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INTRODUCTION

Energy plays an essential role in human lives and it is paramount for a country's economic growth and development (Esen and Bayrak, 2017). This is because it facilitates productive activities which further enhances investment in economic activities such as agriculture, industries among others. This ultimately reduces poverty level, promotes sustainable economy and human development (Akinola, *et al.*, 2017). In addition, the energy required to meet the needs of households are referred to as household energy, and they are used for variety of purposes such as for lighting, heating, cooking and so on. Malla *et al.*, (2014) reported that about 2.5 billion people the world over depend on traditional biomass fuels (wood, charcoal, agricultural waste, and animal dung), while about 400 million people use coal. The majority of households in sub-Saharan Africa – some 700 million people – rely on traditional biomass for cooking, whilst it continues to decrease in other regions (Lambe *et al.*, 2015). Efforts to bring modern energy access to all – electricity and clean fuels – are far outpaced by population growth. Which is why the National Research Council concluded guardedly that, “slower population growth would be beneficial to economic development for most developing countries” (Mazur, 1994).

Energy consumption per capita of a country as opined by Esan and Bayrak, (2017), is regarded as an important indicator of economic development. Studies have also attempted to classify energy into different forms such as primary and secondary energy (Adetunji *et al.*, 2007), solid and non-solid energy (Emagbetere *et al.*, 2016) among others. This paper attempt to review existing literature by conceptualising household energy dynamics using the energy ladder concept. It is expected that the paper will provide reasons for household energy transition in the context of the energy ladder concept in order to enhance policy design and interventions that will improve the quality of lives of households in Nigeria and similar other developing world nations.

Population Characteristics in Developing Countries

The world's population according to the United Nations (2005); UNEP (2009), was said to be growing by around 78 million people per year, for the most part in Asia and Africa. In many countries experiencing rapidly growing population, and thus growing dependency ratio, the influx of young people into the job market exceeded jobs created, but not fast enough to march the rapid growth in the labour force (UNDP, 1996; Cincotta and Engelman, 1997). In addition, high fertility and population growth appear to promote the transition of poverty across generations, while simultaneously widening the gaps in income and health status separating the poor from the upper and middle classes (Ahlburg, 1996; Cincotta and Engelman, 1997). At the same time, developed regions such as Europe are facing a growth close to zero, relying mainly on immigration for a positive population growth (UNEP, 2009). In the developed regions, the ageing population has become a primary cause for concern.

Providing for the needs of the ageing population and the increasing incidence of age-related illnesses creates important challenges for various areas of public policy, such as health, social security and housing. In many developing countries, an ageing population is a trend that takes place simultaneously with the disintegration of the extended family system that has traditionally provided support to the elderly. This makes the challenge even more complex.

In Africa, as in many other developing regions (see for example, Fuligni, 1999; Carapas, 2011; Mokomane, 2012) the extended family is a long established institution which provides its members with sophisticated social security system, an economic support to meet their basic needs for food, shelter, and clothing, and a wide circle of relatives on whom to fall back in times of crisis, unemployment, sickness, poverty, old age, and bereavement (African Union, 2004; Mokomane, 2012). Furthermore, examples of developing countries include Indonesia, Brazil, and almost all African countries. Also, some other developing world nations' peculiar characteristics are discussed below:

1. **Low per Capita Real Income.** Annual income in developing countries is not as high as in developed countries due to the high unemployment rate. Also many of the economies are mono products based, with the incessant price fluctuations due to market driven demands. There is a very urgent need for economic development in the underdeveloped or developing countries. Economic development is needed so that living standards of their people may be raised. The wealthiest nation in Africa according to the World Bank is oil-rich Equatorial Guinea, with a GDP per capita of over USD 30,000, yet less than half the population has access to clean water, and two-thirds of the population live in slums (World Bank, 2016).
2. **Security Not Guaranteed.** Unlike in developed countries, security in developing countries is still very minimal and inappropriate. Therefore, crime rates in developed countries are still relatively high. Unless the poor countries are enabled to share the general prosperity in the developed world, their condition will become more and more difficult. It is this relative difference between the rich developed and poor developing countries which will make the poor countries discontented. Ever-increasing discontent in the poor countries is bound, sooner or later, to aggravate the already explosive situation in the world.
3. **Minimal Health Facilities.** Health facilities in developing countries are also relatively minimal. The lack of proper health facilities makes the population in developing countries more vulnerable to disease. Therefore, the mortality rate in developing countries is also greater than the mortality rate in developed countries, which then results in a low life expectancy.
4. **High Population Growth Rate.** Developing countries have a very large average population compared to developed countries because of uncontrolled population development. This is also a result of the inadequacies in the provision and access to education and health care facilities.
5. **High Unemployment Rate.** In developing countries, the unemployment rate is still relatively high because the available job vacancies are not evenly distributed. In addition, the level of uneven education is also one of the factors causing the large unemployment rate.

6. Imports are higher than exports. Due to the low management of natural resources and human resources, low capital investments into high employment generating manufacturing jobs in developing countries, developing countries more often depends heavily on imports of food, goods and services from abroad, while also over relying on the export of primary commodities lacking genuine efforts to value addition.

Pattern of Population Growth

The age structure of a population affects a nation's key socio-economic issues (Olorunfemi *et al.*, 2015). Countries with young population (high percentage of under 15), such as Nigeria, Angola and India need to invest more on educational facilities, while developed countries like Japan, U.S.A, among others with older populations (high percentage ages 60 and above) need to invest more in the health sector, because the risk of health problems rises precipitously in very old age (Adebayo, 2006). There are basic classifications used by scholars which are mostly intuitive. However, for the purpose of this write up, four typical patterns for population growth are used, and these are: rapidly expanding, expanding, stationary and contracting (See Figure 1).

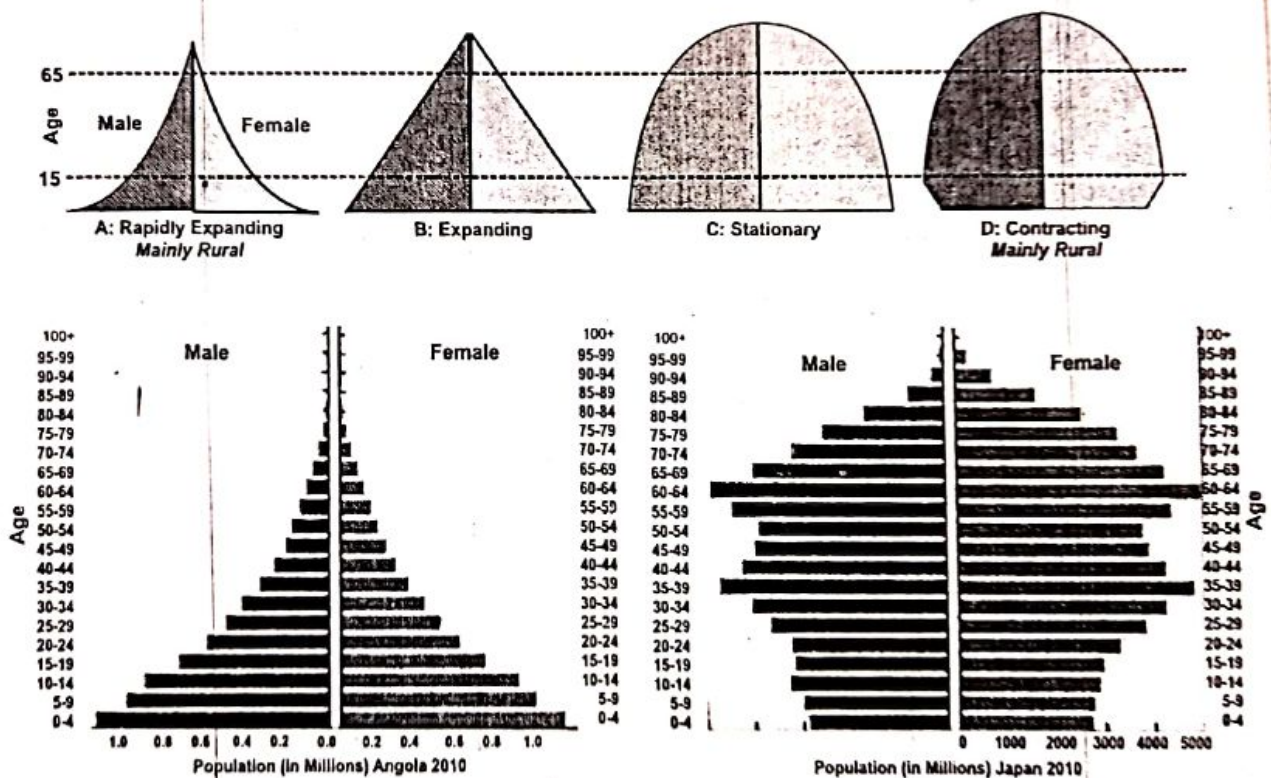


Figure 1: Typical patterns for population growth

Source: https://images.flatworldknowledge.com/berglee/berglee-fig01_025.jpg

Rapidly Expanding Growth: big base also known as 'the Christmas tree'

This depicts populations that have a larger percentage of people in younger age groups. Populations here usually have high fertility rates with lower life expectancies, as depicted by many third world countries. Population in this stage are highly fluctuating, with wide bases and narrow tops. According to the above graphs, India, Indonesia, Nigeria, Mexico, Brazil, Bangladesh, and Pakistan will continue to grow their populations at a rapid pace. Nigeria is growing at a particularly fast rate, and by 2060 it will displace the United States as the third-largest country in the world by population.

Presently, Nigeria experiences high population growth rate of about 3 percent, with almost 60 percent of her population below the age of 30 (Ifabiyi, 2017). Angola is also India's population as shown in the pyramid reflects that there too many young people, and workforce will surely continue to rise. It is also observed that gender ratio will likely be skewed towards more males than females.

Expanding or Slow growth: also referred to as 'the Box'

The United States stands out here as the only country in the top 10 experiencing tempered growth. The structure of the U.S. population depicted by the population pyramid reveals a nation with as many young people as there are old. Here the natural population growth rate is negative, especially due to loss of population over time. An example of the Japanese scenario. A need to maintain population pyramid is a must, necessitating an overhaul of immigration politics and policies.

Stationary or Negative growth:

also known as (The Cup' as a result of loss of population).

This type of population pyramid shows a somewhat equal proportion of the population in each age group, with no decrease or increase in population, rather it is stable. China, because of its One-Child Policy from 1979 to 2015, is not a surprise to see here. While reviewing the results of the seventh National Population Census in China in 2020, the national population was around 1,411.78 million people, around 7.45 million people more than former estimates by the IMF for the year. Germany is another example here, with her total population slightly above 83 million inhabitants by 2020, which makes her the second-most populous country in Europe after Russia and the 16th –most populous country in the world. About 23% of her population being 65 years and over. However, Russia may be an intriguing mention in this category for many – the country has a low birth rate, a low immigration rate, and an unusually high death rate.

In fact, Russia's death rate is 15 people per 1,000 – almost twice that of the U.S. due to a high amount of alcohol-related deaths and emergencies. Elagina, (2021) posited that the Russian population decreased by approximately 500 thousand between 2020 and 2021, with over 146.2 million residents of the Russian territory.

Contracting: mainly found in the country side and in rural Japan.

Energy and Population Transition

Energy transition is the issue of striving to use more environmentally friendly energy sources other than fossil fuels (Taghizadeh-Hesary and Rasoulinezhad, 2020). It is also the pathway for transforming the global energy sector from fossil-based to zero-carbon by the second half of the century (IRENA, 2017); and this has created crucial debates amongst scholars. Scholar such as Saidi and Hannam (2015), Kaberger (2018), Rasoulinezhad and Jabalameli (2019), Diaz *et al.*, (2019) and Taghizadeh-Hesary and Rasoulinezhad, (2020) have all argued that replacing fossil fuels with renewable energy for electricity generation and other economic purposes is long overdue.

Growth in the population, opined by Alimi and Mesagan (2018), will increase energy consumption (energy demand) leading to an increase in energy prices and vice versa. In 1900, 15% of a global population of 1.5 billion people were reported to live in cities (Girardet, 2018). Since 2008, cities host more than 50% of the inhabitants of the planet with the share expected to increase up to 67% by 2050 (Rosenzweig *et al.*, 2010; UN-HABITAT, 2012). Besides, longer distances between the origin of fossil fuels (energy exporters) and the importers' countries will result higher transportation costs and higher carbon dioxide (CO₂) emissions. In addition, Spencer and Mathur (2019), also expressed that emerging and developing nations with a lower income levels need to link decarbonisation policies (manage and lower CO₂ emissions) with their energy transition process.

The Energy Ladder Concept

The energy ladder was first conceptualized by a renowned American IAP researcher Kirk Smith and was introduced to the World Health Organization as early as 1990. The concept portrays an understanding of how domestic energy use changes as countries become wealthier. *It also depict how household energy and development are inextricably linked.* According to Van der Kroon, *et al.* (2013), energy ladder concept (Seen in Figure 2) is mostly used to understand household energy consumption. The theoretical assumption underlying the energy ladder hypothesis is that improvement in energy use correlates with an increase in the household income.

In other words, the concept assumes that low living standards induce greater dependence on lower quality fuels due to combination of income and substitution effects (Baland, *et al.*, 2007). Thus, the main notion of energy ladder concept is that increase in income makes households to shift upwards along an invisible ladder to the use of modern energy sources that are of higher and cleaner quality (Kowsari and Zerriffi, 2011). As seen in Figure 2, the energy ladder diagram depicts that household with lower level of income tend to be at the bottom rung of the ladder.

These households' make use of energy sources such as biomass fuels, crop waste, dung, wood, leaves, and coal which are cheap, unclean and locally available (Hosier and Dowd, 1987). As income increases, households in transition (that is, those at the middle rung of the ladder) consume transition fuels such as charcoal and kerosene, while higher income households (households at the top of the rung) consume energy that is cleaner and more expensive such as LPG, natural gas, or electricity (Heltberg, 2005).

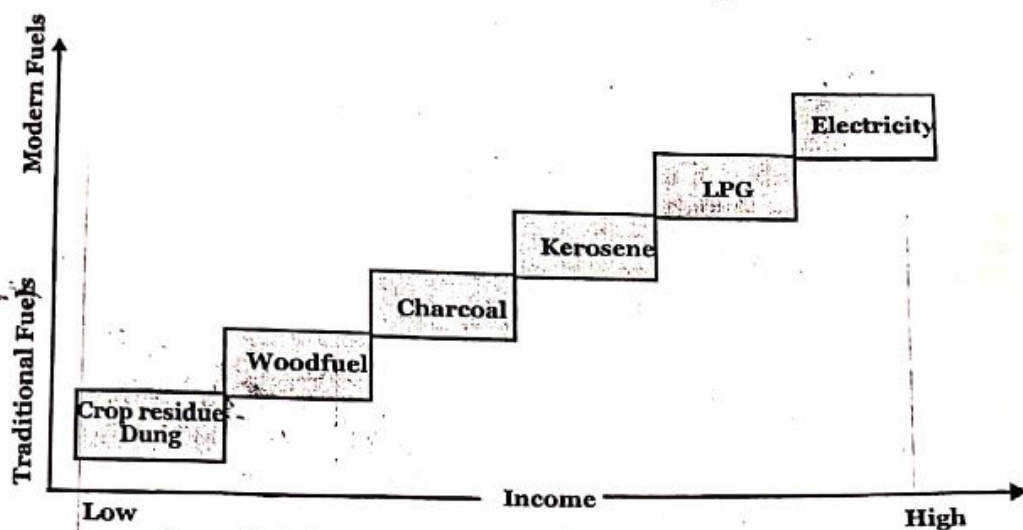


Figure 2: Schematic illustration of energy ladder hypothesis
Source: Leach, (1992).

Studies across the globe such as Rajmohan and Weerahewa, (2007); Brew-Hammond, (2010); Peng *et al.*, (2010); and Kayode, (2016) among others have examined the energy ladder hypothesis with regards to household energy consumption. Similarly, in Nigeria, numerous studies (Abd'razack, *et al.*, 2012; Baiyegunhi and Hassan, 2014) on energy ladder concept have also been embarked upon. Many of these studies tend to agree that income is the major factor determining household energy demand particularly household uptake of modern fuels. For instance, Ouedraogo (2006) investigated urban household energy consumption pattern in Burkina Faso, the result showed that households tend to choose natural gas over kerosene as income rises. Similarly, Baiyegunhi and Hassan (2014) observed in rural Nigeria that the transition from fuel wood to kerosene, natural gas and electricity occurs with increase in income. Thus, there is a positive relationship between income and modern fuel uptake.

Contrarily, several studies believed that economic factors are not the only determinants of household's fuel choice. Other factors such as socio-demographic factors (education and gender of the household heads), cultural or habitual factors, fuel availability, household composition, population, climatic variables, tradition and urbanization are also important factors (Farsi *et al.*, 2007; Toole, 2015; Bisu *et al.*, 2016). For instance, the study by Gupta and Kohlin (2006) sees 'availability' and 'ease of use' as very important factors to consider in fuel choice. In addition, in their study in Bauchi metropolis, Nigeria, Bisu *et al.*, (2016) included change in household size, dwelling ownership status and location, change in season, income, educational levels, availability, and affordability are factors that affected household cooking energy choices.

However, the energy ladder concept has been criticized for being unable to show actual energy consumption dynamics due to several other social and economic factors (Foster, 2000; Masera, 2000). Hence, studies such as Mekonnen and Kohlin (2009), has observed that households in developing countries do not move up the ladder as income rises, rather, they combine different fuels as sources of energy.

Therefore, the review of empirical studies have shown that the switch to a new fuel (modern energy sources) does not necessarily result in a simultaneous stoppage of previously used fuels as implied by the energy ladder concept. For example, Taylor *et al.*, (2011) reported that in spite of the ownership of LPG stoves amidst the migrant households in Guatemala, 77% made use of fuel wood as their primary form of fuel. This act is referred to as fuel stacking and it mostly occur in households of developing countries. Thus, Masera *et al.*, (2000) defined fuel stacking as the use of multiple fuel from both lower and upper levels of the ladder for a particular purpose in order to provide households greater energy security in the face of uncertain and volatile supply, prices, or incomes.

Relevance of Energy Ladder Concept to Nigerian Population

Nigeria as a country is endowed with both human and natural resources. However, the level of poverty and inequality is increasing daily due to high level of corruption, bad governance among others. The United Nations Development Programme (UNDP, 2009) reported that about 65 percent of the Nigeria population are living below US\$1.25 per day. This figure confirmed that Nigerians are living below the poverty line. Similarly, the level of corruption is so high to the extent that the country is ranked among top in the list of corrupted countries (Transparency International, 2012). Corruption has also manoeuvred its way into many sectors of the country including the energy sector as there have been cases of increasing cost and irregular supply of fossil fuels.

This confirmed the UNDP (2005) report that most of the countries involved in the MDG programme failed to take into consideration the energy requirements of their poor. This is reflected in the energy poverty experienced in recent times by many developing countries including Nigeria (Scott, 2012). Thus, Olise and Nria-Dappa (2009) described the energy situation in Nigeria as more pathetic than has been revealed to the global world. They further emphasised the connections between poverty and energy on the basis of the household income ratio to their expenditure on energy. The study also revealed that the poorest households spend about 20-40 percent of the household's income on energy alone.

Comparatively, there is regional variation in energy consumption pattern in the country. The human poverty index (HPI) data revealed that poverty is more pronounced in the northern part of Nigeria (with the exclusion of FCT) as compared to the southern states which have better human development index (HDI). For instance, eight out of the top 10 states with the highest HDI, are in the south; and nine out of the bottom 10 states with the lowest HDI are in the north. Thus, it is not surprising that there is over dependence of the northern population on traditional fuelwood for their cooking.

Also, rapid socio-economic changes in some developing nations such as India and China according to Bhangale and Mondal (2011); Tandon *et al.*, (2011) have dramatically influenced global fuel consumption patterns. For instance, between 1990 and 2005 global final energy use increased by 23% while the associated CO₂ emissions rose by 25 % (IEA, 2008a). Also, manufacturing, household and transport sectors in 2005 accounted for 88% of global energy consumption (Orire and Tilakasiri, 2019). Nigeria is blessed with renewable energy sources such as biomass, wind and solar, as well as non-renewable sources like petroleum and natural gas.

Although, majority of the people rely on the traditional fuel (fuelwood) for their cooking (Sambo, 2008a). The dependence on fuelwood in the country can be credited to its availability and affordability when compared to other sources of energy (Maconachie *et al.*, 2009). In contrast, Sambo (2008a), attributed the reliance on fuelwood by the populace to population growth, low technical efficiency of the traditional cooking style and lack of adoption of other sustainable cooking methods. Note that population growth also exacerbates energy demand with resultant seasonal price fluctuations and vice versa (Alimi and Mesagan (2018). The electricity supply in the country is erratic and unreliable that people now depend on power generators to meet their energy demands. Opara (2013), reported that the country managed to generate 5,000 megawatts (MW) of electricity for its population in 2012, as compared to at least 40,000 MW, which is required to sustain the basic needs of the population. This figure indicated that Nigeria produces far less than Africa and the world average (Sambo, 2008b; Sambo, 2009; Research and Markets, 2011). Thus, the reason for the over dependence of the population on traditional fuelwood for their cooking (Maconachie *et al.*, 2009).

Furthermore, in another study by Naibbi and Healey (2013), the spatial variation in the distribution of fossil fuel in Nigeria was equally revealed. Through their analysis, the South-West zone received the highest supply at 41.54%, followed by the South-South zone with 23.87%. The North-West, which has the highest population in the country, only received 5.92% of the total supply, while the North-East and South-East zones received the lowest supply. The Federal Capital Territory, having the smallest population, received 4.91%. Additionally, Naibbi and Healey (2013) study further revealed variations in the supply patterns of fossil fuels which was disaggregated by modern cooking fuel type. In terms of the percentage share of the Household Kerosene (HHK) supply between the various states in Nigeria, Kaduna in the north; Lagos, Edo, Delta and Rivers States all in the south and the FCT received a large supply of HHK. The differences in the supply pattern of HHK matches the disparity in the consumption pattern of fuelwood in the various states. In other words, areas with lesser supply of modern fuel, consumes more fuelwood and vice versa.

Generally, the review of empirical studies have shown that the usage of different cooking fuel types among households in Nigeria indicated that more fuelwood is being used for cooking than any other fuel type especially in the north. Although, the difference between the rich and the poor in Nigeria in terms of fuelwood usage is negligible particularly in the northern states, where even the affluent families have to rely on fuelwood for domestic cooking due to the shortage of modern fuel supply (Maconachie *et al.*, 2009). For instance, about 86% of households still depend on fuel wood as their source of energy (Oyedepo, 2012; Bisu *et al.*, 2016). Similarly, solar energy is the least popular form of energy. However, kerosene which is the second most important fuel after fuelwood (in terms of usage among households) dominates the southern parts of the country, particularly in the southern states of Lagos, Oyo, Rivers and Ogun where the use of kerosene surpasses any other cooking fuel types, regardless of its surging pump price over time. Studies like Adelekan *et al.*, (2006); Kowsari and Zerriffi, (2011); and Sovacool, (2011) have also shown that the use of fuel wood is largely found in lower income families in the developing countries. In addition, there seems to be little/no regional variation in terms of the transition from the use of traditional fuel (fuelwood) to the use of modern cooking fuels.

The reason for this limited variation may probably be due to the high prices and unreliability in the supply of modern cooking fuels. Hence, a contrast to the energy ladder concept that assumes ready availability and uniform supply of all fuel types, so households can choose their cooking fuel based on their income levels (Kowsari & Zeriffi, 2011).

However, the choice of fuel type in Nigeria is a matter of availability and reliability in supply of fuels and not income as assumed by the energy ladder concept. From the foregoing, it is obvious that Nigerians are not moving up the energy ladder, rather, they are ascending it and in some cases, making use of multiple fuel types (fuel stacking) at the same time. In conclusion, efforts have been made in this paper in reviewing some existing empirical findings on the population-energy concept, population characteristics and growth pattern with emphasis on developing world nations as well as the relevance of energy ladder concept to Nigerians with emphasis on household energy transition.

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