more than the already installed equipment's inefficiency, followed by the sellers' lack of guidance and the lack of technical know-how of maintaining the equipment by the consumers.

CONCLUSION

The major problems affecting the satisfaction of solar energy consumers include lack of proper guidance by the solar installers/sellers on the best practice of using solar equipment to achieve greater energy efficiency. Also, buying of defective equipment without or with only short-term warranty. Other reasons are lack of technical know-how by the consumers on maintaining their solar energy and the lack of prior knowledge of the solar energy equipment's right capacity to be installed.

On the degree of how the problems affect the consumers, buying a piece of defective equipment affects them much more than the lack of prior knowledge on solar panels' right capacity to be installed. Also, the lack of guidance by the installers to the consumers on maintaining their solar energy causes more problems as it translates to the lack of technical know-how by the consumers themselves.

RECOMMENDATIONS

The study recommends the following:

1. Firstly, there is the need to create awareness on the part of the consumers in the right place to buy quality solar equipment with a long warranty period. They should also involve professional installers to help do load analysis to determine the right equipment to buy. Also, they need to acquire some knowledge on how to maintain their solar equipment. Such awareness could help even when the installers did not guide them. Thus, creating an avenue such as Facebook groups, presenting a radio or television program that provides adequate knowledge on maintaining solar energy equipment could go a long way.

2. Finally, on the installers' side, government and non-governmental organizations such as the solar energy society and the African solar society should provide a certificate or diploma program that provides skills acquisition on the solar energy installation maintenance and consumer guide. That way, the installers could enroll in such programs that in the end, result in issuing a license to the qualified ones.

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