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Rural household fuel energy transition: Evidence from Giwa LGA Kaduna State, Nigeria

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ABSTRACT

Rural household access to clean and affordable modern energy is critical to improving living standards in developing countries. Rural households in northern Nigeria in particular, are almost entirely dependent on fuelwood for their basic cooking needs. This has adverse effects on households' health, their productivity and environmental degradation. This paper analyzes the effect of households' socio-economic characteristics on choice of cooking fuel. A multinomial logit (MNL) model was used to estimate the determinants of fuel choice in Giwa Local Government Area of Kaduna State, Nigeria. Data analysis shows that the patterns of fuel usage are consistent with the 'energy stacking' theory as fuelwood are often used alongside modern fuels, and majority of the households depend largely on fuelwood as its principal cooking fuel. Modern fuels thus have failed to displace traditional fuelwood. Empirical results of MNL model shows that household head's age, educational attainment, household size, income, type of dwelling unit, the duration of food cooked and price of fuelwood are statistically significant factors influencing households' choice of cooking fuel. Implications for regional and national fuel policies are discussed.

Introduction

Access to clean, sustainable, modern, affordable and reliable energy services is an enormous challenge facing the African continent, particularly Nigeria. Energy plays a vital role in a nation's economic growth, progress and development. It is vital for socio-economic and human development as well as for poverty eradication (Eleri et al., 2012; Oyedepo, 2012). In spite of Nigeria's position as the sixth largest petroleum oil exporting nation and a leading gas exporter, the nation suffers enormous energy crisis with only about 40% of the nations' population of about 160 million people connected to the national electricity grid (Omokaro, 2008). The grid is plagued by frequent outages that last for as long as 20 h daily in places that are connected to the grid. Nigeria's current available electricity generating capacity is about 3920 MW with per capita power capacity of 28.57 W which is grossly inadequate for domestic household consumption (Ibidapo-Obe and Ajibola, 2011). Currently, 15.3 million households lack access to electricity, per capita electricity consumption has been less than 150 kWh per annum (World Bank, 2011). The North and South energy access divide is widely acknowledged. For instance, in Lagos (Southern Nigeria), almost all 1.7 million households are connected to the national grid, while only over a million households are connected in Kano (Northern Nigeria) (Eleri et al., 2012).

Energy poverty in Nigeria goes beyond lack of access to electricity. In 2006, fossil fuels made up of 94% of export from Nigeria with only a tiny fraction available for domestic use (Vincent-Akpu, 2012). An estimated 72% of Nigerians depend solely on fuelwood as cooking energy source (NBS/CBN/NCC, 2011). The major energy consuming activities in Nigeria's households are cooking, lighting and use of electrical appliances (Energy Commission of Nigeria, 2005). The energy consumption mix is dominated by fuelwood (50.45%) while the share of petroleum products and hydroelectricity is 41.28% and 8% respectively (Omokaro, 2008). However, over 90% of households in northern Nigeria where deforestation and desertification are most prevalent and threatening the livelihood of inhabitants still depend on fuelwood for cooking, using the traditional "three stone fires". While most households in Nigeria still collect wood for their cooking, some especially in the wood deficient northern Nigeria tend to buy wood (NBS/CBN/NCC, 2011). Fuelwood is increasingly commercialized as an energy source, with about 38% of households in Nigeria buying fuelwood from the market (Eleri et al., 2012). More households in the South use kerosene for cooking than in the North. Per capita LPG use in Nigeria is one of the lowest in Africa despite being one of the World's leading exporters of natural gas (NBS/CBN/NCC, 2011).

Today, more households are climbing down the energy ladder — moving from electricity, gas and kerosene to fuelwood and other traditional biomass (Eleri et al., 2012), and with the astronomical rise in the prices of modern fuel and the increasing level of poverty in Nigeria, the fuel choices of many of the nation's agricultural population

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and some of rural poor households remain largely the utilization of unprocessed fuelwood (Fawehinmi and Oyerinde, 2002). The high dependence and utilization of wood for energy generation, with an estimated 27.5 million kg per day consumption have contributed to deforestation of hundreds of hectares of woodland, loss of biodiversity, soil degradation and greenhouse gas emission, resulting in desertification throughout Sub-Saharan Africa and especially in the rural areas of Nigeria (Amaewhule, undated).

The growing energy poverty in Nigeria can also be strongly linked to a lack of energy law. Although a number of policy initiatives do exist (such as National Energy Policy 2003; National Policy Guidelines on Renewable Electricity 2006; Renewable Energy Master Plan 2005; National Energy Master Plan 2006), government commitment to effective implementation is lacking. The lack of energy law has reduced investors' confidence on these policies. The lack of institutions with clear vision and resources to champion universal access to both power and cooking energy for the poor and inadequate access to finance are major constraints; households and SMEs lack financial products to enable them to acquire pro-poor energy services such as clean biomass cook stoves, LPG and solar lanterns. There are also no clear service delivery models for public support for expanding access to energy services (Eleri et al., 2012).

For a developing nation like Nigeria, owing to its energy crisis, issues relating to energy choices and household energy transitions are important from a policy standpoint. The choice of domestic cooking fuel in rural household in Nigeria is an issue for addressing deforestation and health hazards resulting from indoor pollution. Efforts at encouraging households to make substitutions or transitions that will result in more efficient energy use and less adverse environmental, social and health impacts are encouraged. Therefore analysis of the factors determining energy choices and use pattern in rural households in Nigeria are necessary as a first step. In the light of these facts, this study seeks to investigate the different cooking fuel choices available to rural households in Giwa Local Government Area of Kaduna State, Nigeria, and analyze the determinants of the behavior of rural household fuel choice.

The rest of the paper is organized as follows: The next section discusses the theoretical and conceptual framework, followed by the research materials and methods (the description of the study area and empirical model for the study). The empirical results and discussion are presented thereafter followed by conclusions and implications for energy policy.

Theoretical and conceptual framework

The theory of household fuel energy choice is often based on the on the "energy ladder" model (Heltberg, 2003) and the associated fuel switching. This model placed more emphasis on household income and relative fuel prices as the basis for fuel choice (Barnes and Floor, 1999; Barnes et al., 2005). Based on household income, the energy ladder model depicts a linear three-stage switching process. The first stage involves a heavy reliance on centuries old biomass fuels, while in the second stage household moves to "transition" fuels involving the use of kerosene, coal and charcoal, and in the third stage, they switch to the use of LPG, natural gas or electricity which is a function of increased household income, and other factors such as deforestation and urbanization (Inayatullah et al., 2011).

However, the simple nature of the energy ladder model placing emphasis on income wealth and substitution as a determinant of household fuel choice has been criticized by many studies (Heltberg, 2003; Masera et al., 2000; UNDP/ESMAP, 2003) for its assumption that as household income increases, the household discards the consumption of traditional fuels for the use of modern clean fuels which they can afford. These studies have shown that households often do not fully ascend the "energy ladder" but rather 'fuel stack', which means that with an increase in income, traditional fuels are not completely discarded, but are rather used in conjunction with modern clean fuels. There is also growing evidence in literature that other than household income, the distance of the household from biomass sources (Hyde and Kohlin, 2000; Pachauri, 2004) increased fuelwood availability (Narain et al., 2008), and fuelwood shortages as a result of deforestation (Veld et al., 2006) may also be an important factor influencing household fuel choices.

Nonetheless, there are exceptions that need to be considered from the 'energy ladder' model. In rural areas of many developing countries, a large proportion of middle-income households who could in principle afford modern and convenient form of fuels continue to rely fully or partly on traditional biomass fuels (Heltberg, 2003). A number of factors such as age, family size, level of education of household head, type of food cooked and taste of food cooked with fuelwood, whether or not the household owns the dwelling units are important factors that determine household cooking fuel choice (Osiolo, 2009; Pundo and Fraser, 2006). It therefore suggests that income, although very important, is not the only determinant of household cooking energy source. Many other factors both on the demand and supply sides are now considered (Inayatullah et al., 2011). Household energy source is now explained as a portfolio choice rather than as a ladder process (Osiolo, 2009).

Therefore, modeling households' fuel energy choice is considered under the general framework of consumer theory (Lancaster, 1966; Rosen, 1974), which suggests that consumers derive utility not from a commodity but from the attributes embedded in a commodity. Information at households' disposal about the various fuels influences their decisions which are driven by households' economic and non-economic constraints. The economic factors may include availability and market price of fuel, household income and expenditure, while the non-economic factors may include socio-economic characteristics such as household size, age, gender, house ownership, type of dwelling, location of residence, distance to fuel source, and access to electricity (Osiolo, 2009). This study follows evidence from literature that households choose fuel based on bundles of household socio-economic, income and agro-ecological characteristics (Heltberg, 2004; Jumbe and Angelsen, 2011; Masera et al., 2000; Osiolo, 2009; Pundo and Fraser, 2006).

In this study, it is assumed that a household faces a choice among alternative fuel types, the individual household is assumed to consider the full set of offered alternative fuel types in a choice situation and has to choose the alternative that maximizes utility (Hensher et al., 2005). Consider a households' choice of a fuel type and assume that utility depends on the choice made from a set (C) i.e. the choice set that includes all the possible fuel alternatives. Thus, a household is assumed to have a utility:

$$U_{ij} = Q\left(Z_j, S_i\right) + \varepsilon\left(Z_j S_i\right) \tag{1}$$

where for any household i, a given level of utility will be associated with any alternative fuel choice j. The utility derived from any alternative fuel type depends on the attributes (Z) of the fuel type and other socio-economic and agro-ecological factors affecting households' decision. Choice made among the alternative fuel types will be a function of the probability that the utility associated with a particular option (j) is higher than that associated with another alternative fuel types. The statistical model of probability P_{ij} that alternative j is chosen by household i is given by

$$P_{ij} = prob\left(U_{ij} > U_{ia}\right); \quad a = 1, 2, 3 \ldots\ldots j; a \neq j. \tag{2}$$

Thus if the ith household selects fuel type j, then U_{ij} is the highest utility obtainable from among the j possible choices.