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Energy Poverty and the Security Challenges in Northern Nigeria-Incidence and the Potential for Renewables

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Abstract- A Multidimensional Energy Poverty Index (MEPI) has been used to study the incidence of energy poverty in Nigeria. Secondary data from the United States Agency for International Development was collated from over 44,000 households, from which calculated MEPI for the various regions of Nigeria show that the southwest had the least incidence of energy poverty, while the northeast region had the highest energy poverty. Cogent connections have been made between recent security challenges in the northeast with energy poverty. Reports taken from studies and the mass media show that vast majority of attacks occur in the geopolitical region. Thus, renewables such as solar and wind energies abundant in northeast Nigeria have been identified as potential solutions to ending energy poverty and hence a strategic pathway to arresting the current security challenges.

Keywords: multidimensional energy poverty index, renewable energy, security challenges, North East Nigeria.

I. Introduction

Energy is an important and key element in human life, influencing virtually all areas such as even environmental sustainability [1]. The

World Economic Forum (WEF) describes energy poverty as the "worst poverty of all" and as a major impediment to development [2]. Energy poverty is the lack of access to modern basic energy services such as clean cooking facilities and access to electricity [3]. The need for energy cuts across virtually all areas of human existence for example, access to clean energy would help women in cooking, saving time and energy and avoiding health issues, access to electricity will afford the opportunity to get entertainment from both radio and television, knowledge and information dissemination [4].

Globally, 1.3 billion people do not have access to electricity and over 2.7 billion depend on traditional biomass for cooking consequently making the provision of modern and reliable access on a global scale a huge challenge [3]. Nussbaumer et al. [5] opined that the role of energy cannot be overemphasised in tackling global development challenges such as climate change, education, food security, health, inequality and poverty. Energy poverty is evident mainly in developing countries as majority of the people lack access to various forms of energy [6]. According to Chevalier and Ouedraogo [7], the poor are the main victims of energy poverty and the World Energy outlook [8] reported that sub-Saharan Africa has the highest level of energy poverty with over 31 per cent electrification rate and 80 per cent of the people relying heavily on traditional biomass.

In Nigeria, energy poverty is evident in the frequent interruption of electricity supply to households and industries, households' inability to afford clean energy due to poor income and then households who can afford this pay for it beyond their cost budget. About 40% of the Nigerian populace have no access to electricity grid with over 70% still depending on traditional biomass for cooking [9]. Obi and Menson [10] believe that low access, poor quality and inadequate quantity are the key evidences of energy poverty in Nigeria. Ogwumike and Ozughalu [11] reported that over two-thirds of households in Nigeria rely on fuel wood for cooking hence validating the presence of energy poverty in Nigeria. Some key studies of energy poverty in Nigeria include [9,11, and 12] to mention a few. However, previous approaches on analysing energy poverty in Nigeria have failed to deeply examine and capture the socio-economic deprivations households experience due to energy poverty. This study did not only assess energy poverty at the national level, but also attempt to measure this deprivation at the sub-zone, state, and wealth index level using a Multidimensional Energy Poverty Index (MEPI). Its contribution to the insecurity of life and property currently faced in Nigeria's northeast in the form of terrorism was also be examined. The potential of alleviating energy poverty by harnessing the abundant renewable energy sources

available in the region in the form of wind, solar, and biofuels was discussed.

II. Methodology

Multidimensional Energy Povervy Index (MEPI)

This methodology was drawn from Nussbaumer *et al.* [5]. The MEPI is a novel metric for measuring energy poverty stemming from literatures from the Oxford Poverty and Human Development Initiative (OPHI) on Multidimensional Poverty Index (MPI) presented in [13, 14]. This is based on Amartya Sen's theory of deprivations and capabilities [15]. The design of the MEPI enables it to capture and evaluate a set of energy deprivations a person or household experiences.

In consideration of the multidimensional nature of energy poverty, the MEPI is basically composed of five dimensions which represent basic household energy service measured by six indicators (see table 1). For a detailed description of the methodology and computation of the MEPI see ref. [5]. Most importantly, the MEPI measures energy poverty in ***d*** variables across a population of ***n*** members. Furthermore, the methodology permits the uneven weighting of the indicators. Energy services perceived by the researcher as more essential where allotted a bigger weighting share (see table 1) the weighting vector *w* is the weight applied to the variable *j*. It is defined as:

$$\sum_{j=1}^{n} w_j = 1 \qquad (1)$$

Finally, the MEPI introduces a deprivation cut-off which is the set of conditions a member in the population must achieve. Nussbaumer *et al.*'s study sets the cut-off at 0.3. Therefore, any person whose MEPI is above the 0.3 cut-off is considered as energy poor.

Summarily, if

MEPI > 0.7, Acute energy poverty is incident

0.3≤MEPI≤0.7, Moderate energy poverty

MEPI < 0.3, Low energy poverty

MEPI = H x A

Where **MEPI** = the combination of the information on both the incidence and intensity of energy poverty.

H = q/n is the headcount ratio or incidence which represents the proportion of total number considered energy poor; **q** represents the number of people in energy poverty and **n** is the total number of people. **A** is calculated as follows:

$$A = \sum_{i=1}^{n} (k)/q \qquad (2)$$

which is the average of the censored weighted deprivation counts $\mathbf{c_i(k)}$. It represents information on the intensity of the MEPI. This methodology stems from the fact that people do not want energy in itself but the services provided by energy, which is made available by different fuels and technologies and has the potential to improve livelihood, health and education as well as reduce poverty in developing countries.

Data Source

The data used in this research was the survey done by the MEASURE DHS (Demographic Health Surveys) projects. The DHS is funded by the

United States Agency for International Development (USAID).

Table 1: The Dimensions and Respective Indicators for the MEPI with Cut-offs, and Weightings in bracket

Dimension	Indicator (weight)	Variables	Deprivation cut-off (energy poor if….)
Cooking	Modern Cooking fuel (0.2)	Type of cooking fuel	Any fuel use besides electricity, LPG, kerosene, natural gas or biogas
	Indoor pollution (0.2)	Food cooked on stove or open fire (no hood/chimney), indoor, if using any fuel beside electricity, LPG, natural gas or biogas	True
Lighting	Electricity access (0.2)	Has access to electricity	False
Services provided by means of household appliances	Appliance ownership (0.13)	Has a fridge	False
Entertainment/education	Entertainment/education appliance ownership (0.13)	Has a radio and/ or television	False
Communication	Telecommunication means (0.13)	Has a Mobile phone and/ or Phone land line	False

The DHS collects and publishes national representative data on issues such as maternal and child health, fertility, family planning, gender, HIV/AIDS, malaria and nutrition. The DHS data was used because the information from the data contains a range of updated indicators related to energy poverty at the household level. The DHS survey on Nigeria for 2003 and 2008 provide estimates for rural and urban areas of the country, the six zones, and several of the 36 states and the Federal Capital Territory (FCT). However, one of the major problems of micro data is likelihood of missing data. This was treated by case deletion to avoid influencing the result of the analysis. For example, in 2008, there were 1333 households with single or multiple missing information this was consequently subtracted from the total number of households interviewed. Also, the 2003 DHS data were collected and used for comparison with the 2008 so as to ascertain the change of energy poverty within 5 years. The 2003 data was chosen because it was the

only data with updated information as those from 2008. Although, there were some missing variables in 2003 such as data on generating set, indoor pollution and mobile phones, for the sake of a fair comparison, these data were removed from 2008. Both datasets were representative of the population at that point in time.

Strengths and Limitation of MEPI

The MEPI primarily measures deprivation instead of access and takes into account the multidimensionality of energy poverty**.** It further estimates the headcount (incidence) and intensity of energy poverty, i.e., how many people and how energy poor they are**. MEPI** is based on Micro-data (survey) and allows for decomposability between rural and urban and sub-national. It is also more importantly centred on energy services**.** Finally, it is complementary to other metrics such as Energy Development Index (EDI). On the other hand, literature has shown that energy poverty is primarily a challenge in Africa, most especially sub-Saharan Africa where paucity of data is a major obstacle to effective research. This paucity of data poses a major challenge in the computation of the MEPI. However database like the 2008 DHS survey shows an improvement in data evidenced in the addition of more data on energy related services.

Table 2: Interview Data

Interviewees (Age 15-49)	2008	2003
Households	34,070	7,225
Women	33,385	7,620
Men	15,486	2,346
Interview response rate (%)		
Households	98	99
Women	97	95
Men	93	91

III. Results and Discussion

Traditional Biomass use and its effect on Households

This objective was achieved through the review of relevant literatures on the impacts of traditional biomass, and these impacts were categorised into; environmental, health and social impacts. Table 3 presents the findings.

To measure energy poverty, six indicators belonging to five dimensions were considered in order to capture the deprivations households experience from the incapability to use energy services.

Figure 1 shows the percentage of people deprived in each indicator of the MEPI. Also, it compares the performance of the urban and rural areas with that of the national aggregate.

Table 3: Energy Poverty at the National,Urban and Rural Areas

Category	Impact
Environmental	• Reduces Agricultural productivity • Worsens deforestation and desertification • Increases the accumulation of Greenhouse Gas
Health	• Indoor pollution from traditional biomass contributes to 1.5 million deaths annually • Toxic fumes from indoor pollution causes more deaths than Malaria • High concentration of CO, NO2, SO2 and TSP leading to chronic illnesses such as lung cancer, pneumonia and allergies • Burns and Scads as well as the possibility of injury and violence during collection
Social	• Expands socio-economic inequalities among men and women as women tend to spend more time collecting fuels and cooking • Deprives women and children especially female children the time for formal education

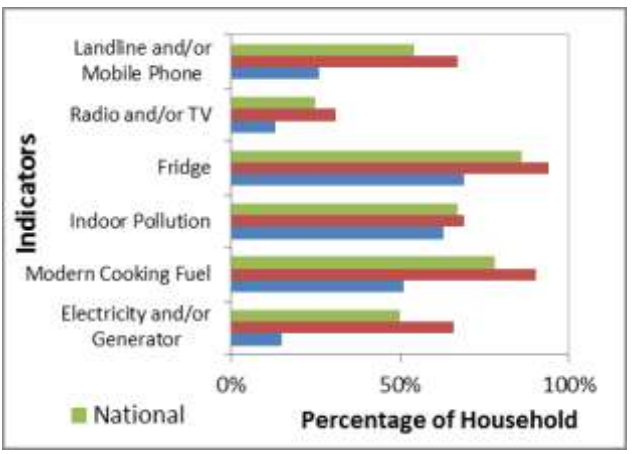

Figure 1: Percentage of Households Deprived in each Indicator for National, Urban and Rural .

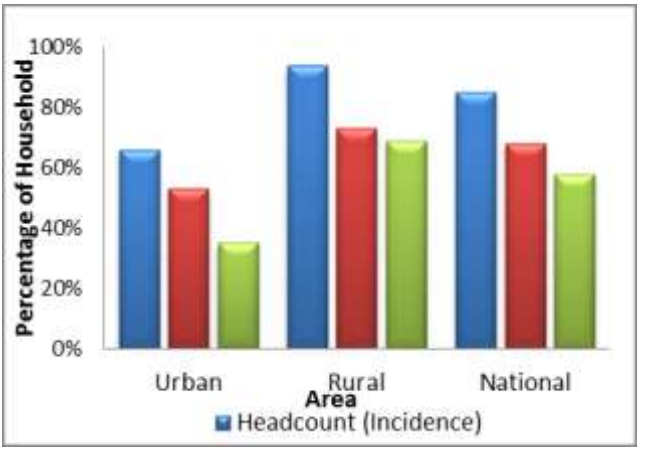

Figure 2: Comparison of Energy Poverty in Rural and Urban Areas with National Aggregate

At the National level, it can be seen that a large proportion of households are deprived in all the indicators except in radio and television.

However, it is important to note that these appliances depend on electricity. The study reports that 78% of households in Nigeria are deprived of modern cooking. The implication of this is that more households depend on traditional biomass other than the clean fuel of electricity, and LPG for cooking and are therefore, exposed to indoor pollution with its associated hazards.

Major reasons for this may be ignorance, affordability and availability of this modern fuel. This tends to be higher in the rural areas where 90% of households are deprived of modern cooking fuel compared to 51% in the urban areas. Drawing from literature, culture and education could be a major determinant for this inequality. Furthermore, it can be seen that 50% of households do not have access to lighting from either grid electricity and/or generators; this implies that they depend on lighting from other sources such as candles and lanterns.

The effect of this deprivation of electricity can also be seen in the percentage of households deprived of cooling from the use of fridges, as can be seen all categories were most deprived in that indicator.

It can be seen from Figure 2 that the incidence of energy poverty is high in Nigeria at 85% which implies that 85% of households in Nigeria are energy poor. In the urban areas, 66% of the households are living in energy poverty. This is relatively higher in the rural areas where 94% of rural inhabitants are energy poor. The intensity of the energy poverty at the national level is 68% which means that an average energy poor household is deprived of 68% of all indicators. Comparing rural and urban households, it can be seen that households in rural areas are deprived of an average of 73% of all indicators. This is lower in urban areas where on the average a household is deprived of 53%. The implication of this is that many households lack these basic necessities more in rural areas than in urban. It furthermore validates studies that rural households are the

most affected by energy poverty. It will be recalled that the MEPI cut off was set at 0.3, with a MEPI of 0.58; Nigeria has a moderate level of energy poverty. However, decomposing this to the urban and rural areas, the results show that with a MEPI of 0.35, energy poverty is moderate in urban areas. Energy poverty in rural Nigeria is very acute owing to a MEPI of 0.69 thus; alleviation policies and strategies should first begin in rural areas.

Energy Poverty at the Geopolitical Zone Level

It can be seen from the Figure 3, MEPI shows the degree of the energy poverty in each geopolitical-zone in Nigeria. The degree of energy poverty in the South West, South South, and South East is moderate. However, with an exception of the North Central zone, the degree of Energy poverty in Northern Nigeria is critical. This to an extent may reveal the wide gap in development between the South and North. Furthermore, it highlights the capability of the MEPI to be decomposed in order to show the figures for the components of a Nation thereby avoiding erroneous generalisation. To demonstrate this, it can be seen that the MEPI values for the North East far surpasses that of the Nation (Figure 3).

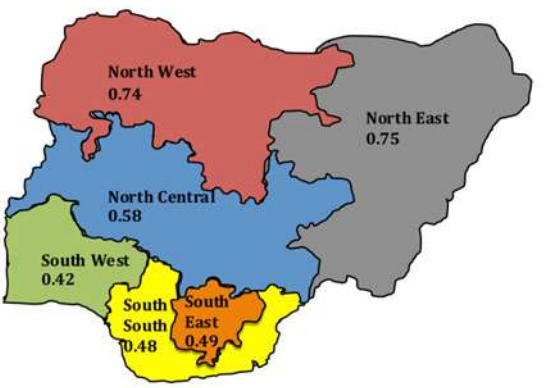

Figure 3: Map showing the MEPI of various Geopolitical zones of Nigeria.

Relationship between Energy Poverty and Security

There is a strong correlation between energy poverty and the security challenges currently being faced in the country. Figure 4 shows data collated by Raleigh [16] and reported on the BBC [17] about the incidence of insecurity caused by Boko Haram attacks for the years 2012–January 2015. As the figure shows, the epicentre of these attacks is the northeast of the country and this coincides with the fact that the region has the highest poverty as evidenced by its MEPI of 0.75.

Poverty has been fingered as one of the underlying causes of the conflict, whereby poor, unemployed and vulnerable youths are recruited to the ranks of the militants. As energy poverty is a major aspect of poverty as a whole, tacking energy poverty is a sure route to addressing the conflict and security challenges. Energy poverty not only affects people's

access to education and enlightenment through the mass media, it also hinders efforts to combat the security problems. For example lack of steady electricity can mean round the clock CCTV monitoring is not possible. The role renewable energy can play is therefore invaluable.

Potential of Renewables

As Nigeria's power demand is expected to rise at an average annual increase of 8.2%, it has become evident that frequent disruption of gas supplies to the gas fired generation plants cannot keep up with this demand [18]. This may not augur well if energy poverty is to be overcome. Renewable energy has therefore been identified as an alternative source that can alleviate energy poverty in Nigeria. This is due to its likelihood to solve the nation's huge economic and industrial challenges and its possibility of attracting foreign investors.

In the amended draft Energy Policy Document, data from the Energy commission of Nigeria shows that the average daily solar radiation ranges from 3.5 kWh/m^2-day in the coastal belt of the south to 7.0 kWh/m^2-day in the North for 4–9 hours daily all year round [19]. This is probably one of the highest in the World. In terms of wind energy, there is also an appreciable amount, and analysis of the patterns suggests an average of 1 – 5 m/s wind speed at 10 m height. Despite the peak months occurring between April and August, there is huge potential to generate between 8 and 51 MWh/yr alone from wind.

As a result, solar and wind energy can potentially lift Nigeria and indeed the country's northeast out of energy poverty if the abundant resources are exploited. Indeed the Draft National Renewable Energy and Energy Efficiency Policy document projected that 30,000 MW can be generated from renewables alone as compared to the total 4,000 MW currently generated from all sources. Therefore, concerted effort and organisation by the government and private sector is required to achieve this goal.

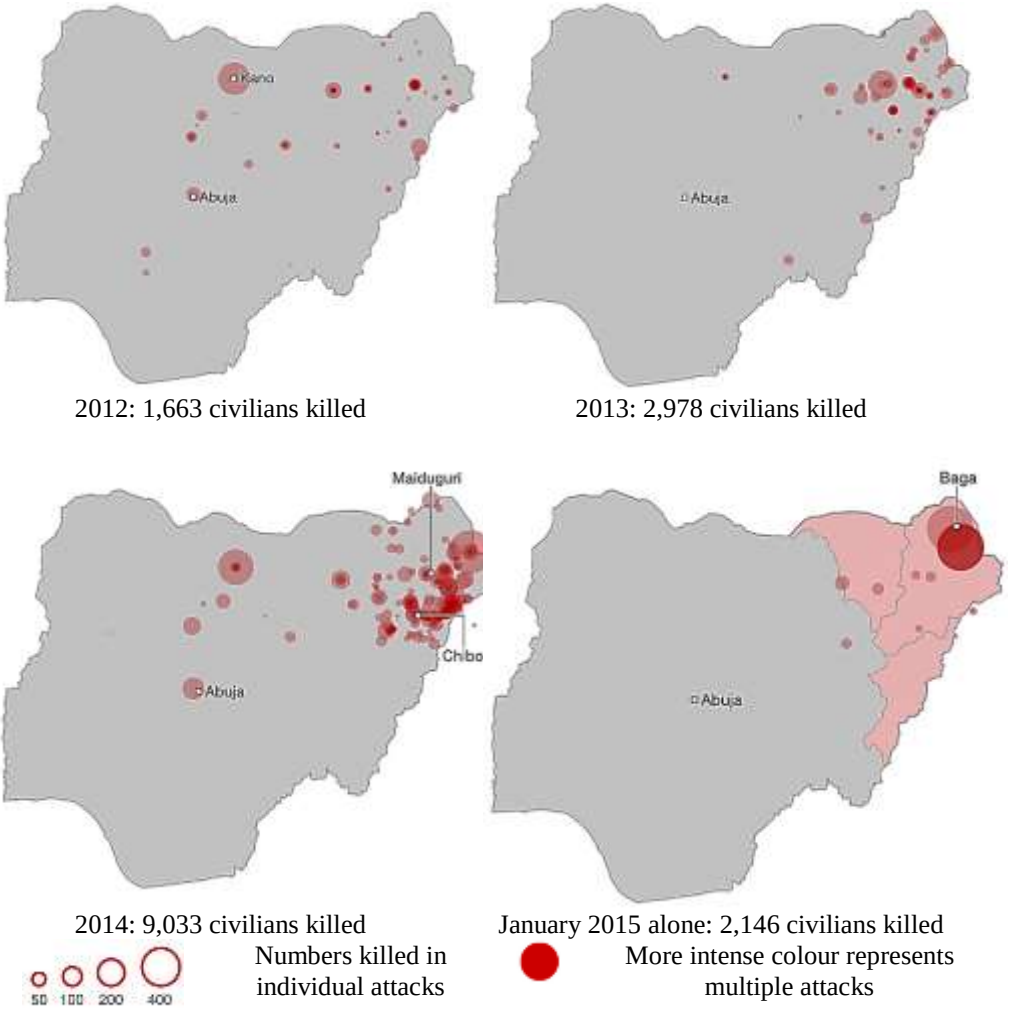

Figure 4: Terrorist attacks in Nigeria 2012-2015 (Source: Source: Raleigh [19]; BBC [20]).

IV. Conclusions

Developing countries have long been identified to be at the receiving end of energy poverty. Several performance metrics have been used by the WHO, UNDP and other organisations to quantify what the WEF calls "the worse type of poverty". In this study, Multidimensional Energy Poverty Index, MEPI developed by Oxford Poverty and Human Development Initiative (OPHI) on Multidimensional Poverty Index (MPI) was used to study the incidence of energy poverty in the various states and geopolitical regions of Nigeria. The secondary data used was that of the Demographic Health Service of the United States Agency for International Development (USAID) which was obtained by way of interviews collated from over 7,000 and 37,000 respectively for the years 2003 and 2008. Calculated MEPI indices for the various regions of Nigeria show that the southwest had the least incidence of energy poverty

while the northeast had the highest. Energy poverty in the northeast region is characterised by deprivation of access to basic modern energy sources such as electricity, petrol, and cooking gas. Energy inefficiency and indoor pollution are predominant. Recent social and security challenges in the northeast of the country have been shown to have a strong correlation with poverty and indeed energy poverty, with the vast majority of attacks occurring in this geopolitical region. As a result, renewables such as solar and wind energies abundant in northeast Nigeria have been identified as having huge potential to ending energy poverty and hence may be alternatives for arresting the current security challenges.

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