

**SPATIAL EXPLORATION AND ANALYSIS OF ELECTRICITY POVERTY:
A CASE STUDY OF IBADAN, SOUTHWESTERN, NIGERIA**

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by

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ABSTRACT

Energy poverty is a global phenomenon, with varying intensity across countries. Electricity is unarguably an important source of energy essential in satisfying the demand for modern energy services for socio-economic well-being, households' productivity and economic development of a nation. Despite the abundance of energy resources in Nigeria, an estimated 113 million people, representing about 70 per cent of the population, lack access to electricity, while the remaining 30 per cent have only intermittent and unreliable access. The thesis identifies and examines the causes and consequences of energy poverty and the role of energy (specifically electricity) in poverty reduction and as an engine of households' economic growth and prosperity. The study provides a pragmatic methodology of Geographic Information System (GIS) as an interface between development studies and energy geography. The thesis contributes to energy geography and resource management based on the deprivation experienced by households attributable to the failure of the public energy service delivery system. The poor reliability of the grid-based system has created an "energy services gap" that is met by alternative costly backup off grid-solution of self-generation of electricity. The use of generators in most households is now the mainstay of electricity provision and has become the electricity provider, while the electricity provider is now standby. Households are consequently climbing down the energy ladder because electricity that is at the top of the ladder is not always available. The socio-economic suppression, depression and deprivation along with the financial burden on households' income are the bane of energy poverty in the study area. The study establishes that access is not the problem in an urban area in Nigeria but the inadequacy and unreliability of electricity supply in substantial quantity and reliable quality. To promote living and economic growth, it is desirable that households have secure and affordable electricity.

DEDICATION

This thesis is dedicated to the Trinity (God the Father, the Son and the Holy Spirit) that made my heart desire a reality. Lord, receive my praises and thanksgiving from a grateful heart.

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My profound gratitude goes to the Almighty God, the owner and giver of life, wisdom, knowledge and understanding that made my desire, dreams and visions a reality. I acknowledge your sovereignty O LORD; for in YOU, I live, move and have my existence Acts 17:28. To God alone is the glory for granting the mercy, grace and strength to complete this study.

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ABBREVIATIONS AND ACRONYMS

AfDB	Africa Development Bank
AGECC	Advisory Group on Energy and Climate Change
AGO	Automotive Gas Oil
BP	British Petroleum
BPE	Bureau for Public Enterprises
CBN	Central Bank of Nigeria
CMD	Centre for Management Development
DC	Direct Connection
DECC	Department of Energy and Climate Change
DFID	Department for International Development
EAPN	European Anti-Poverty Network
ECN	Energy Commission of Nigeria
ECN	Electricity Corporation of Nigeria
ECOWAS	Economic Community of West African States
EDI	Energy Development Index
EFA	Education for All
EFIA	Enhancing Financial Innovation and Access
EISD	Energy Indicators for Sustainable Development
EPI	Energy Poverty Index
EPSR	Electric Power Sector Reform
ESDA	Exploratory Spatial Data Analysis
ESMAP	Energy Sector Management Assistance Programme
ESI	Electricity Supply Industry
ESI	Energy Sustainability Index
ESRI	Environmental Systems Research Institute
EUB	Energy Utilities Board
EU	European Union
FG	Focus Groups
FGD	Focus Groups Discussion
GDI	Gross Domestic Income
GDP	Gross Domestic Product
GEA	Global Energy Assessment

GHG Greenhouse Gases
GI Geographic Information
GIS Geographic Information Systems
GNESD Global Network on Energy for Sustainable Development
GPS Global Positioning Systems
GRA Government Reservation Area
HDI Human Development Index
HDR Human Development Report
IAEA International Atomic Energy Agency
IBRD International Bank for Reconstruction and Development
ICEED International Centre for Energy, Environment and Development
IEA International Energy Agency
IIED International Institute for Environment and Development
IMF International Monetary Fund
IARC International Agency for Research on Cancer
IJAR International Journal of Academic Research
IPP Independent Power Producers
MAN Manufacturers Association of Nigeria
MW Megawatts
MEPI Multidimensional Energy Poverty Index
MD Maximum Demand
MDGs Millennium Development Goals
MYTO Multi-Year Tariff Order
NBS National Bureau of Statistics
NDA Niger Dam Authority
NDHS Nigeria Demographic and Health Survey
NEPA National Electric Power Authority
NEPP National Electric Power Policy
NESCO Nigeria Electricity Supply Company
NESI Nigerian Electricity Supply Industry
NERC Nigerian Electricity Regulatory Commission
NDPHC Niger Delta Power Holding Company
NPC National Population Commission
OECD Organisation for Economic Co-operation and Development

OPEC Organisation of the Petroleum Exporting Countries
OFID OPEC Fund for International Development
SPSS Statistical Package for the Social Scientist
SSA Sub-Sahara Africa
PCA Power Consumer Assembly
PHCN Power Holding Company of Nigeria
PMS Premium Motor Spirit
PPA Power Purchase Agreement
PWD Public Works Department
SEA Sustainable Energy Africa
UEMOA West African Economic and Monetary Union
UNCSD United Nations' Commission on Sustainable Development
UNCTAD United Nations Centre for Trade and Development
UNDP United Nations Development Programme
UNECA United Nations Economic Commission for Africa
UNESCAP United Nations Economic and Social Commission for Asia and the Pacific
UNESCO United Nations Education Scientific and Cultural Organisation
UNICEF United Nations Children's Fund
UNPF United Nations Population Fund
US United States
USAID United States Agency for International Development
USEIA United States Energy Information Administration
USTDA United States Trade and Development Agency
VAT Value Added Tax
WDI World Development Indicators
WEA World Energy Assessment
WEC World Energy Council, London
WEO World Energy Outlook
WHO World Health Organisation
WSSD World Summit on Sustainable Development

Currencies

Naira (₦) Nigerian Naira
US\$ United States Dollar

£ United Kingdom Pound Sterling

Units of measurement

US\$1 = ₦160

US\$1.6 = £1 (GBP)

W Watt

kW Kilowatt (1 kW = 1,000 W)

kWh Kilowatt-Hours

mb/d millions of barrels per day

tcf trillion cubic feet

tcm trillion cubic metres

CHAPTER ONE

INTRODUCTION

Energy is the golden thread that connects economic growth, increased social equity, and an environment that allows the world to thrive (Ban Ki-moon, 2012). Energy is fundamental to human life (Adams, 2010), a basic requirement of modern societies and an essential input for socio-economic development (Goldemberg et al., 2002). According to the International Energy Agency (IEA) (2011), modern energy services are crucial to human well-being and country's economic development. The United Nations Development Programme (UNDP) (2010) describes access to affordable modern energy services as fundamental to human activities; national development; economic growth and an essential component of poverty reduction. Countries fall into the vicious circle of poverty, social instability and underdevelopment when there is no adequate access to modern energy services (IEA, 2004).

Globally, over 1.3 billion out of the total world population (of over 7 billion) lack access to electricity (IEA, 2011). This figure represents about 20 per cent or one-fifth of the world's population. More than 95 per cent of these people are located in sub-Saharan Africa and Asia with 84 per cent in the rural areas. Five hundred and eighty-five million of them are located in sub-Saharan Africa, while six hundred and seventy-five million of them are located in Asia (IEA, 2011). Northern Africa has almost universal access (roughly 99 per cent), Latin America 93 per cent, eastern Asia and the Pacific 90 per cent, and the Middle East 89 per cent. Conversely, southern Asia has an electrification rate of 60 per cent, while sub-Saharan Africa has a rate only of around 29 per cent. Together, the southern Asian and sub-Saharan African populations without electricity account for 83 per cent of the total world population without electricity. Sub-Saharan Africa has by far the lowest urban and rural access rates, at 58 per cent and 12 per cent, respectively (UNDP/WHO, 2009). Africa accounts for over a sixth of the world's population with nearly 1 billion people, but generates only 4 per cent of global electricity, while three-quarters of the electricity generated in Africa is used by South Africa, Egypt and the other countries along the North African littoral (The Economist, 2007). Access to modern forms of energy continues to elude the majority of households (7 out of 10) in sub-Saharan Africa (SSA) and developing Asia (IEA, 2007; WEC, 2007). The lack of access to energy services hinders opportunities for economic development and improved living standards are constrained and closely linked to a range of social concerns, including poverty (UNDP, 2004).

1.2 Energy and the poor – Energy as a poverty issue

Poverty is one of the world's most fundamental issues that urgently need to be addressed. At present, there is a global attention. Moving people out of poverty informs the policy foundation of the Department for International Development (DFID). The concept of poverty does not have a universal and single definition given its multidimensional nature that extend beyond the economic arena to encompass factors such as the inability to participate in social and political life (Sen, 1985; 1989). Poverty has been conceptualised and defined either in economic terms (an income of less than US\$1 a day) or in social terms (lack of access to adequate levels of food, water, clothing, shelter, health care, education and energy) (UNDP, 2006). The Programme of Action of the World Summit for Social Development (United Nations, 2006, resolution 1, annex II) characterised poverty as follows:

Poverty has various manifestations, including lack of income and productive resources sufficient to ensure sustainable livelihoods; hunger and malnutrition; ill health; limited or lack of access to education and other basic services; increased morbidity and mortality from illness; homelessness and inadequate housing; unsafe environments; and social discrimination and exclusion. It is also characterised by a lack of participation in decision-making and in civil, social and cultural life (para. 19).

The energy dimension to poverty is known as energy poverty. It is the lack of access to reliable and affordable modern energy services (IEA, 2011) (see Chapter 2). Energy access is about providing modern energy services to everyone around the world. The theory of "modern" energy services are those energy services rendered through the use of energy sources that are other than the so-called traditional (e.g. fuel wood, animal dung, shrub and grass). These services are defined as household access to electricity and clean cooking facilities (e.g. lighting, fuels and stoves that do not cause air pollution in houses) (IEA, 20012).

Energy is crucial to reducing poverty and unhindered access to basic energy services is central to poverty reduction. The development committee of the Organisation for Economic Co-operation and Development (OECD) countries has proposed reducing the proportion of people living in extreme poverty by half by 2015. One out of five people lack access to modern electricity across the globe, while an additional one billion people have unstable, intermittent and unreliable access to erratic electricity supplies (UN, 2011). Lack of electricity and heavy reliance on traditional biomass are hallmarks of poverty in developing countries (IEA, 2002). The provision of social services and infrastructure facilitates the basic functions of a society, which are necessary to provide essential services and ultimately reduce poverty (Bazillian, 2015).

The World Bank (2012), reports that about 1.3 billion people live in extreme poverty in developing countries, using the threshold of one dollar and twenty-five cents (US\$1.25) per day. Therefore, to reduce the percentage of people living on less than US\$1 per day by half by 2015, as recommended in the Millennium Development Goals (MDGs), access to affordable energy services is a requirement (UN, 2005). Achieving universal access to energy services require accelerating action to expand energy access at the local, country, regional and global level with strong political and financial commitments across the globe with strategic partnerships (IEA, 2010). Several indices have been proposed towards addressing the vicious cycle of energy poverty (Pachauri et al., 2004; UNSD, DESA, IAEA, 2005; Vera and Langlois, 2007; Chen and Ravallion, 2008; Mirza and Szirmai, 2010; UNDP, 2010; IEA, 2010; Nussbaumer et al., 2011). The use of indicators is widespread in development research and practice (Mirza, 2010). The International Energy Agency's World Energy Outlook (2010) estimates that an investment of US\$756 billion (US\$36 billion per year) would be required to achieve the target of universal access to modern energy services by 2030.

1.3 Energy resources in Nigeria

Nigeria, the most populous African nation-state, the geographical context for this thesis, is a country that is richly blessed with an abundance of energy resources both renewable (solar energy, biomass, wind, small and large hydropower) and non-renewable (crude oil, natural gas, coal) that can be used to generate electricity (ECN, 2007; Sambo, 2008). One of the many challenges and problems facing Nigeria in the last two decades is the inability of government to provide and enable adequate, reliable, stable and uninterrupted power supply. In spite of Nigeria's position as Africa's leading oil producer and exporter, what does the country have to show for it? Instead of economic growth and development, it is ranked amongst the poorest countries in the world. Nigeria's crude oil reserves is in excess of 36.2 billion barrels; 187 trillion standard cubic feet of proven gas reserves; 2.75 billion metric tonnes of coal, of which 650 million tonnes are proven reserves (ECN, 2007; Sambo 2008; CIA, 2009; CPE, 2009; Oil & Gas Investor, 2009; Revenue Watch Institute, 2010; BP, 2010; Oil & Gas Journal, 2011). According to British Petroleum (BP) (2009:6), the "proven reserve" is "generally taken to be those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reserves under existing economic and operating conditions". Nigeria's aggregate crude oil production, including condensates and natural gas liquids, was 768.6 million barrels (mb) in 2012, averaging 2.10 million barrels per day (mbd) (CBN, 2012). The estimated capacity of the main renewable energy sources are large hydropower 11,250 MW; small

hydropower 735 MW; solar radiation 3.5 kWh/m/day – 7.0 kWh/m/day; wind 2-4 m/s (annual average) at 10m height with potential for hydrogen fuel, geothermal and ocean energies (ECN, 2007).

The country's economy depends heavily on crude oil exportation, which accounts for about two-thirds of government revenue, with estimated earnings of US\$2.2 million a day and contributing over 90 per cent to the Nigerian Federation accounts. Therefore, oil is the financial backbone of the country's economy. The foreign exchange earnings from crude oil export is about 80 per cent of the budgetary revenues and about 13 per cent of the country Gross Domestic Product (GDP) (Sambo, 2008a, Sanusi, 2012). According to a World Bank (2011) report, 80 per cent of Foreign Direct Investment in Nigeria went to the oil sector, while only about US\$1.2bn of the US\$ 6.09bn total went to the non-oil sector. This shows the country's dependence on the oil and gas sector. Nigeria produces 21.2 per cent of Africa's crude oil and the country's crude oil export accounts for 2.6 per cent of global production (BP, 2010:8), and ranked the world's eleventh largest producer of crude oil (USEIA, 2010:2).

In addition to oil wealth, the country has a further undiscovered potential natural gas reserves estimated at 600 trillion cubic feet, making Nigeria the world's seventh largest in natural gas reserves and the largest in Africa (USEIA, 2010). The gas reserve is at least twice that of crude oil in energy terms (Nigerian National Petroleum Corporation (NNPC), 2010). The volume of gas produced in 2012 stood at 2.16 billion million standard cubic feet (mscf) (CBN, 2012). Nevertheless, the gas commodity is not yet universally available to households and industries in the country (Obasi, 2013), with about 70 per cent of natural gas lost by venting and leakage (Hopkins et al., 2009) or flaring (Ologunorisa, 2001; Osuji and Awiri, 2005). The World Bank (2007) estimated an average of 2.5 billion standard cubic feet (scf) of associated gas is flared daily and put the annual loss caused by gas flaring in Nigeria at over \$2.5 billion. Gas flaring is wasteful and is a major issue for climate change and human health (Edino et al., 2010; Orogun, 2010). The World Bank further states that wasted gas in Nigeria has the potential to solve over half of the African continent's energy needs. The consumption of 1.8 kilogrammes per capita, compared to the West African regional average of 3.5 kilogrammes has placed Nigeria among the lowest LPG consuming nations in Africa (Momoh, 2014; Omotowa, 2014). The country has one of Africa's lowest per capita uses of cooking gas/LPG at 0.4kg/person (Ewah et al., 2012). The abundance of natural gas in the country could provide a cleaner energy than other fossil fuels and an important part of the future energy mix.

The country's total earnings from crude oil export from the 1970s to date stood at over US\$600 billion (Ezekwesili, 2013). The Central Bank of Nigeria (CBN, 2008; Revenue Watch Institute, 2010) reported external reserves of US\$60.1 billion in 2008, but the reserves have since then consistently diminished and currently stand at less than US\$45 billion (CBN, 2013). Despite the high foreign reserves and enormous revenue earnings from crude oil and gas export, the prevalence of poverty is high and most Nigerians have not benefitted from this legacy of wealth. This has been attributable to the failure of government to distribute the country's vast oil revenues more equitably. The country's refineries are not functioning at full capacity. The nation has to rely on imported petroleum products. The trend of Nigeria's population in poverty from 1980 to 2010, for example, suggests that the more the nation earned from oil, the larger the population of poor citizens: 17.1 million in 1980, 34.5 million in 1985, 39.2 million in 1992, 67.1 million in 1996, 68.7 million in 2004 and 112.47 million in 2010 (Ezekwesili, 2013).

Notwithstanding the abundance of energy resources and reserves in Nigeria, the supply of processed energy is still far below the demand, resulting in short supply of electrical power (Sambo, 2009). Nigeria is a wealthy country in terms of human and natural resources but the country has failed to capitalise on its natural resources to maximise the social, economic and environmental development of its population (Polgreen, 2006; Gashawbeza 2006). The country's high level of poverty, lack of basic social infrastructure has all been attributed to the high level of corruption (Kar and Freitas, 2012). Transparency International's (TI's) (2013) Corruption Perceptions Index (CPI) report ranks Nigeria 144 amongst 177 most corrupt countries in the world. The TI states that: "countries at the bottom of the index will never get out of the poverty trap if they don't tackle corruption and the poor people get hurt the most." The Nigerian economy is an extreme case of the resource-curse economy, owing to the failure to turn resource wealth into sustainable prosperity for her population characterised by unbridled corruption, leadership failure, unwanton waste of resources, infrastructural decay, poverty and joblessness together with darkness and power outage. The resource curse theory suggests that developing countries that are endowed with natural resources tend to underperform economically relative to their resource-poor counterparts (Idemudia, 2012). Collier, 2007; Wenar, 2008 and Di John, 2010 provided a definition of resource curse, as "natural resources (oil) abundance in less developed/developing countries tends to generate negative development outcomes, including growth collapse/poor economic performance, corruption and ineffective governance". In other words, oil resource has become an obstacle to prosperity in less developed/developing countries because they have been unable to use their wealth from natural resources to sustain economic growth and political

stability (Collier, 2007). The combination of enormous oil and gas resources and revenues are supposedly considered an advantage and a blessing to the nation. The blessing seems to have instead become a curse because of the dismal performance of Nigeria's development using both the human development index (HDI) and country's gross domestic product (GDP) performance indices. Over 80 per cent of Nigeria's oil revenue has historically gone to only one per cent of the population largely owing to systematic corruption and graft (Amuwo, 2009). Corruption in Nigeria and to a greater extent in most African countries remains the most important obstacle, to economic and social development. Corruption remains the main cause of systematic waste of the country's resources and cause of poverty in Nigeria (Charas et al., 2014) and has stifled industrialization and infrastructural provision. Obayelu (2007) notes that the importance of infrastructure for economic growth and development cannot be overemphasized.

The World Bank (2011) acknowledged the poor state of the power sector (electricity) as a major impediment for doing business in Nigeria. This situation is reflected in insufficiency of electricity supply across the country losing about US\$22 billion to power shortage annually. One then begins to ask questions about what has happened to the budget allocation in the power sector and the over US\$40 billions of dollars expended since 1999 to date without significant improvement. The former President of Nigeria, Jonathan Goodluck, in 2008, when he was Vice President argued that "the discovery of oil and the dependence of oil has caused Nigeria's economy and development to remain stagnant over the last several decades" ... he goes on to say that the overdependence on oil has put an unpleasant bracket in our national economic freedom" (UPI Energy, 2008). The United Nations Secretary General, Ban Ki-Moon, in his 2013 International Anti-Corruption Day message, noted that: "corruption is a barrier to achieving the Millennium Development Goals (MDGs) and needs to be taken into account in defining and implementing a robust post-2015 development agenda". The UN Secretary General further stated that: "to achieve an equitable, inclusive and more prosperous future for all, we must foster a culture of integrity, transparency, accountability and good governance". According to Sissoko (2013), the UN representative in Nigeria, "if only 10 per cent of the money lost to corruption is channelled back to development, it would be enough to achieve the Millennium Development Goals by 2015".

The World Bank (2006) reported 9 out of 10 Nigerians live on under US\$2 per day, while the World Bank (2013) reports that Nigerians "are relatively poor, with about 46 per cent of the population living in absolute poverty and there is high inequality". The National Bureau of

Statistics (NBS) (2012) puts the poverty rate of Nigeria at about 69 per cent, which represents 112.5 million Nigerians. Nigeria, was one of the 50 richest countries in the early 1970s but has retrogressed to become one of the 25th poorest countries at the threshold of the 21st century (Soludo, 2006). Nigeria has the 3rd largest number of poor population, after China and India (Ogunmola and Badmus, 2010). According to the United Nations Development Programme (UNDP) (2010:162), two-thirds of the Nigerian population, representing 65 per cent of the country's approximately 160 million people are living below the poverty line (less than US\$1.25 per day), out of which US\$0.45 is spent per day on the average for their basic energy needs (Hammond et al., 2007). The Governor of the Central Bank of Nigeria (CBN), Mallam Sanusi (2011) claims that 90 per cent of the people are living on less than US\$2 per day, while 70 per cent live on less than US\$1 per day amid rich natural endowment.

The United Nations Development Programme's (UNDP's) (2013) reports on Human Development Index ranked Nigeria 153 out of 186 countries, with an HDI value of 0.471 (with 1 being the highest score), well below other oil-producing states such as Libya (0.769), Saudi Arabia (0.782) and Indonesia (0.697). It placed the country in the low human development category. Poverty and illiteracy have been identified as two reasons why Nigeria's human development ranking is low (World Bank, 2013). The poverty figure in Nigeria (over 90 million people) is higher than the combined population of 10 other West African nations, excluding Ghana and Cote D'Ivoire (UNDP, 2010). The World Energy Council (WEC) (2013) Energy Sustainability Index ranked Nigeria 84 out of the 129 countries based on their performances on the three aspects of the energy trilemma. The World Energy Council's definition of energy sustainability is based on three core dimensions, energy security, social equity, and environmental impact mitigation (WEC, 2013). These three goals constitute a "trilemma". The World Energy Trilemma refers to the fact that a sustainable energy system needs to provide secure, affordable, and environmentally sensitive energy. The "energy trilemma" provides a clear framework to deliver the energy transformation and make sustainable energy systems a reality (WEC, 2013). The provision of social services and infrastructure facilitates the basic functions of a society that are necessary to provide essential services and ultimately reduce poverty.

1.4 Background to electricity situation in Nigeria

Electricity is a form of energy resulting from the existence of charged particles necessary to energize machinery, appliances and lightening (Ngutsav and Aor, 2014). The Energy Commission of Nigeria (ECN) (2007) estimates that about 100 million Nigerians have been

identified as having no access to grid-supplied electricity, while 50 million people of 15.3 million households receive low or irregular supply with the bulk of the electricity supplied to the urban areas. The figure represents 60 - 70 per cent of the country's population. Only 10 per cent of rural households and 30 - 40 per cent of the country's total population has access to grid-electricity, with about 30 per cent of their demand for power realised (World Bank, 2005; Sambo et al., 2007). At present, Nigeria has less than 40 per cent access to electricity, which means more than 25 million households across the country are without electricity (Nebo, 2014). The World Bank further observes that Nigerians constitute 10 per cent of the world population with no access to electricity. The United Nations special rapporteur on extreme poverty and human rights and adequate housing in Nigeria (Carmona and Rolnik, 2014) signed a joint petition with reference number NGA 5/2013 condemning Federal Government of Nigeria over poor power supply and inability to provide functioning metering system in the country. The International Centre for Energy, Environment and Development's (2012) study, "Financing pro-poor energy access in Nigeria," reported the gap between electricity demand and supply continues to get wider on a yearly basis as industrialisation and population increase and the proportion with access to electricity is declining. The estimated total installed capacity of the combined hydro and thermal power stations, as at 2012 was 9287 MW. However, the power generation capacity available is between 3500 - 4000 MW from both the country's main distribution utility - Power Holding Company of Nigeria (PHCN) and Independent Power Plants (CBN, 2012). Opara (2013) asserts that the country struggled in 2012 to generate less than 5000 megawatts (MW) of electricity from the installed capacity for its over 170 million population, as compared to at least 40,000 MW which is required to sustain the basic needs of such a population (UNDP, 2010). The rule of thumb for any developed industrial nation is that at least 1 Gigawatt (that is, 1000 megawatts) of electricity generation and consumption is required for every 1 million head of the population (Road Map for Power Sector Reform in Nigeria, 2010).

The per capita electricity consumption of Nigeria is amongst the lowest in the world and far lower than that of many other African countries and 3 per cent of South Africa's and 7 per cent of Brazil's consumption. Electricity consumption is the total amount of electricity (kWh) available in a given economy for immediate consumption (Ngutsav and Aor, 2014). The per capita energy consumption was 129 kilowatt-hours (kWh) per person-less than half of the Ghanaian average, nine times less than the African average, and 22 times less than the world average (Sambo, 2009; Research and Markets, 2011). The Central Bank of Nigeria (2010) reported that residential consumption accounted for 56.3 per cent of total electricity consumption, while commercial and

street lighting and industrial consumption accounted for 25.7 and 18.0 per cent of the total, respectively. At present, households' electricity consumption of 150 kWh on a per-capita basis is among the lowest in the world, as against the world average of 2600 kWh and average values of 1500-2000 watts (13,140 kWh/capital year) proposed by Goldemberg et al. (1985) and Spreng (2005) and 120 kWh per person proposed by Sanchez (2010). The huge deficit has meant that the majority of the population lives far below the 4000 kWh level required for achieving a decent standard of human existence (UNDP, 2010). The implication is that a considerable and significant generating capacity has not been added to the electricity network grid. According to Sambo (2008b:33), "more than US\$6.46 billion annual investment would be required for the Nigerian electricity sector to meet the UNDP's (2010) requirements of 4000 kWh". Thus, it will be difficult and expensive for Nigeria to sustain its economic development and drive diversification policy, energise human capital development process and attain the MDGs and encourage private investors without making available a reliable and affordable energy to all.

The Nigeria electricity sector is characterised by poor quality performance and unreliability of supply (Oduлару and Okonkwo, 2009; Olise and Nria-Dappa, 2009). The report of World Bank's Energy Sector Management Assistance Programme (ESMAP) (1993) concisely captures the state of electricity supply in Nigeria. The precarious and persistent electricity crisis has long been in existence, as evidenced by the incessant power failure and load shedding widespread in the country. Lee and Anas (1996) describe Nigeria as a representative of those developing countries where the public sector is inefficient and the private provision of electricity compensates for public sector inefficiency. The problem in the Nigerian electricity sector is attributable to vandalism of electrical installations, poor funding of the industry, old and insufficient installations, low tariffs, insufficient gas supply, water level fluctuations, stream flow variability and huge debts owed the electricity industry (Lee and Anas, 1991; Simpson, 1992). The World Bank (1993), in the ESMAP report, alludes to the above when identifying the root causes of poor performance of the electricity industry in Nigeria as lack of autonomy on the part of the defunct utility service provider's (defunct NEPA) management and excessive government control, particularly in the areas of procurement, finance, tariffs and personnel policies. An estimated electricity requirement of 60,000 MW is required by the 170 million population as against the maximum generating capacity of 5120 megawatts (MW) of the existing power plants (at peak), a situation which puts the electricity sector below 10 per cent performance. Individuals and businesses are currently bridging the difference between demand and supply through alternative power generation to secure a reliable supply. The current plan as envisioned in the Roadmap for Power Sector Reform "Vision 20-

2020” is to ramp up future supply to as much as 40,000 MW by the year 2020. According to Nwanze (2014), an investment of about US\$35 billion is required to achieve the government target of 40,000 megawatts by 2020. This informed government desire to involve the private investors with the financial capability and technical expertise to move the power sector forward (see Chapter four).

The Nigerian economy is categorised by a large formal and informal sector, with many of the people in the sectors depending on electricity for daily production and livelihood primarily for industrial, commercial and residential purposes. The consequential effect and aftermath of the huge energy deficit and gap in Nigeria characterised with poor service delivery have forced a significant number of residential households, small and medium businesses and those in the industrial sector to provide their own electricity. The use of generating sets and inverters is at a huge cost to households, businesses and the Nigerian economy (Ikeme and Ebohon, 2005; Akinlo, 2009). However, the generation of electricity from solar photovoltaic and solar thermal technologies is still very low. The acceptance of solar powered off-grid solutions is high but outside the reach of many households in Nigeria in spite of the environmental benefits over fuel-based energy resources. An estimated US\$1.5 billion was spent between 2002 and 2008 purchasing generator sets and about US\$3 billion on fuelling and maintaining generators annually (Research and Markets, 2011). The Energy Commission of Nigeria (2008) estimated that Nigerians spent about ₦1.56trn (US\$975mn) on alternative power supplies. In 2012, this estimate has reached ₦3.01trn (US\$1.9bn). The Governor of the Central Bank of Nigeria (CBN), Mallam Sanusi (2012), reports that Nigerians spend US\$13 billion on generators and petroleum products (petrol/diesel) to provide electricity in homes and industries. The Nigerian economy has been described as a “fuel generator economy,” a situation where households and businesses incur extremely high overhead cost in maintaining their power generators and ensure unsafe health environment by their carbon footprints (Iwuamadi and Dike, 2012). The report of the Director General of Centre for Management Development (Usman, 2012), reveals that an estimated 60 million Nigerians invest about ₦1.6 trillion (US\$10 billion) to purchase and maintain standby generators annually. The ownership of generators is a common household phenomenon, a necessity and a must-have household item in most Nigerian homes as a result of the erratic electricity supply, with some households having up to three different generating sets in their custody.

The Central Bank of Nigeria's (2012) report on foreign exchange sales under the Retail Dutch Auction System (RDAS) for the last week in January 2012 revealed that 15 firms purchased ₦1.180 billion (US\$8.2 million) in one week to import generators alone for the commercial and industrial sector. The 2014 annual budgetary allocation further confirms the "fuel generator economy" label with about ₦836.6 million (US\$5,228,750) budgeted to run and fuel generators at the presidency and other ministries, departments and agencies of government (Onuba et al., 2013), while ₦654.02 million (US\$4,087,500) was spent on fuelling and maintenance of generators in 2013 (Amaefule et al., 2012). The use of generators in almost all residential homes and industries is a symbol of the failure of the development of the public energy service delivery system and a clear vote of no confidence in the public power utility company in Nigeria. The federal government has consistently proven to be incapable of providing and guaranteeing an adequate and regular supply of electricity. Generation of electricity from individual diesel and petrol generators is estimated at 6000 megawatts (MW), approximately twice the capacity of grid-generated electricity (CPCS, 2011). It has been estimated that Nigerians spend between five and ten times as much on self-generated as they do on grid-supplied electricity (CPCS, 2011).

The inadequate provision of electricity has been identified as the major impediment to the attainment of Nigeria's vision to become one of the 20 developed economies in 2020. This is because of the direct bearing it has on households' productivity and other economic indicators, like unemployment rate and low capacity utilisation in the manufacturing sector (Road Map for Power Sector Reform in Nigeria, 2010). According to Krizanic, 2007, electricity provision has become as equally indispensable as food supply. This informed the choice of electricity among the many sources of energy for this study. Furthermore, the importance and the role electricity plays in the day-to-day activities of individual and the socio-economic development of any nation cannot be ignored. An estimated 834 manufacturing companies, out of 2,400, have relocated out of Nigeria in the last five years to neighbouring countries, such as Ghana, Republic of Benin, where there is stable and uninterrupted supply of electricity (Mbisiogu, 2013). Electricity provides the basis for human development and the economic growth of a nation. Over the past decade, the Nigerian electricity sector has received tremendous government attention, with billions of US dollars in expenditures towards providing an efficient electric utility sector and improving the network grid tripod of generation, transmission and distribution sub-sectors plus natural gas supply infrastructures to power plants without any commensurate outcome. Empirical studies have proved that the lack of reliable supply of electricity hampers growth. The relevance of electricity to seven of the eight Millennium Development Goals (MDGs) is very noticeable, as

none of the Millennium Development Goals can be met without major improvement in the quality and quantity of energy services, particularly electricity (UNDP, 2010).

Emphasizing the importance of electricity provision during the launching of the Roadmap for Power Sector Reform, the Nigerian President, Goodluck Ebele Jonathan (2010), said, “without power (electricity) you cannot empower people economically”. Therefore, meeting the challenges of providing adequate, reliable, and affordable electricity service requires an efficient electric power sector capable of closing the huge energy gap and breaking the vicious energy poverty and lack of electricity access (Adegbulugbe, 2011). It also requires customers who can afford to pay, hence the link between poverty elevation and energy poverty. To overcome the vicious circle of energy poverty and human under-development, governments must act to improve the availability and affordability of modern energy services, especially electricity (IEA, 2004). Access to electricity is particularly crucial to human development and individuals’ access to electricity gives a better indication of a country’s electricity poverty status than statistics on their average consumption.

The provision of clean, affordable and accessible energy is widely considered the cornerstone of development. Access to efficient energy sources has been linked to an improvement in people’s level of well-being. In spite of the enormous energy resources nature has endowed Nigeria, a large number of the population still live in poverty and do not have access to basic modern energy services. Nigeria has failed to capitalise on its natural resources to maximise the social, economic and environmental development of its population (Polygreen, 2006; Gashawbeza, 2006). Electricity supply when available is often characterise with low-voltage, accompanied with frequent disruptions and intermittent supply that is erratic in nature. The multiplier effects of the huge energy deficit on household’s productivity have far-reaching impacts particularly on the low-income (urban poor) households that are already struggling with the numerous impacts of poverty and socio-economic problems. The inadequate access to electricity provision and modern energy services therefore undermine household’s socio-economic development, productivity and prosperity.

1.5 Aim of the Study

This study examines the causes and consequences of the inadequacy and unreliability of electricity delivery in Ibadan, Oyo State, South-western, Nigeria and in so doing contribute to the literature on the relationship between energy, development and poverty.

1.6 Objectives of the Study

The objectives of the research are to:

- Analyse the delivery of electricity to households as a way to understanding the spatial issues of demand, supply and consumption in the study area;
- Evaluate the implications of energy poverty from electricity delivery characteristics and compare grid-supplied to self-generated electricity;
- Analyse the relationship between households' income and expenditure on electricity consumption with social-survey-derived variables;
- Investigate and analyse the barriers associated with access to electricity and the problems of non-payments of electricity consumed

These objectives map to specific research questions as follows:

- What is the pattern of supply and consumption across space and time in the study area? How do we know how much is supplied and consumed?
- What are the comparative economic costs of grid-generated and self-generated electricity?
- Are there any significant relationships between household income, electricity consumption and the socio-economic characteristics of the area? Does land-use contribute or play any significant role in any of these relationships?
- Is there any energy poverty exhibited in the study area?
- What are the critical determinants for overcoming the barriers of access to affordable electricity to increase the willingness to pay for electricity consumed?

It is within this context that this thesis examined and analysed the causes of energy poverty in Ibadan, by adopting a three-stage approach. The first stage involved the mapping of the study area with the use of remote sensing (RS) and geographic information system (GIS) techniques to provide a sampling framework that is statistically valid and to place the results in a spatial dimension. The second stage involved the primary data collection at the household level, using a questionnaire, focus group discussion and interviews of key informants. The third stage encompassed data analysis, using simple descriptive statistics, multivariate statistical techniques, thematic/content analysis and spatial analytical techniques of GIS. The GIS approach provided an insight into measuring energy poverty by using maps to visualise the geography of the sampled populations with regard to location and to show the magnitude of energy poverty, allowing the identification and analysis of the location where it existed in the study area of Ibadan.

1.7 Background to the Study Area

The research study area, Ibadan, (Figure 1.1) is located in the southwest of Nigeria, with an estimated population of 2,550,593, according to the 2006 National Population Commission's census results (NPC, 2006a). Ibadan is an historical city; a state capital dated far back 1960 when it was the capital of the old western region. The city of Ibadan comprises 11 local government councils or boroughs collectively known as the "Ibadan Metropolis". The local government area (LGA) is the third tier of government in a three-tier federal system. The population of the five central LGAs in Ibadan is around 1,338,659, according to the census results for 2006. The growth of the population of Ibadan has also been likewise noteworthy. From a war camp consisting, in 1829, of a motley collection of soldiers, the population rose from the estimated 100,000 in 1851 to 175,000 in 1911. Between 1911 and 1921, it increased at about 3.1 per cent per annum to 238,075. The rate of increase between 1921 and 1931 was 0.5 per cent per annum, while it was only 0.8 per cent per annum for the period between 1931 and 1952, when the population rose from 387,133 to 459,196. From then on, the population of Ibadan metropolitan area increased at a growth rate of 3.95 per cent per annum from 1952 until 1963, by which time the population had risen to 1,258,625. The population rose to 1,829,300 in 1999 at a growth rate of 1.65 per cent from 1963 and increased to 2,550,593 in 2006 at a growth rate of 2.35 per cent. However, the population growth is gradually shifting with a growth rate of 4.7 per cent per annum between 1991 and 2006, according to the provisional census figure released by the National Population Commission (2006). The population growth rate has been on the increase, despite the fact that census figures have been less than reliable.

The growth of Ibadan could be traced back to 1946, when it was made the headquarters of the then Western Region of Nigeria. According to Ayeni (1994), "the Metropolitan Area of Ibadan has one of the highest population densities in the country and the mostly densely settled areas remain the central and indigenous core of the city". The inner city area is the oldest, has the lowest quality residence and the highest population density in the city. According to Mabogunje (1962: 56-77), residential land use was made up of a core area, inhabited largely by the indigenous Ibadan population. The core area was a high-density area formed by the process of compound disintegration, sometimes known as "growth by fission" (Mabogunje, 1962). That is, compounds were increasingly broken up into a number of separate housing units. Under more recent changes in economic conditions, some of these sub-standard old compounds have been pulled down and replaced with new modern houses. The resultant new residential districts contain low to medium quality residential areas where population densities are in the order of four hundred (400)

people per hectare. In all cases, these are post-1952 developments by immigrants of non-Yoruba origin living around Sabo, Ekotedo, Oke-Ado and Mokola. The high-density residential area is located at Akingbola inhabited largely by the indigenous Ibadan population, while Agbowo is largely inhabited by students and junior staff of the University of Ibadan because of its proximity to the university. There is a market called Bodija located within the study neighbourhood, while Bodija Isopako area is largely populated by a mix of students, indigenes and non-indigenes. The medium-density residential areas are mostly those inhabited by immigrants of non-Yoruba origin, living around Agbowo Express, while Bodija Ashi and Ashi Express are the residential areas that have low population and housing densities (Figure 1.2).

The third categories of residential areas are the high-class Government Reservation Areas that have low population and housing densities of four to eight houses per hectare. These include Agodi government reservation area (GRA), Jericho GRA, Commercial and Link Reservations, Iyaganku GRA, Alalubosa GRA and Bodija Estates. The principle of the GRA development can be illustrated by the description given to it by Lord Lugard in 1904 (Falade, 1998). The former European (estates) Reservation Areas, now renamed government reservation areas (GRA), developed as a cool fruit and flower garden where one could sit on a shady veranda in the privacy of one's own home. Extensive public open spaces with recreational grounds and sports fields are located near both office and home, reached by shady pathways. The GRAs were the British government's version of the garden city in Nigeria. During the early colonial period, the housing activities and policies of the Government in Nigeria focused on the provision of quarters for expatriate staff and for selected indigenous staff in some specialised occupations like railways, police, education (UNCHS, 2005). This period saw the establishment of GRA as well as a few African quarters aptly described as the era of "housing reservations."

The study area was selected based on the cosmopolitan nature of the city, diversity of the inhabitants in terms of tribe, culture and language, and the socio-economic characteristics of the different residential densities. The researcher's knowledge and familiarity of the terrain together with the previous work done in the city, which exposes the increasing level of inadequate provision of electricity informs the choice of the city. The poor reliability of the grid system has over the years proven to be the bane of energy poverty in Ibadan and most cities in Nigeria. The availability of data such as satellite imagery and building footprints of households likewise informs the choice of the study area as it provided a good starting point for the field survey exercise to commence.

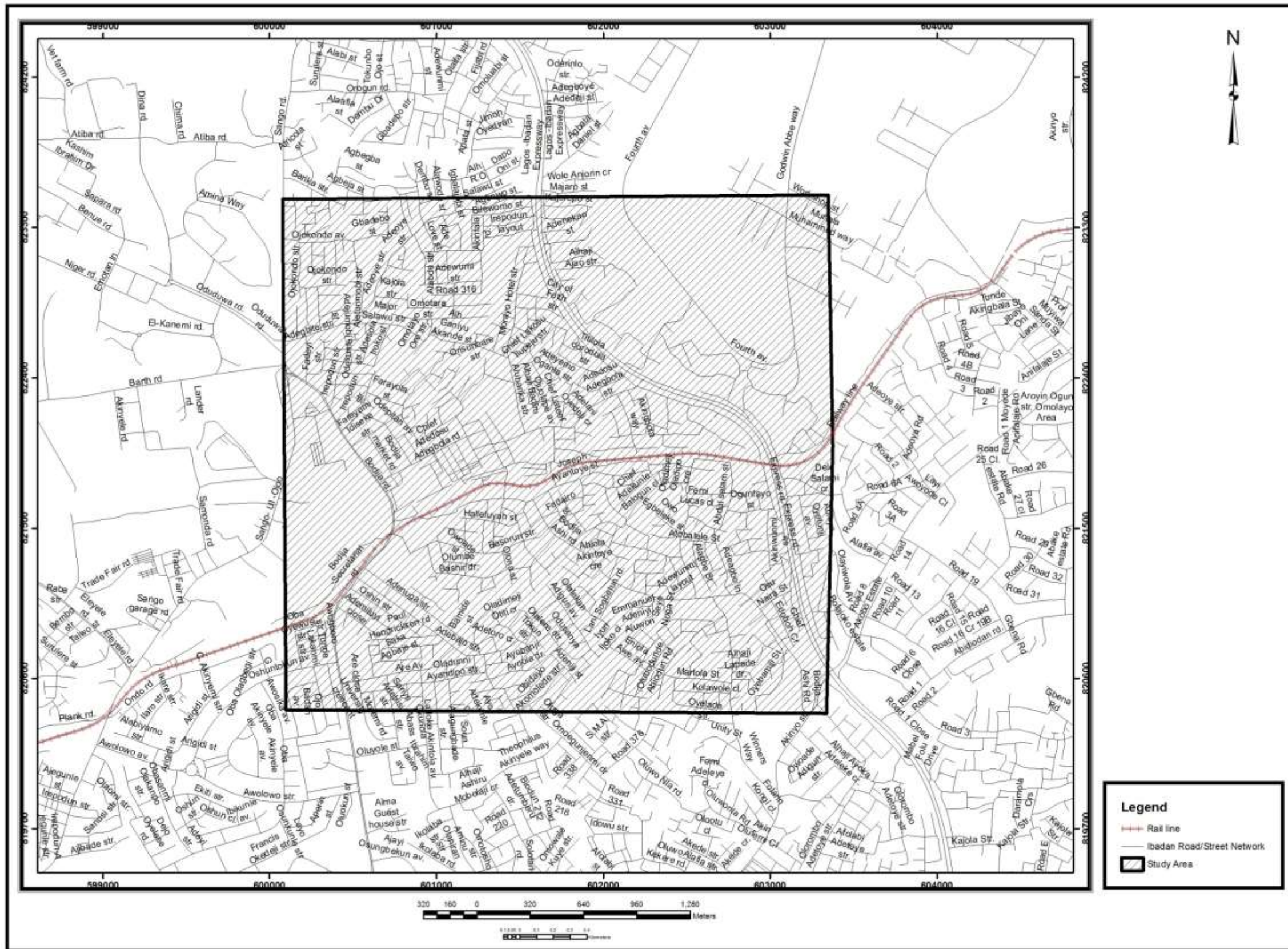


Figure 1.1: The study area Ibadan and its environs

This thesis critically examines the inadequacy of quantity and reliability of quality of electricity supply and the consequences of energy poverty. The absence of spatial evidence to support decisions and policies is common to resource management and sustainability issues in most developing countries. The critical assessment of the spatial dimension of the energy poverty nexus is needed to inform policy towards a more efficient energy system and institutional regulatory framework towards reducing energy poverty. The crisis in energy provision is commonly referred to as the “energy-poverty nexus” and the term can be described as the connection between the inadequate energy situation and the despairing socio-economic living conditions faced by most people in developing countries. Energy supports the provision of basic needs and the services provided by energy are a crucial input to the primary development challenge of providing adequate food, shelter, water, sanitation, medical care, and access to information. The energy crisis is two-fold and it is defined by the challenge of curbing carbon-dioxide emissions and switching from fossil fuel use in the rich nations, coupled with the need to supply even basic modern energy to the developing countries.

The lack of access to affordable electricity and the consequences of energy poverty are both spatial and temporal. The spatial analytical approach and methods used in identifying relationships and pattern in geographic data are, therefore, necessary and important for investigating and analysing the problem. This requires the need for spatially detailed analysis to understand the causes and consequences of energy poverty. The study examined and analysed the problems from the spatial context. The spatial analytical techniques of geographic information systems (GIS) are required to facilitate spatial data collection, management, processing, analysis and visualisation.

The research further examine the perceptions of the inadequate provision of electricity, as captured by household survey in relation to fulfilling households’ energy services demand and desire towards achieving basic living requirements. The variations in these relationships were analysed using multivariate statistical techniques that allowed the relationships between the socio-economic variables examined and the produced summary statistics that describe the strength of association between the variables examined. The results were then further analysed with the production of an energy index map. The energy index map ranked households sampled in the study and provided an insight into measuring energy poverty using household average income in relation to expenditure on energy. The index map allowed visualizing the geography of the sampled populations with reference to location, by identifying patterns and trends. The

importance of the energy index map is not only proving that energy poverty exists but also showing the magnitude of energy poverty and identifying where it exists. Furthermore, this research evaluated the role of energy services provision on households' productivity and economic development. However, it is imperative to mention the different combination of energy mix that households utilise as an alternative source in achieving households' energy services desire.

This study came at the transition period of the power sector reforms and privatisation of the state-owned defunct Power Holding Company of Nigeria (PHCN) and the subsequent handing over of the electricity generation (Gencos) and distribution (Discos) companies to the private investors/owners. However, the Nigerian government is making a conscious effort in strengthening and improving the electricity services provision in a world where energy security, climate change, environmental sustainability, development issues and poverty alleviation are of global concern and on the global policy agenda. The interrelationship between energy, socio-economic development and poverty is at the very core of this thesis. The study provides a pragmatic methodology of the application of Geographic Information System (GIS) as an interface between development studies and energy geography, as illustrated in Figure 1.1. The focus of this study is on energy poverty (specifically electricity) and the role of energy in poverty reduction is greatly emphasised in the study.

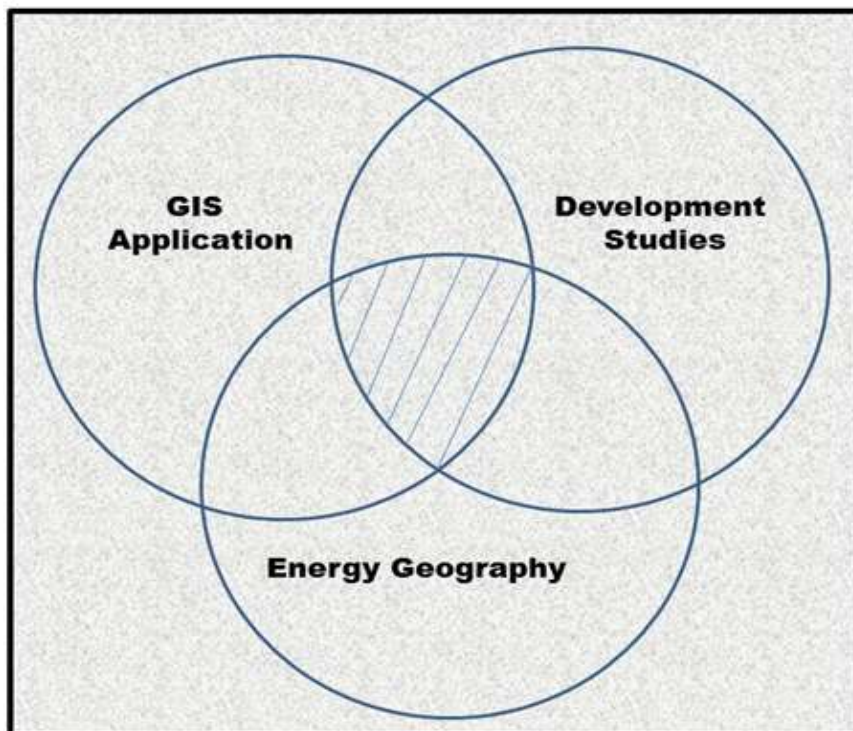


Figure 1.3: Interface of GIS application, development studies and energy geography

1.8 Structure of the Thesis

This section provides an overview of the structure and composition of the thesis with a brief narrative and descriptive contents of each chapter. The thesis is divided and organised into seven chapters with various sub-headings and sections. The thesis follows a conventional transition from the introduction to the context for the research, followed by the methodology adopted, to more substantive/empirical results and findings leading to the discussion and conclusion. The layout of the chapters is presented in Figure 1.4, while the summary of the contents of each chapter is described below.

Chapter One presents the general discussion chapter that provides the background introduction to the study and discusses the rationale and objectives of the study. It further introduces the application of geographic information system as interface between development studies and energy geography.

Chapter Two reviews the literature that provides context to the research. The chapter introduces energy and development, examines the lack of access to modern energy services and the consequence of energy poverty from global perspectives, and further narrows it down to urban energy poverty in the sub-Saharan Africa. The chapter provides an insight into the metrics and indicators used in measuring energy poverty. It further highlights household's energy use in sub-Saharan Africa and the concepts of energy ladder. Energy and gender-related issues together with the unique role played by women in meeting households' energy domestic needs were also reviewed. The nature of state-owned, liberalised energy sector and the power sector reform in sub-Saharan Africa were further examined. The last section presents a summary of the review.

Chapter Three presents the methodology adopted, starting with the approach taken to conduct this research and methods of data collection and methods of data analysis. A detailed justification of the methods of data collection including remote sensing and GIS techniques; household survey (questionnaire administration), focus group discussions and interviews of key informants used in the study is provided. The GIS section explains data preparation and processing with the use of remote sensing and GIS methods to aid the selection of the general population (households) from where the randomisation was done, and provides the sampling framework that is statistically valid. The chapter also captures the way the researcher addressed the problems of validity and objectivity, given that the methods of sourcing data in the study neighbourhood were primarily

quantitative and qualitative. The last section evaluates the various methods used for data analysis.

Chapter Four presents the nature of electricity service delivery in the study area. It further highlights the installed and available generation capacity in order to expose the huge energy gap and the path that leads to the power sector reform in Nigeria. This chapter further presents the details of the research results and findings of the research together with a critical analysis and interpretation of its outcomes towards addressing the objectives of the research. The first part of the results provides a descriptive summary of the socio-economic and demographic characteristics of the sampled households in the study. The second part explores and analyses the pattern of electricity consumption.

Chapter Five presents the implications of the nature of electricity service delivery in the study urban area. It identifies and analyses the relationship between electricity consumptions and socio-economic characteristics so as to understand the underlying social processes of the problem of energy poverty. The chapter notes that a multiple regression analysis and cross-tabulations was performed to find the different factors that could explain the relationship between electricity consumptions, household expenditure and socio-economic characteristics. The problem of non-payments and barriers associated with access to electricity was also analysed. The last part provides an assessment, nature and implication of the energy poverty nexus arising from the study in the Nigerian context.

Chapter Six discusses the key theoretical and empirical findings of the preceding chapters. It explains the research findings with a view to relating this study with the findings of the others in the developing and developed world contexts. It brings together and organises the emergent key findings in order to understand the nature of energy poverty and the underlying social processes. It links the aim and objectives, literature review and the major findings that emerged from the research to present the conclusions to this research and propose some recommendations concerning the implications of the findings. The limitations of the research and the policy implications based on the findings of the study are equally highlighted. The last section of the thesis appraises the contribution of the research and offers some suggestions on possible areas for further research.

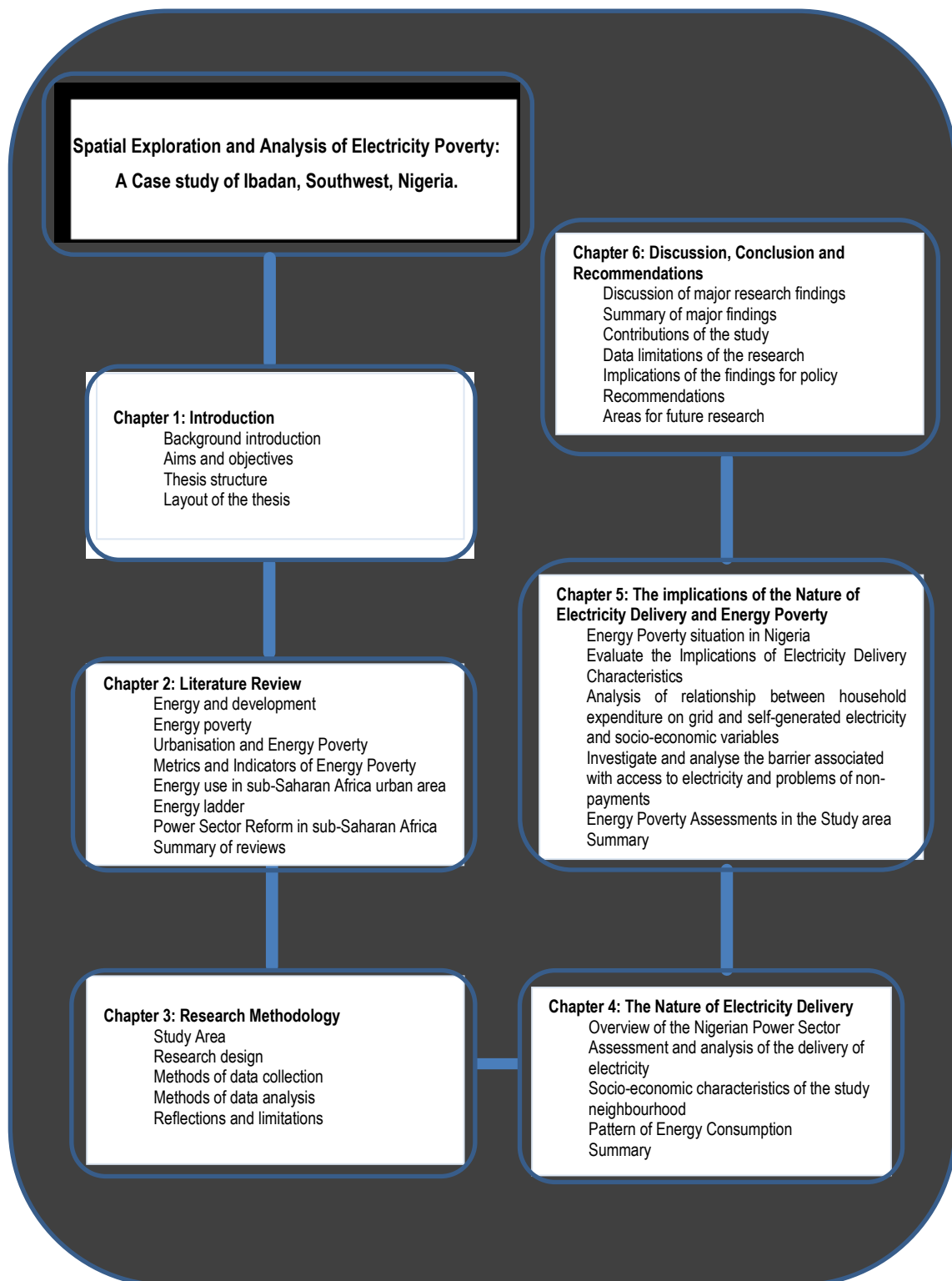


Figure 1.4: Layout of the thesis

CHAPTER TWO

CONTEXT FOR THE RESEARCH

2.1 Introduction

This chapter provides the context for the research and is divided into six parts. The literature review proceeds from a broader global perspective and then narrows down to the sub-Saharan African context that matches the aim of the thesis. The first section of the chapter provides a background introduction to energy and development. The second section offers a review of energy poverty at the global level and the context of developing economies, while further narrowing it down to urbanisation and energy poverty. The third section provides an insight into the metrics, indicators and models used for measuring and assessing energy poverty. Household energy use (particularly) in sub-Saharan Africa urban areas are presented in the fourth section. The fifth section provides an overview of the concept of energy ladder as an imaginative ladder of household energy preference with a rise in income. Energy and gender-related issues together with the unique role played by women in meeting household energy domestic needs are discussed in the sixth section. The seventh section provides a background to the liberalised energy sector and the power sector reform in sub-Saharan Africa countries while a summary of the review is presented in the last section of the chapter.

2.2 Energy and Development

Energy and development are widely acknowledged to be closely related. Energy is a fundamental enabling factor and an essential input for socio-economic development (Johansson and Goldemberg, 2002; Davidson and Sokona, 2002; Nussbaumer, 2012). Economic growth is an indispensable requirement for overcoming poverty. Therefore, it will be difficult for any country to achieve sustained economic growth without improving access to cleaner and modern forms of energy and the services that they provide (GE, 2012). The importance and the role played by energy in households' productivity, economic survival and development have been well documented in the literature (Modi et al., 2005; Gaye, 2007; Prasad, 2011; IEA, 2012; Nussbaumer et al., 2012). According to Gardner et al., (2006:24): "Development is a complex term and most simply, development means all people reaching an acceptable standard of living, and having the basic things they need to live. Development is a never-ending process: people will always be striving to improve the quality of their lives and the lives of their children".

An estimated 1.3 billion people - nearly a quarter of the world's population continue to live in extreme poverty, on less than the equivalent of \$1.25 per day and nearly half of the world's population live on less than \$2.50 a day (UNDP, 2014). These poor people lack access to opportunities and services such as modern energy services considered a prerequisite for development (IEA, 2010). These services are defined as household access to electricity and clean cooking facilities that do not cause air pollution houses. Energy services are the desired and useful products, processes or services that result from the use of energy; for example, illumination, comfortable indoor climate, refrigerated storage, motive power (water pumps and transport) and appropriate heat for cooking. Energy is not an end in itself but it underpins human survival and can therefore be used as a basis for development and economic growth aimed towards poverty reduction. However, poverty reduction must centre on inclusive development towards ending of social exclusion (UN-DESA, 2010). The provisions of reliable, secure and affordable energy services are central to addressing many of today's global development challenges including poverty, inequality, climate change, food security, health and education as well as wealth creation and economic development (Bazilian et al., 2011). Figure 2.1 provides the socio-economic importance and benefits of energy provision and the link between energy and development as described by (OECD and ADB 2004).

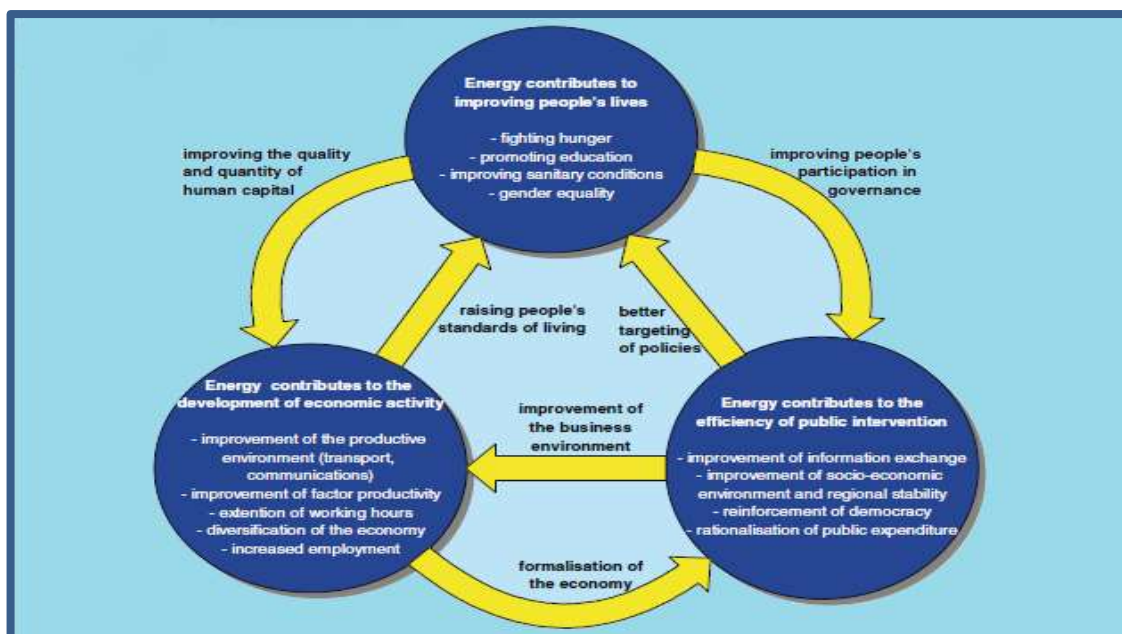


Figure 2.1: Link between Energy and Development

Source: OECD Development Centre and African Development Bank (2004) African economic outlook, Paris

The debates around the meaning of development and competing understandings of poverty was fuelled by the realisation that rapid growth during the 1960s and early 1970s was accompanied by continuing poverty and rising inequality in many countries of the world (Sen, 2001). The economic and social development of the developing countries is perhaps the greatest challenge currently facing society (Thirlwall, 2011). The concept of poverty is central to contemporary meanings invested in development and has waxed and waned within the development thought and have shaped development policy and action towards, or away from, direct goals of poverty reduction and eradication (Hulme, 2013). Quite a number of commentators in the field of development studies have emphasised that poverty reduction and poverty alleviation strategies must be placed at the very core of development practice (Hulme, 2010; Potter et al., 2012).

Development is a contested concept, with there being no clear consensus about its meaning (Escobar, 2006) despite it being a widely used concept today. The term came to prominence in the academic literature after the Second World War when major political and social changes were taking place in the Third World, which was largely defined in terms of economic poverty. One landmark event was US President Harry Truman's inaugural address in January 1949, which introduced the term 'underdeveloped areas' and marked the launch of the global effort to develop the world and eradicate poverty (Potter et al., 2008). The fear of communism became one of the most compelling arguments for development, it being a widespread concern among Western governments that if poor countries were not rescued from poverty they would succumb to communism (Escobar, 2006). A clear illustration of such work was Rostow's highly influential book, *The stages of economic growth: a non-communist manifesto* (Rostow, 1960). Rostow, like many academic and policy authors in this period, described and defined development in relation to the concept of economic growth, although a range of other framings, such as modernisation, distributional justice or socio-economic transformation also emerged (see Hodder, 1968; Brookfield, 1975; Lipton, 1977; Robert, 1978; Mabogunje, 1980; Harriss, 1982; Chisholm, 1982).

Ever since Truman's speech, a wide variety of strategies have been tried to enhance the development of the world's poorer countries. There are a great number of explanations for underdevelopment and concepts of development. Different positions in development policy are based on differences in underlying development theories. Theory is the critique, revision and summation of past knowledge in the form of general propositions and the fusion of diverse views and partial knowledge in general frameworks of explanation (Pieterse, 2009). Development theories are collective theoretical accounts of how desirable change in society might be best

achieved or are accounts of the problems created by attempts to create positive changes. They reflect the diverse political positions of their adherents, their place of construction, their philosophical perspectives and whether their disciplinary locations. Different theories have been associated with development over time as illustrated in Table 2.1.

Table 2.1: Meanings of Development over time

Period	Perspectives	Meaning of Development
1800s	Classical Political Economy	Remedy for progress, catching up
1870>	Latecomers	Industrialisation, catching-up
1850>	Colonial Economics	Resource management, trusteeship
1940>	Development Economics	Economic growth-industrialisation
1950>	Modernisation Theory	Growth, political and social modernisation
1960>	Dependency Theory	Accumulation-national, autocentric
1970>	Alternative Development	Human flourishing
1980>	Human Development	Capacitation, enlargement of people's choices
1980>	Neoliberalism	Economic growth-structural reform, deregulation, liberalisation, privatisation
1990>	Post-Development	Authoritarian engineering, disaster
2000	Millennium Development Goals	Structural reforms

Source: Pieterse (2009), Trends in Development Theory.

In the 1970s, a series of critiques emerged around all these conceptions of development, notably from variants of Marxism. Dependency theory like modernisation theory emerged in the post-war period, although was often based on Marxist understanding of economic relations and power. The theory was developed in the late 1950s, in part through the work of the Director of the United Nations Economic Commission for Latin America (Prebisch, 1959) who highlighted that economic growth in the advanced industrialised countries did not necessarily lead to growth in the poorer countries. According to dependency theory, underdevelopment is seen as the result of unequal power relationships between rich developed capitalist countries and poor developing ones. Thus, economic activity in the richer countries often led to serious economic problems in the poorer countries. The concept of dependency as an explanation for economic underdevelopment was developed most prominently by Baran and Frank (Baran and Frank 1957, Frank 1966, 1972 1979 and Amin 1974). Instead of being developed by their connections with the centre of the global capitalist order, dependency theory argued that peripheral societies were always placed in a position of dependency on the core, and in effect were being actively underdeveloped by the core.

Dependency theory was criticised by Marxists for its focus on exchange relations over relations of production. The criticism was based on Frank's conception of capitalism in terms of a certain kind

of market exchange relation, with production oriented towards the market. The critics argue that his conception of underdevelopment is not set forth in terms of a class analysis (Chilcote, 1974; Petras, 1981). By focusing on exchange relations, it pays relatively little attention to relations of production, as a result neglecting the analysis of social relations of production and consequently the configuration of classes and their relationships. Without an analysis of the social relations of production, there are no classes, no class struggle and consequently no revolution. One outcome of such work was the development of world systems analysis, associated with the work of Wallerstein. According to Wallerstein (1974), poverty is a direct consequence of the evolution of the international political economy into a fairly rigid division of labour which favoured the rich and penalised the poor. He argues that the modern world system is distinguished from empires by its reliance on economic control of the world order by a dominating capitalist centre in systemic economic and political relation to peripheral and semi peripheral world areas. Wallerstein rejects the notion of a "Third World", claiming that there is only one world connected by a complex network of economic exchange relationships - i.e., a "world-economy" or "world-system" in which the "dichotomy of capital and labour" and the endless "accumulation of capital" by competing agents (historically including, but not limited, to nation-states) account for frictions.

All these strands of Marxist/neo-Marxist work was criticised by proponents of economic growth centred theories of development, and associated perspectives such as modernisation, distributional justice and socio-economic transformation, not least for providing a largely critical account that seemed to provide no room for practical actions to improve the lives of people. In contrast, there continued to be strands of development theory that focused on providing practically orientated perspectives. Examples include: Cowen and Shenton (1996) argument that development refers to remedies for the shortcomings and maladies of progress; Hette's (2008) claim that development implies intentional social change in accordance with societal objectives; Pieterse's, (2009) definition of development as organised interventions in collective affairs according to a standard of improvement. Kothari's (2005) and Potter et al.'s (2008) definitions of development as attempts to reduce poverty and world inequalities in an effort to guide the world to a situation of betterment and improvement over time, and Potter and Conway's (2011) associated definition of development as a systematic effort to improve conditions for the poor, disadvantaged and excluded majority in ways that might help improve the lives of members of the general population and intrinsically guide development and improve human welfare. The work of Kothari, Potter at al., Potter and Conway, demonstrate how these studies often had a clear emphasis on the benefits of development. Saul (2004:230), for example, argues that: "the very

essence of development studies is a normative preoccupation with the poor, marginalised and exploited people in the South". Chamber (1985) similarly argued that development theories should be focused around actions that helped the poorest amongst society to demand and control more of the benefits of development. Therefore, for development to thrive it must continue to evolve in ways that increasingly address the range of concerns that are expressed by ordinary people in their daily lives, most notably in those countries or regions where such daily lives are often a struggle for existence with the intention to lift them out of poverty.

From the mid-1980s, there was a growing focus on understanding of development as capacitation (Sen, 1999). The focus of this concept was outlined in the Human Development Report of UNDP as "the enlargement of people's choices" which was seen as being usually achieved by expanding human capabilities. Another perspective on development at the heart of poverty reduction around the same time was Neoliberalism. Neoliberalism is a term used to describe an economy where government has few, if any, controls on economic factors (Harvey, 2005). Put simply, economic factors are shifted from the public sector to the private sector. Neoliberalism promoted the idea that poverty depended solely on inability to develop economically (Green, 2006). The IMF and World Bank were the most high profile pushers of neoliberal economic policies. The strategy involved applying strict "structural adjustment conditions" on their loans to promote poverty reduction strategies through quantifiable measures. These conditions were invariably neoliberal reforms where the central objective of economic growth were envisioned to be achieved through structural reform such as privatisation of utilities (see section 2.7), liberalisation and deregulation.

In the 1990s, the concept of post-development theory emerged, associated particularly with the work of Escobar. Highly influenced by notions of post-modernism and post-structuralism, this approach focused on the problems associated with attempts to foster development, arguing that they often not only failed to create the outcomes they promoted but also created a series of other problems, not least in perpetuating relations of dependency. Post-development theorists such as Sachs (1992), Escobar (1995), Estera (1996) and Rist (2003) saw the concept of development as a tool for the consolidation of Western hegemony, arguing efforts to establish development were always unjust, never worked, and had now clearly failed. Development theory and practice were critiqued for, amongst other things, ignoring the local values and potentialities of traditional communities are largely ignored (Rist, 1990) promoting Western power as science (Nandy, 1988) and giving rise to 'laboratory states' (Vishvanathan, 1988). Post-development theorists argue for the development of more localised and pluralised ideas about development (Ferguson, 1990;

Escobar, 1995)., and suggest that Westernised notions of development worked by discursively creating 'abnormalities' such as underdevelopment, backwardness, landlessness and indeed poverty, before then proceeding to establish actions to address them in what is constructed effectively as a normalisation programme that denies the value of local cultures.

Development efforts have sought to increase income, lift poor people out of poverty and improve their quality of living. However, from the various development theories outlined, this study is situated closely under the human development perspective. Human development is an approach that focused on people, their opportunities and choices, and to date, it remains useful to articulating the objectives of development. One of the basic objectives of human development is to have access to the resources and social services needed for a decent standard of living. The lack of access to electricity is a major constraint to economic growth and increased welfare in developing countries. The access to modern energy services and levels of electricity consumed are important in evaluating human well-being and economic growth. Empirical studies of the linkages between energy use and Human Development Index (HDI) indicate a strong correlation between energy consumption per capita and improved living standards (Goldemberg, 2001; Smil, 2003; Dias et al. 2006). The IEA (2010) devised the Energy Development Index (EDI) to better understand the role that energy plays in human development (see section 2.3.2). The United Nations (2015) builds on the Millennium Development Goals (MDGs) to launch a new Sustainable Development Goals (SDGs) with goal number 7 aimed to ensure universal access to affordable, reliable, sustainable and modern energy for all. Therefore, improving access to cleaner and modern forms of energy and the services it provide is a requisite for households' productivity and a sustainable economic growth, which is an essential requirement for overcoming poverty. Thus, freeing people from the grip of poverty is a vital task of development and making sure people have access to the basic things they need is essential for development to take place. Development is not possible without energy, and sustainable development is not possible without sustainable energy (UN, 2012). Energy is vital for eradicating poverty, improving human welfare and raising living standards (UNDP, 2000). Modern energy services are very essential to the smooth and meaningful development of a society by supporting the economy and promoting the well-being of an individual.

Development was first measured from the 1950s to the early 1980s in terms of economic growth, by means of Gross Domestic Product (GDP) and Gross National Product (GNP) per capita and in particular growth of production and income (UNDP, 1990; Thirlwall, 2011). The Gross Domestic

Product (GDP) per capita measures the value of all goods and services produced by a nation or a territory, whether by national or foreign companies. The Gross National Product (GNP) per capita is the Gross Domestic Product to which net income derived from overseas is added. This approach uses income per head of the population as a measure of development, suggesting that the higher the income of a country or territory, the greater is development (Potter et al., 2012). Thus, the growth of GDP/GNP was taken as a measure of development. This approach uses the standard of living of country as summary measure of development (Thirlwall, 2011).

From the late 1980s to the 1990s, development was recognised in the promotion of wider indices of human development: the Human Development Index (HDI), where it was increasingly recognised that non-economic factors are involved in the process of development (UNDP, 1990; 2010). In the original HDI, emphasis was placed on assessing human development as a more rounded phenomenon of three principal dimensions of: a long and healthy life (longevity); education and knowledge and a decent standard of living. The Human Development Report 2010 (UNDP, 2010) translated and changed the formula of the three dimensions of health, education and living standard into four indicators: life expectancy, mean years of schooling, expected years of schooling and Gross National Income per capita. These are then summed to give a single HDI. The measures are then transformed into an index ranging from 0 to 1, from the lowest to the highest levels of assessed human development, to allow equal weighting between each of the three dimensions. The closer to one the more developed a country is and vice-versa (UNDP, 2010). The HDI has been widely criticised and despite these criticisms, the HDI continues to be used today and is important because it consistently draws the attention of governments, corporations and international organisations to portions of development, which focus on aspects other than income like health and education (UNDP, 2010).

The multidimensional nature of development continued from the 1990s to the start of the twenty-first century, whereby wider sets of factors, reflecting more subjective and qualitative dimensions of self-esteem, social welfare and human rights were included as components of development equation (Sen, 1999). These views represent wider aspects of development that are vital, particularly those that relate to the quality of people's daily lives, their freedom from various inequalities, and the attainments of human rights and basic freedom (Potter et al., 2012). This brings about the Millennium Development Goals (MDGs) with associated targets and indicators designed as instruments to steer the world to enhanced levels of development, while the present-day Sustainable Development Goals (SDG) seek to build on the Millennium

Development Goals and complete what MDGs did not achieve. The SDG recognise that eradicating poverty, in all its forms and dimensions including extreme poverty is the greatest challenge and an indispensable requirement for sustainable development. Concisely, development implies increased productivity, higher levels of consumption per capita and a shift from primary to secondary and tertiary economic activities. This can also be likened to the energy ladder concept where a progressive movement of energy consumption from primitive to transition and modern/advance form of energy often leads to increased households' economic growth. However, for development to be meaningful, the concept of accessibility is crucial and attention must be paid to an analysis of the access of the poorest of the poor to resources (Mabogunje, 1980:42) such as potable water, education, health-care, electricity.

Energy is one dimension or determinant of poverty and development. There is a two-way relationship between the lack of access to adequate and affordable energy services and poverty and a direct connection between access to modern energy and human, social and economic development (Mbewe, 2000; UNDP, 2006). The connection between energy and poverty is established by the fact that the poor in developing countries constitute the bulk of the estimated 2.7 billion people relying on traditional biomass (wood, coal, charcoal, or animal waste) for meeting their basic energy needs and the vast majority of the 1.4 billion without access to grid electricity (IEA, 2011; GEA, 2012). The relationship reveals a vicious cycle in which people who lack access to cleaner and affordable energy are often trapped in a re-enforcing cycle of deprivation, lower incomes and the means to improve their living conditions (GEA, 2012). In addition, these people use significant amounts of their very limited income on expensive and unhealthy forms of energy that provide poor and/or unsafe services. Most of these people live in Africa and South Asia (Figure 2.2).

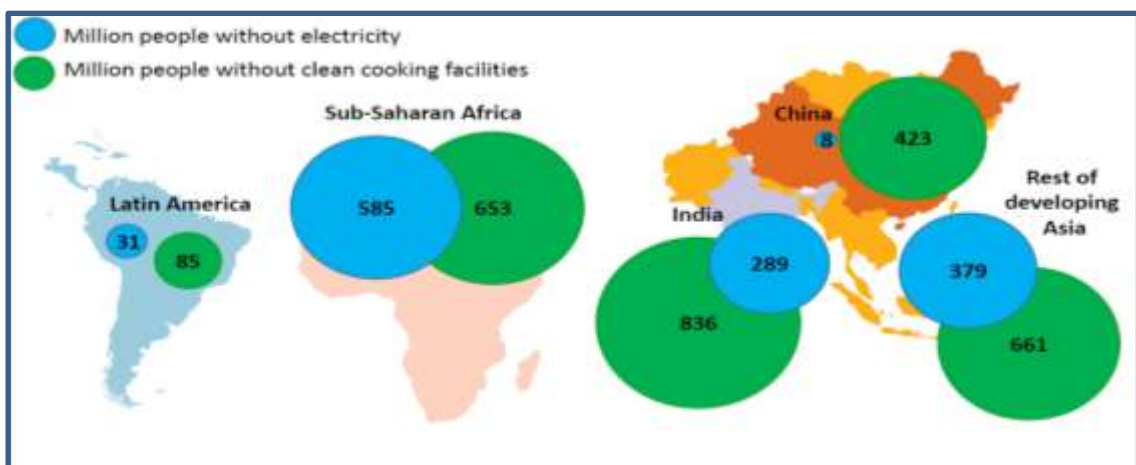


Figure 2.2: Number of people (million) without electricity and clean cooking facilities

Source: International Energy Agency (IEA, 2012)

In many Africa countries, domestic energy is largely sourced from biomass (fuelwood, charcoal and other biofuels such as animal and crop residue). Fuelwood provides over 80 per cent of energy consumed (Courier, 1986; Karekezi, 2002) and the demand is very high because it is the poor people energy source in both urban and rural (Parisot, 1986). Sub-Saharan Africa has the largest proportion of its population having a combination of low access to electricity and reliance on solid fuels, while the largest numbers of the people with limited electricity access live in Asia (IEA, 2009; 2011; World Bank, 2011a) as shown in Table 2.2.

Table 2.2: Number, share of people and percentage of population without access to modern energy services in selected countries, 2009.

	Without access to electricity		Relying on traditional use of biomass for cooking	
	Population (million)	Share of population (per cent)	Population (million)	Share of population (per cent)
Developing Countries	1 265	24	2 588	49
Africa	590	57	698	68
DR of Congo	58	85	63	93
Ethiopia	65	77	82	96
Kenya	33	82	33	80
Nigeria	79	50	117	74
Tanzania	38	86	41	94
Uganda	29	92	31	96
Other sub-Saharan Africa	286	66	328	75
North Africa	1	1	2	1
Developing Asia	628	18	1 814	51
Bangladesh	88	54	149	91
China	4	0	387	29
India	293	25	772	66
Indonesia	63	27	128	55
Pakistan	56	33	111	64
Philippines	16	17	47	50
Vietnam	2	2	49	56
Rest of Dev. Asia	106	34	171	54
Latin America	29	6	65	14
Middle East	18	9	10	5
World	1 267	19	2 588	38

Source: IEA (2012), Measuring progress towards energy for all: IEA, p.532.

The IEA (2009) asserts that 10 per cent of the urban population in developing countries lack access to electricity, compared to 41 per cent of the rural population. An estimated 1.5 billion

people (28 per cent of the population) lack access to electricity in developing countries; 824 million people (79 per cent of the population) in least developed countries (LDCs); and 777 million people (74 per cent of the population) in sub-Saharan Africa (SSA) (IEA, 2009).

Energy is essential to addressing many of today's global development challenges (Nussbaumer et al., 2011) and is naturally the prime mover of economic growth and development (Smil and Knowland 1980:1). Energy is a social necessity and a resource (Darby, 2010) and it is required globally to drive and sustain development (World Bank, 2009; UN, 2010; IEA, 2011; GEA, 2012). The World Energy Assessment (WEA, 2000:31) conclude that: "providing adequate, affordable energy is essential for eradicating poverty, improving human welfare and raising living standards worldwide". A number of interrelated aspects are to be considered when looking at the energy-poverty-development nexus. These include notably persistent poverty and inequality, lack of access to modern energy services, climate change and sustainable development (Nussbaumer, 2012). In addition, are several important issues like energy security and other forms of environmental damages that accompanies energy-use pattern (Nussbaumer, 2012). The environmental impacts of energy sprawl continue to generate concerns and draw the attention of scientists, policymakers, citizens, and environmental groups particularly to the growing global attention on climate change and greenhouse gas emission (GEA, 2012).

Energy plays a critical role in attaining the Millennium Development Goals (MDGs) and improving the lives of poor people across the world - a useful reference of progress against poverty by 2015 and a benchmark for possible progress much beyond that. One clear indication is the absence of a specific Millennium Development Goal (MDG) for energy services of how the theme of energy access had been overlooked in international policy processes. Greater access to, and quality of such services are now considered crucial for meeting the MDGs, even to the extent that universal energy access has been depicted as the "missing MDG" (Modi et al., 2005). A close link has been established between energy use and the eight Millennium Development Goals (Modi et al., 2005; Takada and Fracchia, 2007; UN, 2009; Nussbaumer et al., 2011). Access to a wide range of energy services is a key factor for promoting social progress and economic development that are directly linked to sustainable poverty reduction (DFID, 2002). There is no historical evidence of development and poverty reduction without expanding the use of energy (Saghir, 2005). Recent analysis shows that much remains to be done to expand access to modern energy to facilitate the MDGs (UNDP and WHO, 2009). The World Summit on Sustainable Development (2002) noted that access to modern energy services is fundamental to fulfilling basic social

needs, driving economic growth and fuelling human development. The adequate, affordable and reliable supply of energy is the lifeblood of modern society (Bradshaw, 2010). Over the past decade and in recent times both public and private institutions have broadly analysed energy supply, demand and consumption on a nationwide and worldwide basis (Munasinghe et al., 1993; WEC.TNC 2004; IEA, 2010; Practical Action, 2010).

The provision of a secure and affordable energy to promote living and economic growth has been viewed as the domain and responsibility of government. However, there is a growing attention to the issue of governance as they relate to energy at the global, regional, national and local levels and a growing literature examining global energy governance that recognises the importance of actors, institutions, and processes in addressing diverse challenges including security, climate change and environmental sustainability. Governance has become an increasingly fashionable term, used across multiple disciplines, including political science, law, public administration, economics, sociology, geography and history (Kersbergen and Waarden, 2004). The emergence of the focus on governance (especially as it relates to development) is linked in many ways to processes of neoliberalism and globalisation, which encompasses the global shift from the 1970s onwards to financial deregulation, trade liberalisation, and the consolidation of global production networks (Scholte, 2005). The traditional ways of state-based regulations have been seen as limited in their capacity to govern society, both domestically and internationally and as such non-state actors such as firms, local and national activist groups and civil society organisations have come to play a more important role in issues of public policy (Strange, 1996; Bazilian et al., 2014). There are the emergence of indicators seeking to assess various dimensions of governance such as the World Bank Institute's Governance Matters Indicators which consider issues such as accountability, political stability, rule of law, and control of corruption (Kaufmann et al., 2010). Additionally are the measures to control corruption which in turn is measured by its own set of metrics, notably the Transparency International annual Corruption Perception Index (TI, 2013). According to Grindle (2012) development practitioners and analyst have argued for a more pragmatic emphasis on "good enough governance" that meets the core functions and needs of the poverty reducing development, and encourages improvement and innovation.

Energy governance refers to the actors, institutions and processes that shape how decisions are made about the provision of energy services (Florini and Sovacool, 2011). Sovacool and Florini (2012) listed the actors connected to energy as governments, NGOs, civil society groups, corporations, citizens, and public-private partnerships (PPPs), as well as the institutions or rules

according to which decisions are made and the processes of agenda setting, negotiation, implementation, monitoring and enforcement of rules related to energy. Notwithstanding its importance to countries' socio-economic development and global security, it is only relatively recently that an attempt at a broader examination of energy governance has been undertaken (Goldthau, and Witte, 2010; Florini and Dubash, 2011; Sovacool and Florini, 2012; Van de Graaf, 2013). The energy subject consists of multidimensional issues, replete with public goods problems and externalities, which go beyond the jurisdiction of national governments, limiting their ability to address these issues unilaterally (Cherp et al., 2011; Goldthau, 2012; Karlsson-Vinkhuyzen et al., 2012). Widespread problems such as corruption in the construction and delivery of energy infrastructure, operation of energy utilities and sale of services to consumers, and the prevalence of revenue losses (theft) of energy by those who cannot afford it, or choose not to access energy services legally are all issues of interest in governance (Smith, 2004; Depuru et al., 2011; Tasdoven et al., 2012; Jamil, 2013). There is an emerging consensus that current global energy governance is unsuited to addressing modern day challenges (Victor and Yueh, 2010; Florini and Dubash, 2011), and there is need for a more cohesive framework to address global challenges (Bazilian et al., 2014). The lack of appropriate energy governance at the global level has necessitated the formations of partnerships between groups of countries and institutions to fill some of the gaps, but such efforts can potentially lead to an incoherent institutional framework, and correspondingly uncoordinated actions (Florini and Sovacool, 2009).

Energy access (specifically electricity), for the services it provides, is crucial to development. Access to electricity is not only a result of economic growth; electricity access also contributes actively to economic growth (Biol, 2007). Incidentally, reliability, and not just access, is very important to sustainable economic growth (IEA, 2010). The IEA (2011f) defines "energy access" as: "a household having reliable and affordable access to clean cooking facilities, a first connection to electricity and then an increasing level of electricity consumption over time to reach the regional average". "Access" also involves a minimum level of electricity use, assuming five people per household, at 250 kilowatt-hours (kWh) in rural areas and 500 kWh in urban areas. Modern energy use, particularly electricity, is related to economic development (UNDP, 2005; Besant-Jones, 2006). Therefore, electricity consumption per capita is a good indicator of the socio-economic development level of a country. The growth, prosperity and national security of any country are critically dependent upon the adequacy of its electricity production and supply industry (Roadmap for Power Sector Reform, 2010).

The International Energy Agency (IEA, 2008:37), in the introduction to its World Energy Outlook, suggested that what is needed is nothing short of an energy revolution. It further states that “the world’s energy is at a crossroad, it is no exaggeration to claim that the future of human prosperity depends on how successfully we tackle the two central energy challenges facing us today: securing supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply”. However, in many developing countries, while demand for energy is continuously increasing, its supply is not increasing proportionately (Chen et al., 2009). According to Bradshaw (2010: 282), the central proposition is that the nature of the energy dilemma facing a particular region, state or world region is shaped by the interplay of energy security concerns (both security of supply and security of demand) and the processes of economic globalisation (and the associated drivers of economic and population growth, industrialisation and urbanisation). The biggest challenge, therefore, lies in providing energy for the most disadvantaged population groups, those without capital, knowledge and influence (Practical Action, 2009).

2.3 Energy Poverty

Energy poverty is a growing global problem emanating from a combination of rising energy cost and inadequate income resulting into many households struggling to pay for basic essentials of electricity. Energy poverty has long been defined in Developing-Rural or Western-Urban contexts. Western-Urban refers to industrialised states where energy poverty is defined in terms of social exclusion and material deprivation (Healy, 2003 and Buxar, 2007). A good number of researches has focussed more on the energy access requirements of rural communities and are the priority of many policies and global programmes. The “Developing-Rural context” is specifically targeted to rural areas in developing states where the definition of energy poverty is computed based on estimated energy required to provide electricity for lighting and energy-dense fuels for cooking in a rural locale (Goldemberg et al., 1987; Foster et al., 2000; Pachauri and Spreng, 2004; Parajuli, 2011; Sovacool, 2012). Globally, it has been estimated that 1.6 billion people lack access to electricity while 2.5 billion people rely on biomass for cooking (Modi et al., 2005).

The need to provide an adequate energy supply to meet the ever-growing demand and overcome energy poverty is a major concern and challenge to many developing nations of the world. The IEA (2010) notes the lack of access to modern types of energy as the general focal point in the context of developing countries, while the broader issues that prevent people from satisfying their basic energy needs are the focus of the energy poverty problem in developed countries. Energy

poverty continues to be an especially acute problem in sub-Saharan Africa and many parts of Asia, where it continues to constrain human and economic development (Foster and Briceño-Garmendia, 2010; World Bank, 2013). The context upon which energy poverty is defined differs across country but largely indicates the situation where there is lack of access to clean and efficient sources of energy to the households for their basic activities. Energy poverty could take the form of insufficient quantity, poor quality and low access to energy (Agba, 2011) and a key detriment to labour productivity, economic growth, and social well-being (Oldfield, 2011). Energy poverty is a major barrier to growth and development, which is widespread in vast areas of the world (Club De Madrid, 2007). Thus, energy poverty has no geographical barrier and is not limited to either developed or developing as it spread across all countries of the world though with diverse degrees of intensity. There are no “easy fix” solutions to the challenge of energy poverty, as those most affected are typically the marginalised people of their countries (Bazilian et al., 2013). It can only be reduced if electricity and the services provided by modern energy services is made available on an affordable basis and resources are equitably distributed (Adegbulugbe, 2011).

A major challenge in energy poverty research is the lack of internationally recognised definition and measure of energy poverty. There are various conceptualisations of the phenomenon but there is actually no universally accepted definition of energy poverty. There are various terms used in the literature to describe a lack of access to energy. These terms are normally based or restricted to the scope of that study. The most commonly used term to describe lack of energy access include “energy poverty”, “energy precariousness”, “energy deprivation” and “fuel poverty” (Bouzarovski, 2013). Popular conceptualisations of energy poverty are usually based on minimum physical levels of basic energy needs, minimum energy expenditure required and maximum proportion of energy expenditure in relation to total disposable income or expenditure (Pachauri and Spreng, 2003; Ogwumike et al., 2012). Several attempts have been made to define energy poverty (Foster et al., 2000; UNDP, 2000; Gaye, 2007; Practical Action, 2010; Boardman, 2010; IEA, 2010).

At a household level, this refers to the lack of modern cooking fuels and minimum electricity for lighting purposes (World Bank and UNDP, 2005). Bouzarovski et al. (2012) views energy poverty as a situation where a household is unable to access a socially and materially-necessitated level of energy services in the home. The UNDP (Gaye 2007:4) conceives of energy poverty as the “inability to cook with modern cooking fuels and the lack of a bare minimum of electric lighting to

read or for other household and productive activities at sunset”. The OPEC Fund for International Development (OFID) (2010) defined energy poverty as the lack of adequate, accessible and affordable energy to promote economic growth and meet basic human needs. The Department of Energy and Climate Change (DECC, 2001:6) and the Department for International Development (DFID, 2002) provides a UK description of energy/fuel poverty to mean a state where households are spending more than 10 per cent of their income on energy. The European Union (EU) has not arrived at a common definition of energy poverty but the European Anti-Poverty Network (EAPN, 2008) put it as: “not being able to heat and fuel your home to an adequate level”. Pokharel (2006) defines energy poverty, as a state of insufficient energy sources for basic living with energy requirement satisfying human needs range from 1.0 to 1.3 TOE per annum (0.8 HDI).

The quantitative benchmark that exist in the energy poverty literatures were defined for the lack of access based on physiological needs and purchasing power for a fixed amount of basic needs in goods and services. Access refers to the physical proximity and availability to modern energy carriers of electricity. Access in a much broader sense refers to the quantity requirements that are affordable and stable services, which are delivered in a reliable fashion and ensure consistent quality (Pachauri and Spreng, 2003). The Global Energy Assessment (GEA) in 2012 introduced sustainability components of cleaner energy options to the definition of energy poverty. The IEA (2009) defines energy access on the basis of three incremental levels of access to energy services: (1) Human Needs, (2) Productive Uses, and (3) Modern Energy Services (AGECC, 2010) (Figure 2.3).

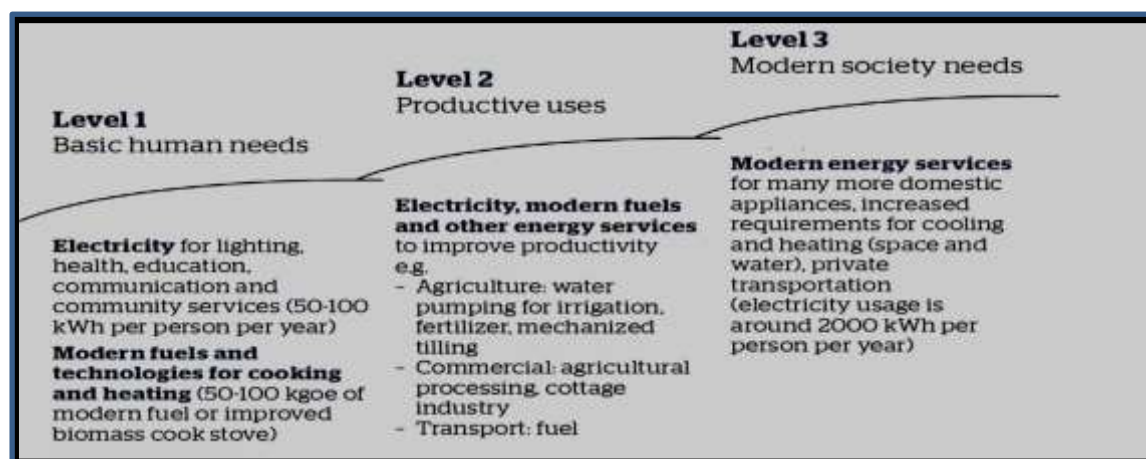


Figure 2.3: Incremental levels of access to energy services

Source: AGECC (2010) Energy for a Sustainable Future, UN, New York, 13

Universal energy access is defined as “access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses”; this emphasises levels 1 and 2 (AGECC, 2010). Individuals with no or limited access to energy are commonly poorer than those with energy access; they are less productive, face heavier work, are more visible to health risks and lack the benefit of modern technologies and communication (Picolotti and Taillant, 2010). Energy access (or lack of it) is to a large extent influenced by the geographical locations and socio-demographics of communities and commonly used indicators in measuring energy access are availability, affordability, adequacy, convenience and reliability (IEA, 2012) (see section 2.3.2). There is therefore, the need for energy access metrics to reflect dimensions of both quality and quantity. Issues such as connection times, supply disruptions, outages, value of lost output, voltage quality, frequency stability and the need for on-site generation are often missing from the energy access agenda (World Bank, 2007).

The focus of this study is on the electricity component of modern energy services in the context of energy poverty in developing economies. The study scope is limited exclusively to households' needs even though other energy needs exist for a society to develop and thrive. For the purpose of this study, energy poverty is defined as the inadequacy of electricity in sufficient quantity and reliable quality in achieving households' socio-economic development. This definition of energy poverty takes a cue from the one given in 2000, by the United Nations Development Program (UNDP/Reddy) as “the absence of sufficient choice in accessing adequate, affordable, reliable, quality, safe, and environmentally benign energy services to support human development”. The study therefore adopts the UNDP/Reddy definition of energy poverty. The study definition of energy poverty offers a guide in the choice of methodology, design of the questionnaire and the indicators used with hindsight that the problem is not that of lack of access but of inadequacy and unreliability. Considerations were given to issues related to requirements necessary for households to have electricity access via connection to the national grid and the average daily hours of electricity supply to households. Other issues considered in designing the questionnaire were pricing as a matter of affordability and fees/levies that must be paid before households get connected to the grid as majority of the urban poor can barely afford the cost of energy supply, whether on-grid or off-grid. Furthermore, average monthly consumption in kWh and Naira were considered in relation to minimum average household consumption as specified by UNDP in addressing the problem of energy poverty and adequate provision of energy services. Electricity supply is critical to household's survival. The lack of access to electricity contributes to household poverty by diminishing the prospects of the local economy within which the poor mostly make their

living. Some of the components of energy poverty that create or reinforce household poverty include the question of supply. Nigeria suffers from the gross inadequacy of grid supply of electricity. With a mere daily generation of about 4,000MW for over 170 million people and one of the lowest per capita wattage in the world. This simply means that if electricity comes only from the grid, every Nigerians will suffer acute energy poverty.

The services that are required from energy are described in Figure 2.4. These services are essential to basic needs of life such as cooking, lighting, warmth, use of electrical appliances, health care (refrigeration of vaccines), communication and entertainment (radio, television, internet), education, transport. When the supply of modern energy services and goods falls below demand or expectation, energy poverty arises resulting in a decline in the living standard of families for sustaining their livelihood (Chaturvedi, 2010). The consequences of lack of energy access often contribute and result in poverty, deprivation and economic decline (Reddy, 2000).

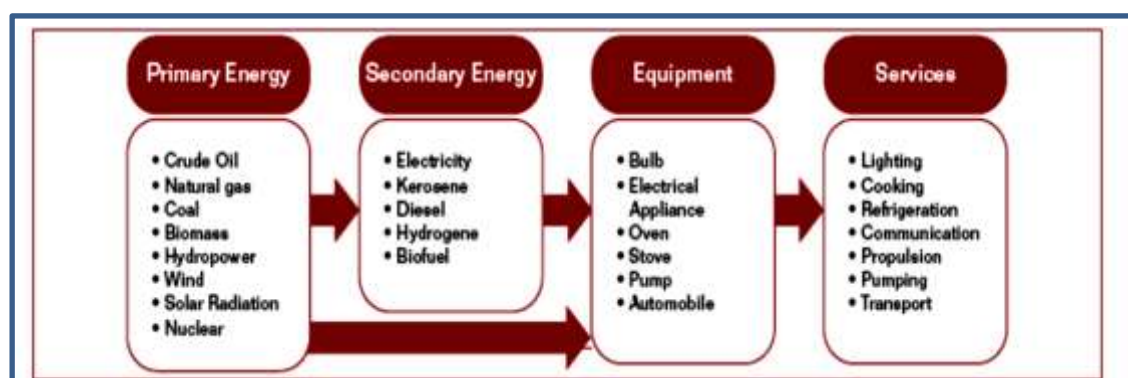


Figure 2.4: Defining energy services and energy chain source
Source: UNDP (2004); ECOWAS and UEMOA (2006)

The sub-Saharan Africa region has attracted increased attention. According to the IEA's new Africa Energy Outlook Special Report (2014), the region's energy resources are more than sufficient to meet the needs of its population-including excellent and widespread solar and hydro potential as well as wind and geothermal-but that they are largely under-developed. The report notes that the use of solid biomass (mainly wood and charcoal) outweighs that of all other fuels combined and that average electricity consumption per capita is not enough to power a single 50-watt light bulb continuously. The inequality in the access to energy services is at present manifest and illustrated by night-time light satellite imagery. The night-time light satellite imagery of the earth provides a spatial sense of the issue of energy poverty as it affects sub-Saharan African countries. As illustrated in figure 2.5, African continent remains largely in the dark with the

exceptions of few areas, notably in North Africa, along the Nile and in South Africa. According to IEA (2007), the annual average of electricity consumption in the World is about 2,600 KWh per capita. Figure 2.6 presents the correlation between human development and per capita electricity consumption. The energy consumption in sub-Saharan Africa is reflective of the levels of poverty. Residential electricity consumption excluding South Africa has been estimated to be equivalent of electricity consumption in New York. Put simply, the 19.5 million population of New York consumes in a year roughly the same quantity of electricity consumed by the 791 million population of sub-Saharan Africa (IEA, 2010).



Figure 2.5: Night-time light satellite image of the earth

Source: National Aeronautic and Space Administration (NASA)

<http://framework.latimes.com/2012/12/06/satellite-images-of-earth-city-lights-at-night/#/1>

The African continent is home to about seven per cent of the world's commercial energy production, yet it accounts for only three per cent of global commercial energy consumption (Practical Action, 2005). Africa faces significant challenges in providing electricity: it houses 13 per cent of the world's population, produces 3 per cent of its electricity with less than 30 per cent of the population having access (Global data, 2014), the lowest in the world, and if South Africa is excluded, the share declines further to 28 per cent (IEA, 2010). High levels of energy poverty in Africa are the driving force for African governments, donor agencies and NGOs to increase electricity access in Africa, whether by fossil fuels or renewable energy (Emordi, 2014). The increasing prominence of energy poverty is evidenced in the context of liberalisation, commercialisation and privatisation of state-owned power utilities sector in most of the developing economies (see section 2.7). The governance of the electricity sector has been a subject of

previous studies, which tend to cover the power sector as a whole or the wider energy sector (Victor and Heller, 2007; Burke, 2012; Bouzarovski et al., 2011; Rehman et al. 2012). Alleviating poverty and social exclusion is now gaining remarkable attention as issue in energy governance. A new approach to energy systems in the developed and industrialising world about energy futures and for the poorer nations is that all countries need to have access to clean, affordable and reliable energy services that do not exacerbate the climate change risks (Bazilian et al., 2013). Energy governance refers to the actors, institutions and processes that shape how decisions are made about how to provide energy services (Florini and Sovacool, 2011).

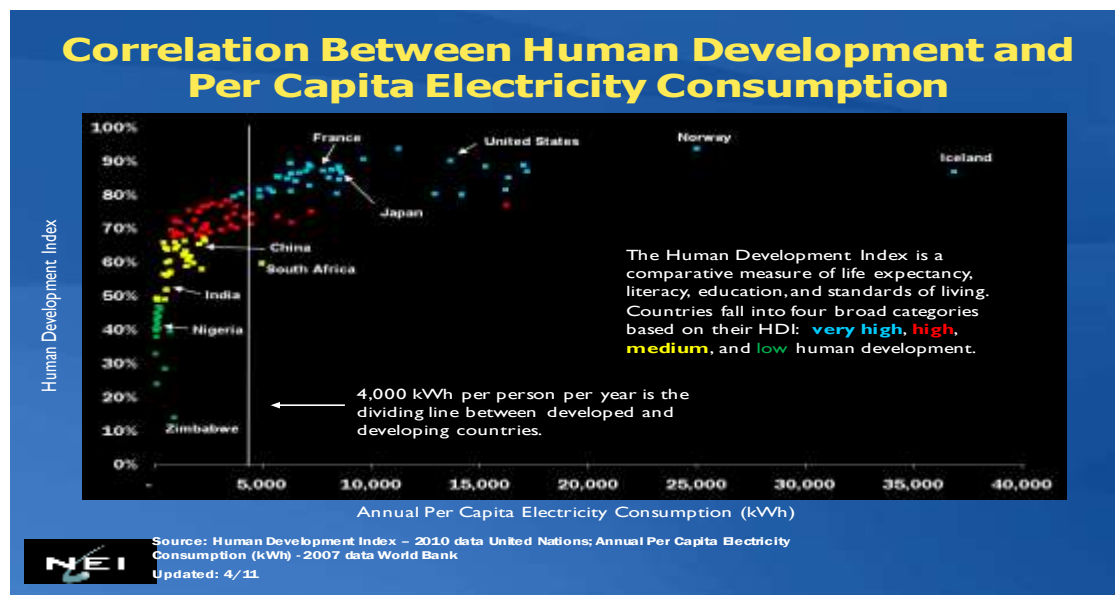


Figure 2.6: Correlation between human development and per capital electricity consumption
Source: Human Development Index – 2010 data United Nations; Annual Per Capita Electricity Consumption (kWh) – 2007 data World Bank

Overcoming this deprivation through the provision of clean, affordable, efficient and reliable energy services can provide benefits to the end users in terms of reducing child mortality rates, improving maternal health, reducing drudgery on women and young girls, as well as increasing productivity, enhancing competitiveness and promoting economic growth of the country as a whole (WHO, 2006; AGECC, 2010). Although access to energy is not one of the Millennium Development Goals, it is undoubtedly one of the prerequisites for the attainment of the goal (UN, 2010). The IEA (2011:8) observes that access to affordable and reliable energy services is essential in reducing poverty and improving health, increasing productivity, enhancing competitiveness and promoting economic growth in developing countries. These necessitate the response of the United Nations in addressing the global energy challenges by declaring 2012 to be the “International Year for Sustainable Energy for All”. The Sustainable Energy for All initiative

has set three objectives for 2030: ensuring universal access to modern energy services; doubling the rate of improvement in energy efficiency; and doubling the share of renewable energy in global energy use. The importance of energy to nearly every major challenge from lifting people out of poverty to reducing the risks of climate change; from powering businesses, schools and clinics to empowering women made the UN General Assembly (2014) to declare 2014 to 2024 the “Decade of Sustainable Energy for All”. The UN Secretary-General, Ban Ki-moon, in an effort to rectify the neglect of poverty created by energy, proposed a new goal to achieve universal access to modern energy services by 2030 (AGECC, 2010). Ban Ki-moon (2012) further stresses that energy is fundamental to everything, from powering the economy to achieve the anti-poverty targets known as the Millennium Development Goals (MDGs), from combating climate change to underpinning global security.

The continued lack of commitment shown by most of the countries participating in the MDGs’ programme to address the problem of energy deprivation is reflected in the level of energy poverty seen today in many developing countries (Florini and Sovacool, 2009; Cherp et al., 2011 and Scott, 2012). The International Energy Agency (IEA, 2011) estimates that about 650 million people of the population living in sub-Saharan Africa would still lack access to reliable electricity by 2030. This is because current actions to eliminate energy poverty are falling short both in terms of scale and pace and if current trends continue, more people in Africa will be without access to modern energy services in 2030 than today (IEA, UNDP and UNIDO, 2010). The OECD/IEA (2010), notes that, without significant political commitment and investment, energy poverty is set to deteriorate even further over the next 20 years. Therefore, an additional annual investment of \$18.5 billion is needed yearly up to 2030, to provide electricity to almost 600 million people currently without access to it (IEA, 2011).

The International Energy Agency (IEA, 2011:8) in its “Financing Access for the Poor” says about US\$48 billion will be required annually to fund the provision of global access to modern energy services toward the year 2030. Ninety per cent of this estimate accounts for access to electricity, while about US\$30 billion is estimated for the provision of modern energy services to the ten largest exporters of oil in sub-Saharan Africa. Prasad (2011) links the level of electricity access and the quality of energy service provision in sub-Saharan Africa to “low levels of consumption, unreliable power supply, power shortages, high electricity costs and unequal electricity access”. The World Bank (2007b) reports that increasing access to electricity in sub-Saharan Africa to 50 per cent will require about \$4 billion per year through 2030, excluding generation investments.

Cohen, 2006 and UN DESA, 2011 in their submission states that energy poverty problem cannot be solved without first determining what per capita energy consumption is for urban areas in developing states.

2.3.1 Urbanisation and Energy Poverty

It has been estimated that more than half of the world's population live in the urban area and they are the locus of energy demand growth with about 81 per cent of projected increase in world energy demand in the coming twenty years taking place in urban cities of the developing world. Poverty is an increasingly visible urban phenomenon. An estimated one third of all urban residents are poor, which represents one quarter of the world's total poor (Ravallion, Chen, and Sangraula, 2007). The numbers of urban poor are predicted to rise (World Bank, 2008). Grimm and Guenard (2002:1074) conclude that "... it appears that poverty is no longer considered as being "solely" a rural phenomenon, but also more and more an urban problem. Poverty is believed to be a condition in which a household has a level of inferior comfort to what is accepted as a basic standard of modern life. The definition of urban poverty is related to the inability of family income to meet basic needs, such as food, housing, health, education, transportation, clothing, water and energy services (WEC, 2006). Poverty has been conceptualised to entail a web of deprivation and is defined in absolute and relative terms. According to Seragledin (1989:23), absolute poverty is the inability to secure the minimum basic needs for human survival. Relative poverty, on the other hand, relates to the condition of the lower 30 or 40 per cent of the income distribution in any country and embraces those who, although barely securing the minimum basic needs, have such limited resources that they lack the means of adequate social participation. Mabogunje, 2006, emphasises that what the poor loses by being caught in the trap is more than a matter of income and assets.

An estimated one third of the urban population in developing countries - almost a billion people currently live in slums (UN-Habitat, 2013). In sub-Saharan Africa, more than half of the urban population lives in slums. However, not all the urban poor live in slums. About 62 per cent of the urban population in sub-Saharan Africa lived in slums in 2012. According to the UN-Habitat (2007:19), "a slum is a group of individuals living under the same roof in an urban area who lack... durable housing, sufficient living area, access to improved water, access to sanitation and secure tenure. A sizable number of the more than 825 million people living in urban dwellings are without access to basic social services. Rapid urban population growth and the inability of governments to provide equitable distribution of services, like energy services, raises concern

about increased urban poverty (IEA, 2011; Tacoli, 2012; Niu et al., 2013). The growing phenomenon of urban poor and urban energy poor in developing regions of the world poses significant challenges to sustainable and inclusive development. This prompted the Global Network on Energy for Sustainable Development (GNESD) to initiate the Urban and Peri-Urban Energy Access (UPEA) study in 2006 to gain insights into the urban-peri-urban-energy access. Energy poverty is no longer a rural-only phenomenon given rapid world urbanisation. Energy affects all aspects of urban poor households' livelihoods and changes in the accessibility and cost of energy can have significant impacts not only on the more obvious physical and financial assets but also on social, natural and human assets and household livelihood strategies and aspirations (Barnes, 1995; Meikle and Bannister, 2003).

The urban growth (urbanisation) is attributed to the increase in the proportion of people living in towns and cities brought about by movement of people from the rural to the urban areas in search of better living conditions (Mabogunje, 2005; Kessides, 2006; World Bank, 2008). Urbanisation has been a common characterisation of developing countries, often leading to mushrooming of slums in urban areas (Karekezi et al, 2008). Sub-Saharan Africa with a growth rate of over 5 per cent has the fastest rate of urbanisation in the world, yet it is the least urbanised in the continent (Mabogunje, 2005). According to the UN-Habitat (2006:11), this growth rate doubles that of other developing regions of the world, for example, Southern Asia 2.89 per cent and Western Asia 2.96 per cent. Urban poverty rates are not only a function of urban growth but rather urban poverty reflects economic and institutional factors in cities (Kessides, 2006:17). The urban poor experience a different dimension of poverty compared to the rural poor (ESMAP, 2005; Kessides, 2006; Mabogunje; 2006). The infrastructure needs that go along with urbanisation can be enormous and many cities have not been able to keep up, and face daunting challenges for the future projected increases in urbanization. The problems of accessing infrastructure and services are particularly acute for the urban poor (World Bank, 2008). Around the world, increasing urbanisation has often facilitated increasing household access to modern energy (Reddy, 2000; Karekezi and Majaro, 2000; WEO, 2014) and contributes to sustained economic growth, which is critical to poverty reduction (World Bank, 2008). Access to basic social services is usually higher in urban areas but can be extremely low for the urban poor, characterise with inadequate quality and unaffordable, and therefore, rely on alternative sources of supply that may be of lower quality and are offered through self-provision. The electricity use per capita is low in sub-Sahara Africa, and in most sub-Sahara Africa countries, electricity consumption has stagnated because of low supply (ERS/USDA, 2008). The energy source purchased and the transition to clean modern

energy in urban areas is largely determined by income levels (see section 2.5). Several studies have been done in Africa countries to examine household access to energy services (Karekezi and Majoro, 2002; Meikle, 2006). These studies show that urban poor households use a combination of different energy sources to meet their households' energy needs. These combinations are often referred to as the energy mix (see section 2.5.1).

Empirical evidence have shown that the population density of the energy poor is higher in urban than in rural areas, with the rural-to-urban migration trend expected to increase over the next 30 years. Rapid migration rates and population growth are imposing pressures on urban electricity supply (Singh et al., 2014). Rapid migration usually entails changes both in production and consumption structures, which alter energy usage patterns (Bennett, 2008). Furthermore, rapid urbanisation and economic development stimulate the growth of electricity needs to grow even faster than overall energy needs (ERS/USDA, 2008). Urbanization is the driver of energy consumption and industrialisation drives energy demand. According to the UN-Habitat (2011), urban areas consume nearly three quarter of the world's commercial energy. As an enabler of development processes, access to electricity in urban contexts plays a key role in providing possibilities and solutions to the urban poor (Singh et al., 2014). Therefore, improved energy access is a crucial means of improving the quality of life and socioeconomic status of the urban poor.

There has been relatively less focus on how energy governance responds to the needs of the poor and a dearth of analysis of how governance arrangements at the global, regional, national and indeed sub-national levels address energy poverty, (Bazilian et al., 2014). Expanding energy access to the urban poor has not been given the requisite focus or priority in development agenda, research and policy (Baker 2008; GNEED 2008; SEA, 2014; Singh et al., 2014). A great deal of attentions has been devoted by Multilateral donor agencies towards increasing energy access. The associated reforms of recent have done little to incentivise the provision of energy services to the poor, nor to reduce overall figures of energy poverty especially in sub-Saharan Africa (Nakhooda, 2011).

The role of energy in sustainable urban livelihoods is gaining tremendous attention because of the direct and indirect impact on the livelihoods of the poor. Evidence linking provision of energy services with achievement of social objectives and generation of economic growth is strong and well documented (Modi et al., 2005). The linkage between energy services and social issues is

represented in Figure 2.7. The figure emphasises that energy services affects different aspects of human life (poverty, urbanisation, population, and lifestyle); although energy services is not a means to an end, it should be seen as a component that supports a number of human needs. In addition, energy has a gender dimension (see section 2.6) while other areas that are not shown such as water supply, maternal health, education and income are also influenced by energy services as captured in the millennium development goals (MDGs). Although, access to modern energy among the urban poor is still low, for instance, majority of the urban poor live in informal settlements around or within the urban areas, which are not well planned or structured to access modern energy services (Baker 2008; GNESD 2008; Karekezi et al, 2013). The informal nature of urban poor housing/residence oftentimes makes provision of modern energy sources to the urban poor difficult. This is evident in urban areas of emerging economies where high numbers of population live in deplorable dwellings, i.e., slums, without access to basic services thus constituting a major challenge to urban governance and design in developing countries (GNESD, 2008).

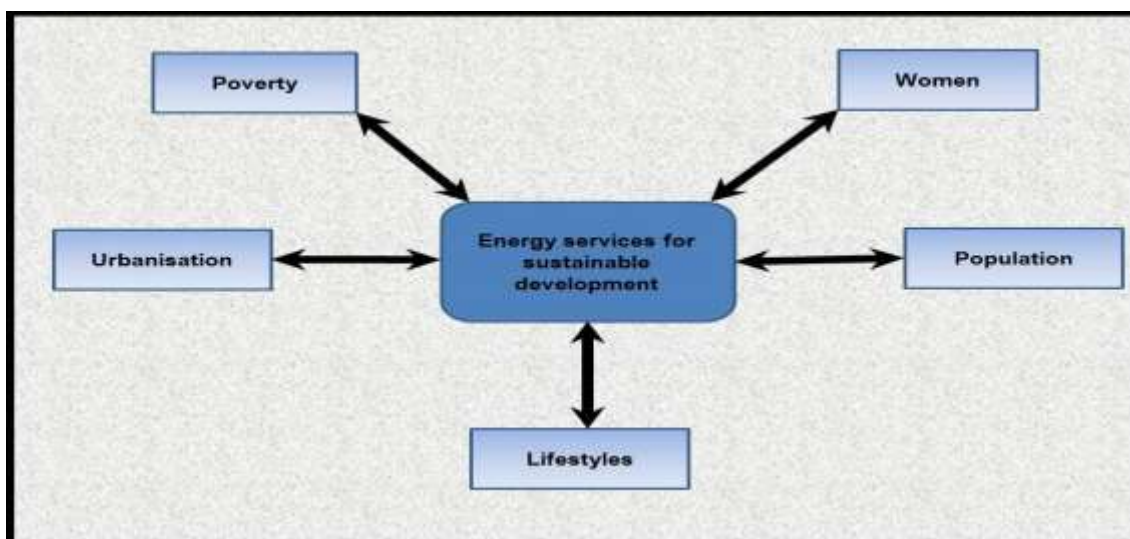


Figure 2.7: Energy and social issues
Source: Reddy (2000)

Developing countries are experiencing a widening gap between the wealthy and the poor, and their urban poor face barriers that prevent them from accessing basic infrastructure and services - including energy (Baker 2008). It has been estimated that the urban poor households spend a significant proportion of their limited income, as much as 25 per cent on energy (Barnes, 1995). The cost of living is typically high in the city and poor urban households give preference to energy sources that are cheap and easy to use for example kerosene for cooking and lighting. The main

energy source used by urban poor households is linked to availability and affordability. Urban population has been projected to reach 60 per cent by 2030, with the majority of this increase in developing countries and more people in Africa will be without access to modern energy by 2030 than today (IEA, UNDP and UNIDO, 2010).

Households require energy for essential services in order to satisfy basic human needs. Despite the fact that energy is considered a basic need, urban poor households continue to largely rely on unsafe, unhealthy kerosene (paraffin), biomass or coal and associated appliances as sources of energy for cooking and lighting, which are the two primary and most energy intensive domestic activities upon which households are entrapped in poverty. The unsafe and unhealthy use of these energy cause major ill health through indoor air pollution arising from combustion in poorly ventilated spaces and use of inefficient appliances in the absence of electricity. Electricity service provision is an important constraint that influences a household's choice to use electricity. The availability of electricity in urban areas is a catalyst to facilitate urban energy transitions from traditional to modern fuels thereby reducing indoor air pollution and carbon emissions. It provides access to essential services of the basic needs of modern life. Practical Action (2010) identifies six different kinds of essential energy service that electricity can be used to provide lighting; cooking and heating; space heating; cooling; information and communications; and earning a living. In order to be able to use electric power for these services, equipment or appliances are necessary, as well as a supply of electricity. However, there is a lack of clear targets for electricity access for the urban poor. Expanding electricity access to the urban poor has not been considered an urban and peri-urban issue. Therefore, improving electricity access to the urban poor will not only satisfy daily electricity needs and improve their quality of life, but also encourage income generation and critical to poverty alleviation (Sagir, 2005). Increased access to cleaner and affordable energy options contributes to monetary gains among the poor and leads to better quality of life, such as an improved diet and amount of food intake, the ability to afford better health and education facilities, and so on (Barnes et al., 2010). Therefore, for developing economies to follow the historical pattern of development through a path of industrialisation, adequate provision of access to electricity is crucial (Bazilian et al., 2013).

2.3.2 Metrics and Indicators of Energy Poverty

Energy poverty as other realms of poverty is measured using indicators and variables that provides explanation of both quality and quantity. Metrics are used for comparative purposes and to track progress towards targets and therefore represent an essential support tool. The use of

indicators and measurement tools is common in development practice and research, and in national and international policy, fiscal and regulatory organisations. The IAEA (2005:2) echoed that, "...indicators are not merely data; rather, they extend beyond basic statistics to provide a deeper understanding of the main issues and to highlight important relations that are not evident using basic statistics. They are essential tools for communicating energy issues related to sustainable development to policymakers and to the public, and for promoting institutional dialogue." Stiglitz et al., (2009) noted that statistical indicators are important for designing and assessing policies aimed at advancing the progress of society. A number of metrics, indices and models have been developed to assess and measure the level of energy poverty. Bazilian et al. (2010) review a selection of metrics in the sustainable development and energy space and summarise many of these indicators as single indicators; set of individual, non-aggregated indicators (or 'dashboard'); and composite indices (Table 2.3).

Table 2.3: Broad categories of sustainable development and energy metrics

Category	Example	Initiator	Reference
Single indicators	International poverty line (\$1 a day)	The World Bank	Chen and Ravallion (2008)
Set of individual indicators, or 'dashboard'	Millennium Development Goals Indicators	UN	UNSD, DESA Foster et al. 2000; IAEA (2005); Vera and Langlois (2007)
	Energy Indicators for Sustainable Development (EISD)	IAEA	
	Total energy inconvenience threshold	UN-U	Mirza and Szirmai (2010)
	Access-consumption matrix		Pachauri et al., 2004
Composite indices	Human Development Index (HDI) Energy Development Index (EDI) Multidimensional Energy Poverty Index (MEPI)	UNDP IEA Oxford Poverty & Human Development Initiative (OPHI)	UNDP (2010) IEA (2010) Patrick Nussbaumer, Morgan Bazilian, Vijay Modi, and Kandeh K. Yumkella (2011)

Source: Bazilian et al. (2010)

The upside of a single indicator is that it provides an unbiased message easy to interpret with regard to one specific dimension. The downside is that such metrics present a narrow picture of the issue measured and in some cases, it is appropriate, for example, measuring the level of economic activity. Single indicators are unsuitable for issues such as energy poverty or

sustainable development. Complex issues such as human development are multidimensional in nature and require a framework that captures the various elements. The MDG, with over 60 indicators, is an example of a dashboard that depicts a much more comprehensive representation that helps track progress on the commitment made in the United Nations Millennium Declaration. Composite indices are created as a compromise between the simplicity of uni-dimensional indicators and the need to account for the multidimensional nature of some issues. They address the shortcomings of one-dimensional indicator in an attempt to produce an outcome that summarises the information to single, easy to interpret metrics. They aim to capture the multidimensional aspects of an issue that cannot be depicted in a single indicator and have proven to be useful for benchmarking performance between countries

The International Atomic Energy Agency (IAEA, 2005) and Vera and Langlois (2007) provide definitions, guidelines and methodologies for the development and use of a set of energy indicators known as the Energy Indicators for Sustainable Development (EISD). Foster et al. (2000) are more specific about energy poverty, using three individual measures to quantify it, based on a pre-defined fuel poverty line. Mirza and Szirmai (2010) developed a new composite index to measure the degree of energy poverty among rural households in rural Pakistan. Practical Action 2010 report, "Poor people's energy outlook 2010" suggests an energy access index based on six essential energy services for which a minimum level of service is prescribed. Separately, it introduces a hybrid set of indicators that assign a numerical value to qualitative aspects of energy access in three main supply dimensions, namely household fuels, electricity and mechanical power. The IEA (2010) devised the Energy Development Index (EDI) in order to better understand the role that energy plays in human development. The Energy Development Index (EDI) is a multi-dimensional indicator that tracks energy development country-by-country, distinguishing between developments at the household level and at the community level (Figure 2.8). It focuses on two key dimensions: access to electricity and access to clean cooking facilities. At the community level access, consideration is given to modern energy use for public services (for example, schools, clinics and hospitals, water and sanitation, street lighting) and energy for productive use, which deals with modern energy use as part of economic activity (for instance, agriculture and manufacturing) (IEA, 2012). Figure 2.9 presents detailed results of 80 countries and ranks countries according to their overall EDI score. It also shows the relative contribution of each of the constituent indicators and shows a country's EDI score in 2002 for comparison. It is an indicator that tracks progress in a country's or region's transition to the use of modern fuels and helps to measure energy poverty by providing a rigorous analytical basis for policy-making.

The Energy Development Index (EDI) is a composite measure of energy use in developing countries (IEA, 2010). The EDI combines three indicators that are equally weighted: per capita commercial energy consumption, share of commercial energy in total final energy use, and the share of the population that has access to electricity. The EDI is calculated in such a way as to mirror the UNDP's Human Development Index and is composed of four indicators, each of which captures a specific aspect of potential energy poverty:

- Per capita commercial energy consumption, which serves as an indicator of the overall economic development of a country
- Per capita electricity consumption in the residential sector, which serves as an indicator of the reliability of, and consumer's ability to pay for, electricity services
- Share of modern fuels in total residential sector energy use, which serves as an indicator of the level of access to clean cooking facilities
- Share of population with access to electricity

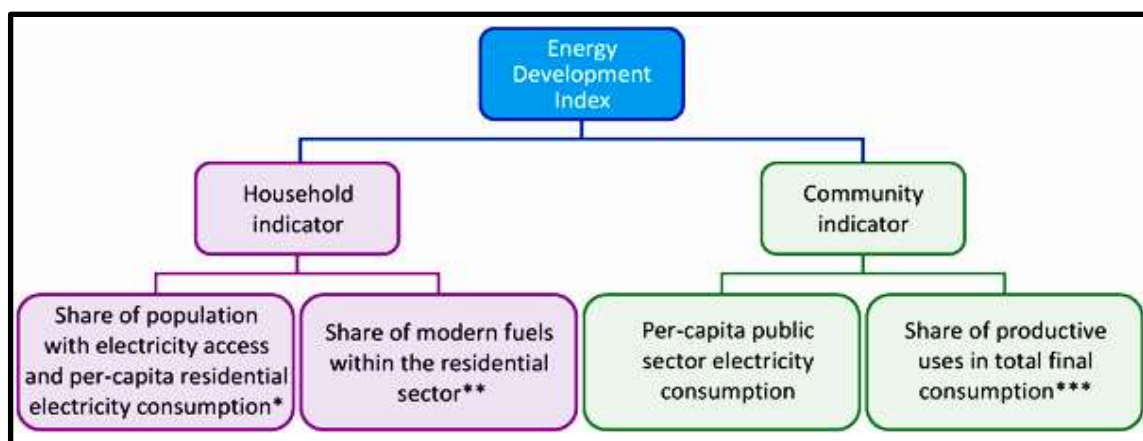


Figure 2.8: Components of the Energy Development Index

Source: International Energy Agency (IEA) 2012

Nussbaumer et al. (2011), evaluate a new metric to measure and report on energy poverty, the Multidimensional Energy Poverty Index (MEPI). While most existing indicators and composite indices focus on assessing access to energy, or the degree of development related to energy, the Multidimensional Energy Poverty Index (MEPI) – focuses on the deprivation of access to modern energy services. The index is composed of two components: a measure of the incidence of energy poverty and a quantification of its intensity. It captures both the incidence and intensity of energy poverty, thus, providing a new tool to support policy-making. The focus is on energy deprivation, as opposed to energy access under the assumption that energy consumption is correlated to development; in addition to the quality of the energy services delivered and/or their

reliability, as well as to the notion of affordability. According to Nussbaumer (2012:10) “MEPI captures the set of energy deprivations that may affect a person; it captures both the incidence (number of energy poor people) as well as the intensity (how energy poor they are)”. It is composed of five dimensions representing basic energy services with six indicators. A person is identified as energy poor if the combination of the deprivations faced exceeds a pre-defined threshold. The MEPI is the product of a headcount ratio (share of people identified as energy poor) and the average intensity of deprivation of the energy poor. The relationship that exists between electricity availability, energy usage and socio-economic characteristics must therefore, be very strong and is essential towards overcoming the obstacle and deprivation associated with human, social and economic development of developing nations of the world in achieving the Millennium Development Goals (MDGs).

The Energy poverty index (EPI) is a new index for comparing levels of deprivation and access to electricity among households and levels of development between countries. It measures various aspects of the link between energy and society, not just the amount of energy available. The access to modern energy services and levels of electricity consumed are important in analysing the level of well-being of a household. The United Nations Secretary-General in his address to the high session of the Economic and Social Council of the United Nations in June, 1993 in Geneva, Switzerland, called attention to the fact that poverty is another face of the generally dehumanising phenomenon of deprivation. To quote him:

“Deprivation is a multi-dimensional concept. In the sphere of economics, deprivation manifests itself as poverty; in politics, as marginalisation; in social relations, as discrimination; in culture, as rootlessness; in ecology, as vulnerability. The different forms of deprivation reinforce one another. Often the same household, the same region, the same country is the victim of all these forms of deprivation. We must attack deprivation in all its forms. None of the other dimensions of deprivation, however, can be tackled unless we address the problem of poverty and unemployment.”
(United Nations, 1993)

The EPI is used to calculate the headcount of each household that are in energy poverty in a given geographical location, community or neighbourhood. The EPI measures the severity of energy poverty for each household based on the amount of electricity consumption in relation to household income. The EPI are usually broken down by household income categorisation and result presented as tables or map. The EPI is calculated based on the percentage of household monthly expenditure on electricity as against average household income (see section 3.7.2). The

EPI map provides a geospatial representation and distribution of percentage of households' income expended on electricity (grid and self-generation).

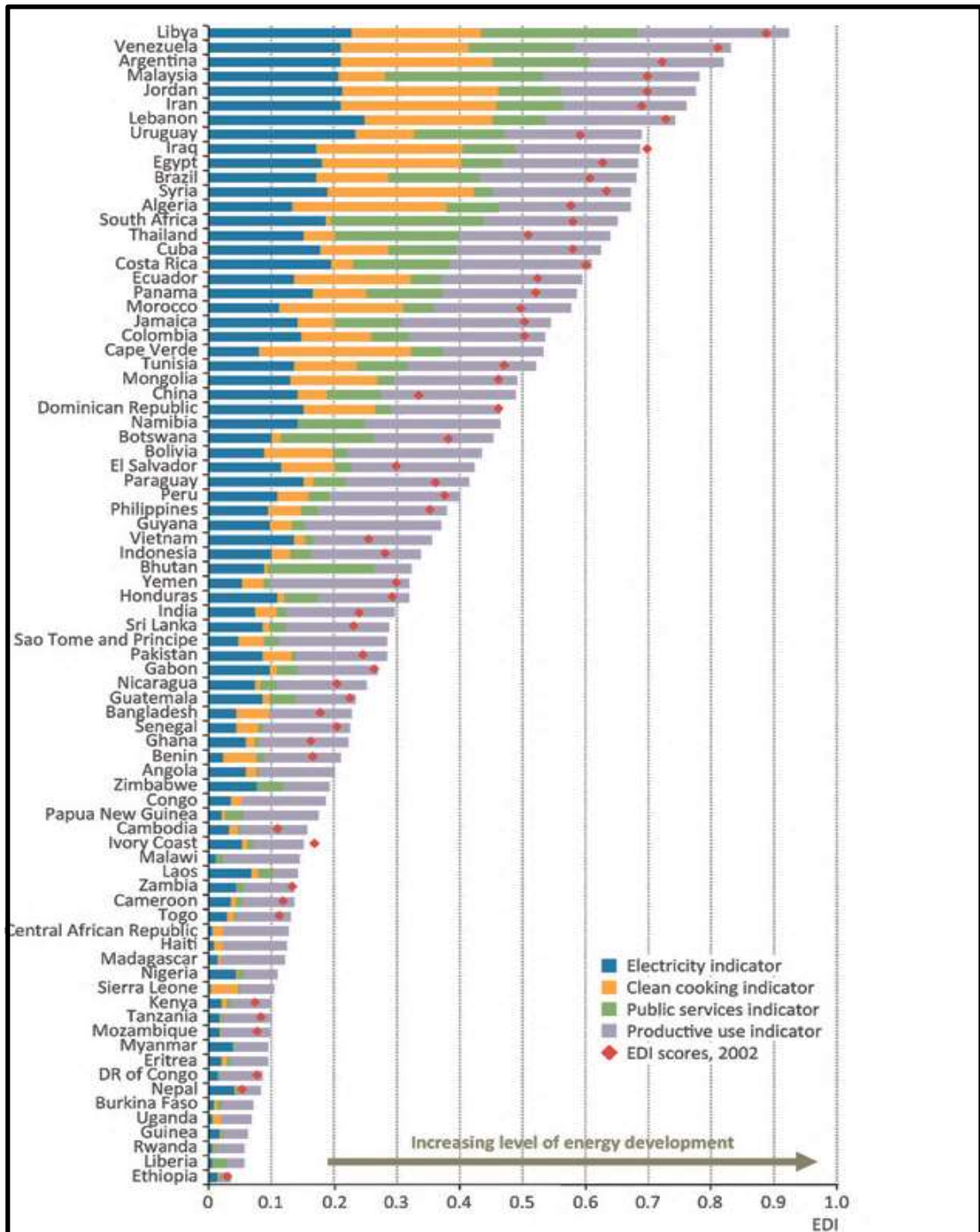


Figure 2.9: Energy Development Index - country results, 2010 (and 2002)

Source: International Energy Agency (IEA), 2012

2.4 Energy use in sub-Saharan Africa Urban Areas

The study of household energy-use patterns and behaviours attracted attention after the oil crisis in the 1970s and was primarily triggered by the perceived connectedness between deforestation and household biomass use. In developed countries, the emphasis of research was on oil dependency, whereas in developing countries the focus was on biomass consumption (Bailis et al., 2009). The key factors affecting the demand of a particular energy type include the relative price of the energy form and the appliance that it will fuel; the availability of the energy and related appliance(s) in the market; the disposable income of the household and cultural preferences (Adenekan and Jerome, 2006). Empirical studies have shown that disparity exists in households' energy consumption pattern and these vary between rural and urban populations, high and low-income groups within a country and among countries. The major factors contributing to these differences are levels of urban sprawl, economic development and living standards (Dziubinski and Chipman, 1999).

The importance of different end uses for energy varies significantly from country to country because of differences in climatic conditions, policies, level of economic development and other factors (Bhattacharyya, 2011). Households are one of the most important energy consumption sectors (Wang et al., 2011). Residential sector energy consumption accounts for about approximately 30 per cent of the total world energy consumption (Swan and Ugursal, 2008). The energy use and demand patterns of households largely revolve around households energy end-uses such as cooking and lighting as well as energy sources for home-based commercial and productive activities in SMEs (Karekezi et al, 2008). Energy services of adequate quality and quantity are required for achieving different purposes among households. According to Anker-Nilssen (2003), caring for our physical well-being is made easier with the use of energy, which provides warm water, lights, entertainment, kitchens to cook in, and so on. The determinant of energy demand in the household sector includes disposable income of household, price of fuel and appliances, availability of fuel and appliances and cultural practices (Leitmann, 1996). The energy ladder hypothesis is one of the most common conceptualisations of energy use dynamics among households. It postulates that low-income households generally use traditional stoves and cooking fuels such as animal dung, charcoal and wood, while households with higher income use modern cooking technology and fuels (see section 2.6).

The energy source purchased and the transition to clean modern energy in some urban areas of sub-Saharan Africa is largely determined by income (Karekezi, 2002). It is important to

understand the energy use patterns of low-income households, in order to appropriately inform the planning and design of policy interventions aimed at improving the welfare of these households (Sustainable Energy Africa, 2014). Several factors have been identified to contribute to low access to modern energy services in developing countries (Gaye, 2007). Among these factors are low-income levels among the un-served population particularly the urban poor, unequal distribution of modern energy services and lack of financial resources to build the necessary electricity grid infrastructure together with weak institutional and legal framework and the lack of political will and commitment to scale up services. Africa's inadequate generation capacity, unreliable transmission and distribution networks constrain economic growth and limit the social benefits of electricity use (Eberhard, 2012).

Empirical studies have suggested three ways in which a country or region can improve access to electricity. The first is to extend and expand the existing grid; the second is to develop mini-grids around particular energy sources; and the third is to develop micro-level systems for rural and marginalised communities using renewable energy technologies, such as solar panels, wind power or small-scale hydroelectricity. Mini or Micro-grid is an electricity distribution network operating typically below 11KV, providing electricity to a localised community and derives electricity from a diverse range of small local generators using renewable energy technologies with or without its own storage (Palit, 2012). Micro-grids on the other hand operate at even at lower levels. Centralised Grid is a network of powerful generators commonly known as power stations that are connected to high voltage power lines over long distances. The centralised grid electricity to remote rural areas has been identified not always to be the most cost effective and efficient means of supply. Mini and Micro-grid generation is a proven concept to enhance quality of life and provide reasonable return on investment to investors. The solution is both sustainable and replicable at village or community level and scale. This type of decentralised electricity generation has been proven to reduce losses and increase availability. Micro-grids have enormous potential as part of the global effort to provide electricity access to the 1.2 billion people who currently do not have access to electricity (Oxfam, 2012; IEA, 2012 and Palit et al., 2013). The World Bank report (Diechmann et al., 2010) supports this spatially disaggregated approach to improve access to electricity in sub-Saharan Africa.

Electricity as a source of energy is vital to the growth and development of any economy. The energy consumption in sub-Saharan Africa is a reflection of the levels of poverty in the continent exclusive of South Africa. The combined power generation capacity of 48 countries of sub-

Saharan Africa is about 80 gigawatts (GW). Per capita consumption of electricity averages just about 40kWh per month in the region and only 10 kWh if South Africa is excluded (Eberhard et al., 2011). This reveals the extremely low levels of electricity use for some sub-Saharan Africa countries. The low levels of energy consumption of modern fuels and electricity further highlighted the energy poverty level in the region. The IEA (2011) report that due to low electricity consumption, the power sector in sub-Saharan Africa excluding South Africa, accounts for less than one per cent of global carbon dioxide emissions. The report further states that this represents an insignificant contributor to carbon dioxide emissions and climate change having the lowest per capita emissions among all world regions and among the lowest emissions in terms of GDP output. Doig and Adow (2011) conclude that increasing energy access in sub-Saharan Africa will have a nominal impact on global emissions, and pursuing low-carbon development will not only minimise its already modest carbon emissions, but will also provide opportunities for climate change adaptation in environmental, livelihoods, and health terms. The IEA report, Doig and Adow, only considers grid-supplied electricity consumption but failed to consider the alternative self-generation of electricity provided by both the formal and informal sector of the economy to meet household energy services demand. The impacts of the emissions from the petrol/diesel powered generators on both human and the environment is equally a significant contributor of carbon monoxide, and related particulates to the ozone layer and the resultant's effect on climate change.

Electricity accounts for roughly 17 per cent of global final energy demand, while energy used for heating accounts for about 44 per cent (Olz et al., 2007). Electricity is critical for providing basic social services, required to power machinery and equipment that support households' social well-being, income-generating opportunities, and is used in varying degrees to achieve different purposes across households, depending on the time of the day. Electricity supply in sub-Saharan Africa is disreputably unreliable. According to Eberhard et al., (2011:189), about 15 per cent of installed capacity is not operational, mainly as a result of ageing plant and lack of maintenance. Power outages are frequent and as a result, self-generation constitutes a significant proportion of total installed power capacity in the region. The power utilities in Africa have failed to provide adequate levels of electricity services to the majority of the region's population, especially the urban poor and the provisions of electricity are confined to the privileged urban middle and upper income groups as well as the formal commercial and industrial sub-sector (Karekezi and Kimanu, 2002).

2.5 Energy Ladder

The choice of household energy preference has often been conceptualised using the “energy ladder” model (Hosier and Dowd 1987). The energy ladder describes a pattern of fuel substitution as a household's economic situation changes (Hosier and Dowd 1987). This is a useful framework for examining trends and impacts of household energy use. The model bears a resemblance to a ladder (Figure 2.10) and contains three stages that represent three categories of energy/fuels: primitive, transition, and modern/advanced energy/fuels.

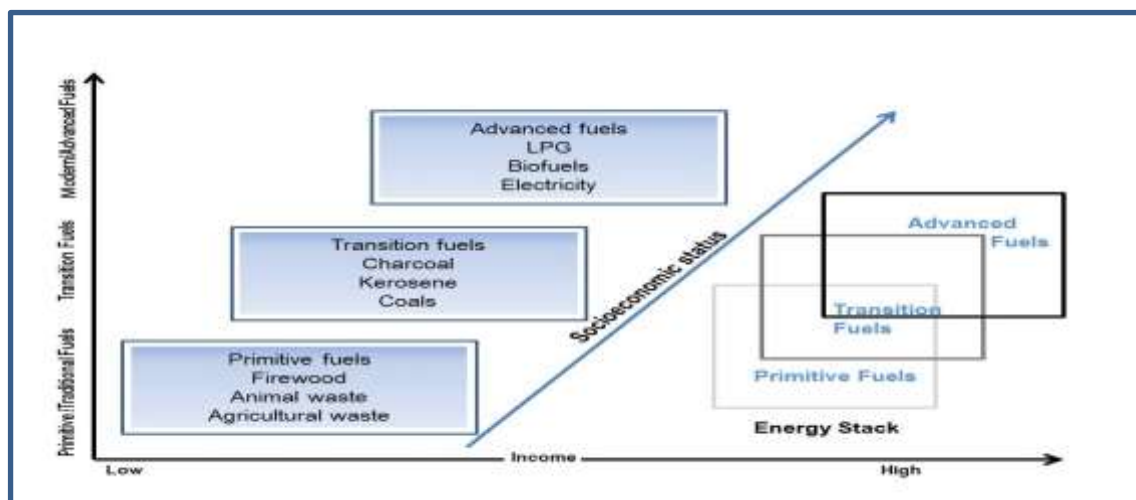


Figure 2.10: The energy-ladder model

Source: Adapted from Schlag and Zuzarte, 2008; Kowsari, R. and Zerriffi, H. (2011:7508)

The energy ladder postulates that household energy use shows a transition in increasing order of importance, starting with “traditional/primitive energy/fuels” such as animal dung, firewood and crop residues, at the bottom; continuing with “transition energy/fuels” like charcoal and kerosene, in the middle; and ending with “modern/advanced energy/fuels” of LPG, natural gas and electricity at the top (Van Ruijven et al., 2008: 2803). The assumption behind this model is that, as a household's socio-economic status increases, they will rationally choose an energy carrier that is more advanced and suitable for their energy service needs (Hosier, 2004; Louw et al., 2008).

Quite a number of studies have focused on the determinants of the mix of energy sources used at the household level (Hosier and Dowd 1987; Heltberg, 2004; Hosier, 2004). In the urban poor households that are already struggling with the numerous impacts of poverty and socio-economic problems, many people use traditional biofuels as their main cooking fuels. Hosier (1993) notes three main reasons for the heavy reliance on traditional fuels for urban energy needs: low income levels; limited energy infrastructure; and erratic supplies of modern fuels. Their choice of energy sources unlike today is constrained to organic sources of energy, which is easier to obtain in

terms of kinetic organic (animal and human labour power) (Wrigley, 1990; 2006). Nearly, all of this energy came from the process of photosynthesis in plants transforming insolation into forms useable by people especially those urban poor households living in peri-urban areas. Biofuels and biomass are energy products derived from organic sources such as wood, crops, and crop residues (Wrigley, 2006). They are non-renewable sources of energy that come with drawbacks such as deforestation and health effects of burning. The use of biomass fuels in inefficient and traditional ways can have severe implications for human health, the environment and economic development (Heltberg, 2005). Exploitation of a new source of energy in the form of coal provided an escape route from the constraints of an organic economy (Wrigley, 2010).

In a typical urban environment, domestic energy consumption conventionally follows the “energy ladder” at the household level. Residents move from consuming less costly and less conventional fuels (wood, biomass) to energy of intermediate price and quality (charcoal, kerosene), then to more expensive, highly convenient types of energy (LPG, electricity) as they experience rise in income and/or with a change in habits over time (Leach, 1987; 1988; 1992; UNCHS, 1991; Smith et al., 1994; Davis, 1995; Nathan and Kelkar, 1997; Karekezi, 2002). Put differently, as households’ income increases, they tend to move from inconvenient and inefficient energy sources to more modern, convenient and efficient energy sources. The energy ladder model emphasises income in explaining households’ energy choice and switching. The energy ladder hypothesis is one of the most common approaches used in studying the household energy use patterns. The hypothesis states that people with low-incomes generally use traditional fuels as their main cooking fuel and people with higher incomes tend to use modern fuels. This hypothesis explains the movement of energy consumption from traditional sources to more sophisticated sources along an imaginative ladder with an improvement in the economic status (income) of households. According to the energy ladder model, income drives fuel/energy choice, where higher-income households will use modern fuels, such as LPG or electricity, while low-income households will more often use firewood and charcoal (Hosier and Dowd, 1987). It is assumed that energy transition occurs from the bottom to the top with increasing socio-economic status either through a rise in income or through a fall in price (Hosier and Dowd, 1987; Hosier 2004). The energy ladder hypothesis is based on an economic theory of consumer behaviour (Hosier and Kipondya, 1993). The concept explains the theory comparatively, that when income increases, households consume more of the same goods with the tendency to shift to sophisticated goods of higher quality. In other words, households will choose the most advanced energy accessible and that is commensurate with their socio-economic profile, replacing lower

quality energy with higher quality one. It further assumes that cleaner fuels are normal economic goods while traditional fuels are inferior. In response to higher income and other factors, households will shift from traditional biomass and other solid fuels to more modern and efficient cooking fuels, such as LPG, kerosene, natural gas, or even electricity. This transition, in which one fuel is completely replaced by another, is often referred to as fuel switching or “interfuel substitution” (Leach, 1992; Barnes and Qian, 1992; Hosier and Kipondya, 1993; Heltberg, 2004). The energy ladder model envisions a three-stage fuel switching process. The first stage is noticeable by universal reliance on biomass. The second stage involves households moving to “transition” fuels, such as kerosene, coal and charcoal in response to higher incomes and factors such as deforestation and urbanisation. The third phase involves households switching to cleaner energy, like LPG, natural gas, or electricity. The main driver affecting the movement up the energy ladder is income and energy prices (Leach, 1992; Barnes and Floor, 1999; Barnes, Krutilla, and Hyde, 2002). The price of traditional fuels compared to modern fuels is also an important driving force for energy/fuel switching (Mekonnen, 2008; Schlag and Zuzarte, 2008).

Other factors that determine energy/fuel choice are energy supply factors related to availability, affordability, accessibility and reliability of fuels (Kowsari and Zerriffi, 2011). Maconachie et al., (2009) observe that households descend the energy ladder as a result of the unavailability and affordability of modern energy sources. Another major factor is electrification - as soon as people have access to electricity, the use of biomass as main fuel choice decreases (Heltberg, 2004; Ouedraogo, 2006). The major achievement of the energy ladder model in its simplest form is the ability to capture the strong income dependence of energy choices.

2.5.1 Energy Stacking

The energy ladder model has attracted a good deal of criticism (Hosier, 2004). The criticisms are that the intricate interactions that typify energy transitions are not well accounted for in the energy ladder model. These criticisms have given rise to alternative models (Foley, 1995; Masera et al., 2000). Several studies (Masera et al., 2000; Brouwer and Falcao, 2004; Heltberg, 2004; Ouedraogo, 2006; Hiemstra-van der Horst, 2008; Mekonnen and Kolhin, 2008) show that household cooking patterns are far more intricate than portrayed in the energy ladder model that shows a linear transition from primitive/traditional fuels to advance/modern fuels with a rise in income. In reality, energy transitions are not usually linear and are not unidirectional and households sometimes substitute fuel for one another.

Masera et al. (2000) suggest a multiple fuel model that states that there are various interacting economic, social and cultural factors that explain or, rather, determine household energy use patterns. Thus, a linear progression and transition from traditional fuels to modern cleaner fuels is hardly attained; instead, households become involved in “energy/fuel stacking”. The process of households using multiple fuels (traditional and modern energy sources) at the same time is termed energy/fuel stacking. The assumption is that modern energy sources are added onto traditional ones, either as substitutes or as complements. Masera et al. (2000:2085) in its findings states that it is “unusual for households to make a complete fuel switch from one technology to another; rather they begin to use an additional technology without abandoning the old one”. The transition to cleaner fuels, according to Masera et al. (2000), is not always one directional or a full switch to a cleaner fuel but often a partial switch. Energy or fuel stacking is the term used to describe multiple energy use patterns (Masera et al., 2000), resulting in a combination of energy being used for different purposes. Foley’s (1995:17) “energy demand ladder” offers another explanation for household energy use patterns, stating that: “the demand for energy is derived from the services it provides or makes possible”. Thus, energy choice is determined by the purpose of the appliance and, as income increases, the need for different appliances increases, therefore broadening energy needs as illustrated in Figure 2.11.

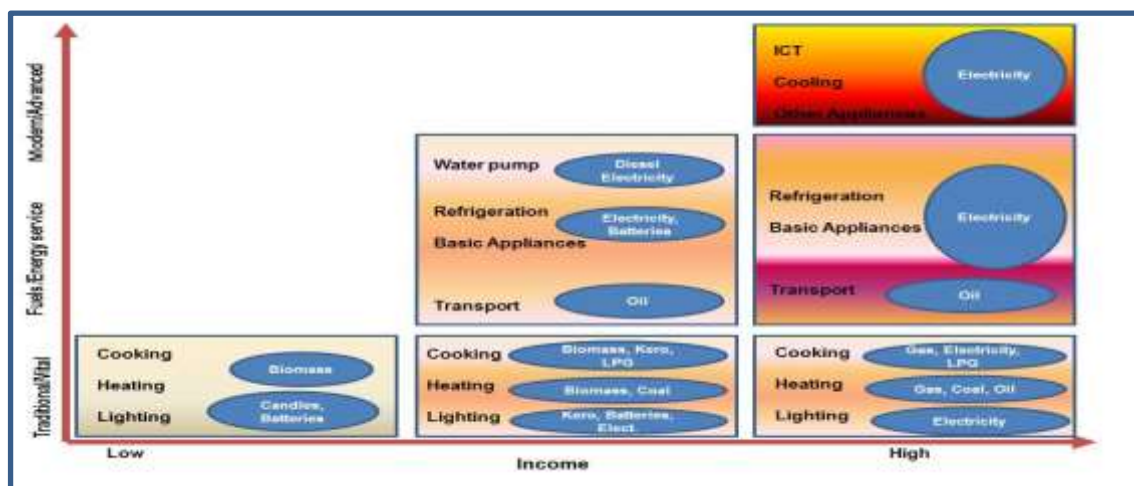


Figure 2.11: Foley's energy demand ladder model
Source: Hosier (2004:425)

2.6 Energy and Gender

The gender dimensions of energy and poverty are evident in many ways and have been well documented in literature (DFID, 2005; Clancy et al. 2003; 2007; Chant, 2008; Dako-Gyeke et al. 2013). Energy plays a major role in meeting most of women’s needs from practical to productive and strategic needs in achieving households’ domestic chores, like cooking, food processing and

women's enterprise development. Generally, men's energy needs and interests are given higher priority than women's and girls' needs and interests (Clancy et al., 2003; Cecelski and CRGGE 2006; Practical Action, 2010; Kohlin et al., 2011). There has been overwhelming evidence from all over the developing world that women are disproportionately affected, as their access to energy resources and benefits is further curtailed by unequal power relations (Kohlin et al., 2011).

Energy poverty has distinctive gender characteristics. Both poor women and poor men suffer from energy poverty. Household's domestic tasks fall disproportionately on women and their well-being relates to energy poverty. Therefore, an improvement in women's household energy use is very important and must be considered in the modern energy service provision. There is a lot of discrimination against women in many developing countries and disregarding these gender inequalities can undermine the potential for transforming women's status and well-being. It has been approximately estimated that 1.3 billion people are living in poverty and 70 per cent of these estimates are women living in female-headed households in rural areas depending on fuel wood for cooking and other domestic uses (Lebelo, 2009). Women's access to decision-making within the household and community is restricted, limiting their ability to influence processes and resource allocation on many issues including energy (Clancy et al. 2003). As poverty intensifies and becomes more pervasive, women are continually under pressure more than men because of the additional burden and pressure on women to sustain their families (Adepoju, 2004). The United Nations Population Fund, 2008, observed that insufficient allocation of resources to gender inequality is a barrier to development. These inequalities are products of household, social and cultural discrimination and as a result, women's capacity to increase their labour productivity and improve their incomes is limited. Potts et al., 2003 argued that researchers, policy experts, and practitioners cannot claim genuine progress in development if they do not ensure that gender equality is emphasized in poverty reduction strategies.

Consumers generally have been excluded from energy policy and practice but the burden falls disproportionately on women and girls, as do the negative health impacts. Quisumbing and Mduccio (2003) observe that, most often, women and girls do all the fetching and carrying of fuel wood spending large amount of time and physical energy, especially in rural areas and within underprivileged communities (Karekezi et al., 2002). An estimated 2.7 billion of the global population depend on biomass for their energy needs (IEA, 2012; GEA, 2012); while 89 per cent of the population of sub-Saharan Africa use traditional biomass for cooking and heating, out of which 162 million live in urban areas (IEA, IEA, 2006). Reddy (2000) notes that, although nearly

every household in rural areas and low income households use some biomass as an energy carrier, poor households will spend more time searching than those in higher-income groups.

The desire for energy services for homesteads and the shortage of domestic energy is forcing women to break away from their traditional roles of homemakers into fuel wood fetchers. Fuel wood (biomass) is a very common source of domestic in rural areas and some urban poor women equally depend on fuel wood. The role of women in traditional fuels (fuel wood) collection is an enormous waste of human efforts and time that could have been more productively used. This enhances social marginalisation and limits the ability to improve living conditions. Access to modern energy can improve women's position in households and society by relieving them from some of the physically demanding chores of day-to-day existence (Holdren et al. 2000; Rehfuss, Mehta and Prüss-Üstün 2006)

According to UN-Energy (2005:3), reliance on biomass fuels is itself a cause of environmental degradation (deforestation); it also places the burden of collection on women and children and causes ill health. Research also suggests that low commercial energy use is correlated with high infant mortality, illiteracy and low life expectancy (Modi et al., 2005:18). The UNDP-WHO (2009:17) reports that: "almost 3 million deaths per year are attributable to solid fuel use, with more than 99 per cent of the deaths occurring in developing countries". In sub-Saharan Africa, cooking on open fires fuelled with wood or charcoal results in 359,520 premature (<5years) child deaths and 23,212 (>30 years) female deaths per year (Doig and Adow, 2011). The provision of clean cooking facilities would prevent the majority of deaths attributable to indoor air pollution from burning biomass (IEA, 2011). The factors responsible for this may be related to the socio-economic characteristics of the women (WHO, 2010). UN-Energy (2005:7) states unequivocally that: "access to electricity contributes to the empowerment of women". It provides the opportunity to enhance income generating activities as well as increase women welfare. The Department for International Development (DFID) (2013) advocates financial empowerment of women, saying it will reduce poverty and inequality in Nigeria. Therefore, providing access to modern energy services is very vital for the empowerment of women, leading to improving women's health and the reduction of time spent accessing energy resources. The increasing phenomenon of energy poverty has resulted in state-owned monopoly of power sector in most of the developing economies to undergo restructuring in an effort to expand access to electricity to reduce poverty and social exclusion.

2.7 Power Sector Reform in sub-Saharan Africa

In most countries, from the middle of the 20th century, electricity has been regarded as a public service. Most African countries utilities companies produced electricity as a social amenity, which is heavily subsidised by government. For a very long time, electricity provision was traditionally the domain of the state, partly due to the large capital requirement of centralised power delivery and the strategic value of energy provision in government policies (Eberhard, 2004). The monopolistic hold by the state-owned vertically integrated utilities in some Africa countries has contributed to the undeniable under-performance and counter-productivity in the delivery of electricity services (Karekezi and Mutiso, 1999; Karekezi et al., 2003). The power sector institutions are characterised by unreliability of power supply, low capacity utilisation and availability factor, deficient maintenance, poor procurement of spare parts, inefficiencies in billing and collections, recurring high technical and commercial losses (Karekezi and Kimanu, 2002; Colling 2002, Alcazar et al., 2002b, Menard and Clark 2002b, Davis 2004). Furthermore, the heavy cost of infrastructural expansion to satisfy a growing demand for energy is unsustainable because government-owned, financed and operated utilities power companies, produce and sell their energy at distorted prices (Olumuyiwa, 2008). There has been a growing trend toward furthering the involvement of private enterprises and minimising the role of the state in operating and regulating the power sector (Bacon and Besan-Jones, 2001). These trends largely continue the expansion of centralised systems with new actors (private firms) and new roles (e.g. independent regulators). However, the implications of this trend, particularly in the case of electrification programs in developing world are still largely unknown, especially when considering the major role decentralised system will play towards increasing electricity access (Kowsari, 2013). The expectancy of privatisation also led to a reduction in investments in the power sector and further deterioration in the operational conditions.

One of the greatest challenges of African countries is the absence of good leadership, lack of transparency and accountability in governance and massive corruption in the system. The current economic challenges bedevilling the Africa continent has been blamed on corruption and mismanagement of the enormous resources that abound in the region. Corruption to a greater extent in most African countries remains the most important obstacle to economic and social development. The African Development Bank (AfDB) President, Kaberuka (2013) states that an estimated US\$2.6 trillion is stolen annually through high-level corrupt practises in Africa. The President further states corruption had become a global threat, causing a serious roadblock to economic development and prosperity. The bank views good governance and anti-corruption

strategies as important to mission of poverty alleviation. Corruption remains the main cause of systematic waste of the African nation's resources, and therefore the main cause of poverty in Africa. The wastes and corrupt practices have left social services in deplorable conditions; one of such is the state of the power sector.

The need to reform the electricity sector arose from the dissatisfaction over its poor performance. Several studies liken poor performance in the energy sector with high state intervention (Karekezi and Mutiso, 1999; Karekezi et al., 2003; Eberhard, 2004; Kowsari, 2013). Over the last 20 years, many developing countries have adopted far-reaching policies that encourage liberalisation and privatisation, often at the behest of major international funders, private investors and development organisations (Eberhard, 2011). Privatisation, liberalisation and deregulation are now global phenomena and a key component of the reform process of structures and economies in the globalised world today. They are the offshoots of economic globalisation. This economic policy (privatisation) is a product of neo-liberal economic reforms that becomes popularised and globalise through the World Bank (WB) and the International Monetary Fund (IMF). Privatisation involves the transfer of ownership or control from the public to the private sector is one of the revolutionary innovations in economic policies of both developed and developing countries (Igbuzor, 2003; Chambers, 2008). Soyebo et al. (2001) defines privatisation "...as the change of ownership of former state owned business to private ownership and control"., Scheider and Jager (2001:6) on the other hand see privatisation first as a transformation of property rights regimes, and secondly, as the reduction of public control. Narain (2003:297-304) identifies three forms of privatisation. The first is privatisation through operational measures without loss of ownership. The second is privatisation through organisation measures and the last method is privatisation through ownership measures.

In both developed and developing countries, privatisation has grown in popularity and acceptability. It has also become an important instrument that government can use to promote economic development, improve the production and distribution of goods and services, streamline government structure, and reinvigorate industries controlled or managed by the state (Rondinelli and Lacono 1996). Therefore, for an economy to be competitive it needs to embrace global standards. Developing countries have embarked on extensive development programmes some recorded as successful and some a failure. Shirley, (1998:35) in her submission states that the success of privatisation should be judged not in terms of the sale or contract itself or the price paid to government, or even the survival or expansion of the enterprise sold, but rather, on the

basis of whether there are net benefits to the economy. Some of the most common paths that have been considered by African countries include corporatisation, commercialisation, contract management, direct sales, and independent power projects (IPPs) (Karekezi et al., 2001). Privatisation has become a popular universal remedy for solving organisational problems of governments by reducing the role of the state and encouraging the growth of the private sector enterprises (Sedighikamal and Talebnia, 2014).

Since the beginning of the 1990s, some sub-Saharan Africa countries have undertaken major structural changes in their electricity sector (Opam and Turkson, 2000; Bayliss and Fine, 2007). The United Kingdom (UK) and Argentina are the pioneers in privatisation and deregulation of the electricity sector. The structural change or reform process often involved unbundling of vertically integrated utilities into separate generation, transmission, wholesale and retail distribution (vertical unbundling) and conversely unpackaging national utilities into smaller district or provincial utilities (horizontal unbundling) with the introduction of some form of competition in all segments of the market except for transmission. A number of African countries have introduced power sector reforms to enhance the management and organisation of utilities and improve the technical and financial performance to increase electricity services (UN-Energy/Africa, 2009). Turkson (2000) provides a very good account of some sub-Saharan Africa countries (Ivory Coast, Ghana, Kenya, Zimbabwe and Uganda) that have undertaken major changes in their electricity sector. The power sector in some of these developing countries of the world is undergoing reform and restructuring, of which Nigeria is no exception (see section 4.2.1). Energy sector reform has a wider meaning and the bulk of existing literature, particularly from multilateral development banks often equate energy sector reform with deregulation or, more specifically, the drastic reduction of Government participation in the energy sector (Karekezi et al., 2001). The restructuring is not just about deregulation and competition. It is also about the creation of a new vision, new opportunities and new ways to think about a business that is over a century old. Pollitt, (1996) in his submission states that private-owned power generating plants exhibit higher efficiency than public-owned plants. Kleit and Terrell (2000) observe that deregulating electricity generation increases efficiency, while Barros and Peypoch (2008) state that regulation without competition decreases efficiency. Policy oriented research emphasised competition and quality of regulation as pre-conditions for the success of utility privatisations (Zhang, et al 2002; Bortolotti et al. 2002; Newberry 2004; Estache et al 2005; Kirkpatrick et al 2006).

Davies et al., 2003, identified that power sector reform can affect the poor in any or all of the following ways: access to energy services; cost; quality of supply; improvement in other services such as health, education and communications; and stimulation of economic development and public sector finances. There is increasing evidence that governance reform of state-owned utilities can improve their performance (Vagliasindi, 2010). However, the overall impacts of power sector reforms from a number of developing countries indicate that it has not achieved much of the desired objectives with only few of the initiatives have resulted in significant improvement in the provision of electricity to the world's poor utilities (Bazilian et al. 2011). The reform have often improved the "health" of individual national utilities, with very few exceptions, they have not led to dramatic increases in energy access, for the simple reason that meeting the electricity needs of the poorest is not very profitable to the utilities (Bazilian et al. 2011). The overall objective of the power sector reform is aimed at transforming power utilities from social welfare institutions into profit-making commercial entities. It is widely claimed that increments in electricity tariffs impact negatively on the poor. The clear benefits of liberalising the markets are unclear, where it has been ideologically pushed on to these countries and often to the detriment despite good intentions to accelerate development in sub-Saharan Africa through massive expansion of access to electricity and modern energy services.

There are enormous investment requirements to close the huge energy gap and access to services. Investment by the private sector in electricity services is for profit. Cost recovery and profitability in these sectors are difficult in developing countries where network size is small, investment needs are huge and affordability of services is a problem. Komives et al. (2005) show that around 40 per cent of utilities in the developing world cannot recover their operation and maintenance costs and about 70 per cent fail to cover full capital costs. The affordability of service charges is a serious issue that cannot be overlooked, especially in low-income economies because under public ownership, services have been heavily subsidised. In most African economies, electricity tariffs were raised substantially following privatisation or restructuring (Eberdthart et al, 2005). Policy makers disregarded the importance of designing tariff structures for the affordability of services during the process of restructuring and privatisation (Estache, 2006). Overall, only countries with better initial conditions in the electricity sectors (universal population coverage, well maintained infrastructure, good availability of fuel resources, favourable climate and geographical conditions) have managed to contain the adverse effects of privatisation on service charges to some extent (Dağdeviren, 2007). Nevertheless, it has been increasingly recognised that privatised and/or deregulated power industries are more susceptible to failures if

capacity constraints are pressing (Borenstein 2002; Smith 2002). The use and abuse of market power is considerable in general but worse under capacity shortages (Sweeting 2004; O'Neill et al; 2005Hansen 2005). There are cases where reforms without privatisation have achieved a good performance with reliable and affordable services, e.g. power and water in Namibia, power in South Africa (Shirley et al. 2002, UNDP 2006; Bayliss and Fine 2007).

The outcome of the power sector reforms have today resulted in separation of control of grid-based system, while the significance of mini-grid and off-grid services is increasing. The post-reform organisational structure of electricity services varies considerably between countries, influenced by both local context and political economy. A number of regional power trade agreements with Memorandums of Understanding (MOU) between countries in sub-Saharan Africa have emerged, such as the Southern African Power Pool (SAPP), the West African Power Pool (WAPP), the Central African Power Pool (PEAC) and the East African Power Pool (EAPP). However, trade is limited and most of this trade has been within the SAPP between South Africa and Mozambique (Foster and Briceño-Garmendia, 2010). In some countries, weak governance (corruption, lack of transparency) has compromised the ideal of sector reform, while the negative effects of reform for consumers (higher tariffs and stronger enforcement of revenue collection) exceed any benefit from improved service performance (Scott and Seth, 2013). The resulting lack of social legitimacy of such power sector reforms is manifested in power theft, vandalism, protest and electoral politics (Williams and Ghanadan, 2006).

2.8 Summary of Literature Review

In spite of the many research work and contributions that have been made to energy studies, there is still much left to do. The importance of energy to everyone makes this field unending and challenging. Much of the attention has traditionally focussed on governance, finance, accessibility, availability and affordability. The attainments of economic and human development are linked to energy production and consumption. Access to different energy sources and levels of energy consumed are important in analysing the level of well-being of a household or country. The monopolistic hold of the power utilities by governments has often resulted in a huge energy gap in most sub-Saharan African nations. The demand for electricity services in cities is high and growing as fast as the urban population and the publicly managed electricity utilities have not been able to meet the demand arising from population growth, urbanisation and industrialisation.

Quite a number of studies have been undertaken on the prevalence of energy poverty in sub-Saharan African countries (Karekezi et al., 2003; Adenikinju, 2005; Sambo et al., 2007; Iwayemi, 2008; Odularu and Okonkwo, 2009; Ogwumike and Ozughalu, 2011; Agba, 2011; Ewah et al., 2012; Bazilian et al., 2013). The attention of urban energy poverty in sub-Saharan Africa started gaining prominence in the last few years (GNESD, 2008; SEA, 2014; Singh et al. 2014) but none addressed the quality and reliability of electricity accessibility and inadequacy of electricity supply resulting in the self-generation of electricity. Providing basic modern energy services to the urban poor requires far more attention than it is presently receiving. The inadequacy and unreliability that accompany the supply of electricity in most African nations have denied households the benefits of modern energy services. The huge electricity deficit has led many Nigerian households to resort to self-generation of electricity using petro/diesel powered generators as an alternative source of electricity supply to satisfy their modern energy needs.

Furthermore, there are few studies that explicitly examined the inadequacy and unreliability of electricity provision from a spatial perspective, particularly within an urban context. Energy poverty in the development context arises from inadequate supply of electricity as much as from limited consumer capacity to pay for electricity consumption. However, in the developed world, 24/7 access is guaranteed and ability to pay is the problem. Energy poverty expresses itself in the inability of households to have secure and affordable electricity to promote living and economic growth. The access to services provided by electricity in sufficient quantity and higher quality is a requisite condition for human development required to alleviate and reduce poverty. There is, therefore, a two-way relationship between human development and electricity services provision, where adequate provision to modern forms of energy precludes poverty alleviation.

Therefore, there is an urgent need to address the issues related to the quality, reliability and inadequacies in the supply of modern energy services to the urban poor. This study fills a gap in the existing literature by examining and identifying the prevailing urban energy poverty (particularly electricity) in Ibadan. The review shows the gap created by lack of access to reliable electricity service provision with far-reaching implications for sustained economic growth and social well-being of the citizenry. It is evident that improved access to adequate quantity and reliable modern energy services is a crucial means of improving the quality of life and socioeconomic status of the urban poor. The identified gap prompted the desire to examine and analyse the causes and consequences of urban energy poverty among households in Ibadan.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the description of the data gathered for the research; methods used and the stages involved in the research processes. The Figure 3.1 also shows the tasks undertaken, the locations where the fieldwork and the analysis was conducted.

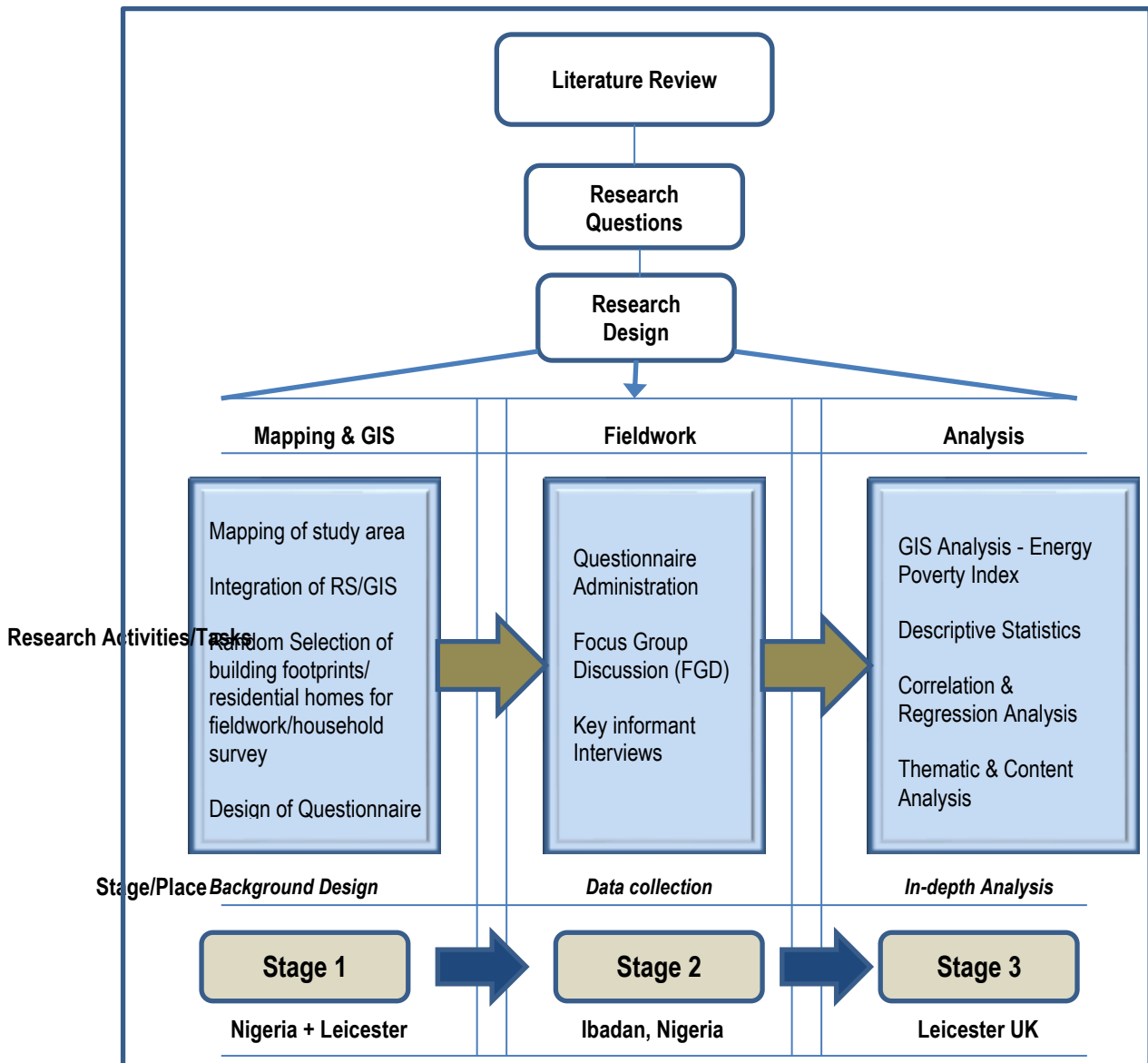


Figure 3.1: The research processes for examining and analysing the causes of energy poverty

The methodology begins by outlining the study area. Subsequently, the methods and strategy used in the execution of this research from data collection to analysis and discussion are

explained in the early section of the methodology. The primary data collection methods used were household field survey questionnaire, focus group discussions (FGDs) and key informant interviews. The secondary data collection informs the sampling strategy for the primary data collection. The secondary data collection adopted a multi-method approach, with the use of high-resolution (0.6m) QuickBird satellite imagery and Geographic Information System techniques; questionnaire administration with quantitative methods of simple descriptive statistical analysis, and a qualitative approach to data collection with the aid of focus group discussions (FGDs) and interviews. The satellite imagery of the study area provided the initial spatial data and backdrop from which the building footprints (customer information) and road network features were extracted through a process known as digitizing.

The use of GIS as a tool and a framework providing an integrated platform through which all relevant data (primary and secondary) and information from various sources are brought together and analysed is key to this methodology. Furthermore, the spatial analytical techniques of GIS provides the platform for mapping the problem and producing the energy poverty index map of the study area, while the qualitative data help reveal and explain the underlying socio-economic and political processes that are creating the problems. The justification for the methods and techniques used for the research and their limitations can be found in sections 3.7.1; 3.7.2 and 3.7.3. The ethical issues considered during the course of the fieldwork, problems encountered and the measures taken to solve them are discussed in section 3.8, while Section 3.9 describes the limitations of data sources.

3.2 Study Area.

The study area Ibadan is located in the southwestern Nigeria and in the southeastern part of Oyo State. Ibadan is the capital of Oyo State. Until 1970, Ibadan was the largest indigenous city in sub-Saharan Africa (Lloyd et al., 1967). At present, Ibadan is the largest city in West Africa and second largest in Africa and the third largest metropolitan area, by population, in Nigeria, after Lagos and Kano, with a population of over 3 million (NPC, 2006). Ibadan is a historical city created in 1829 as a war camp for warriors coming from Oyo, Ife and Ijebu and had been the centre of administration of the old Western Region, Nigeria since the days of the British colonial rule. The principal inhabitants of the city are the Yoruba.

Geographically, Ibadan is located on latitude 7°22'47"N and longitude 3°55'48"E, 128 km inland northeast of Lagos and 530 km southwest of Abuja, the federal capital. It is located between the

forests and the plains and surrounded by seven hills. There are eleven Local Government (LGAs) constituting the Ibadan metropolitan area with five urban local governments in the city and six semi-urban local governments in the peri-urban (less city). Local governments are the third tiers of government in Nigeria recognised by the constitution. The five urban LGAs comprises Ibadan North, Ibadan North East, Ibadan North West, Ibadan South East, Ibadan South West, while the six semi-urban are Akanran, Akinyele, Ido, Lagelu, Oluyole, and Ona, as shown in Figure 3.2.

The total land area of the eleven local governments of the Ibadan metropolitan area is 3,080 km², out of which about 15 per cent falls in urban Ibadan while the remaining 85 per cent is in rural Ibadan. The administrative and commercial importance of Ibadan has resulted in land being a key investment asset and a status symbol for the population. Ibadan North Local Government has the largest land area among the urban local governments, with 145.58 km², while Ibadan North West is the smallest, with 31.38 km². The second largest local government in urban Ibadan is Ibadan South West, with 124.55 km². This represents about 4 per cent of the total land of the city and about one quarter of urban Ibadan. For the rural local governments, Ido has the largest land area, with 865.49 km², representing 27.71 per cent of the total land of the city and 32.54 per cent of the total rural land area. Ona-Ara Local Government follows this, with 277.10 km², while Egbeda Local Government has the least land area of 136.83 km². The general land use pattern of the Ibadan metropolitan area shows a clear distinction of purely residential use for urban Ibadan and agricultural use for rural Ibadan with a population density of 586 person's km². According to Ayeni (1994), residential land use is the most predominant among all land uses in the built-up part of Ibadan.

The study area is situated within the metropolitan area of Ibadan and has been cited in literature for having slums, squatter settlements and other poor urban areas (Fourchard, 2003; Osinubi, 2003; Auclair, 2005). There are the traditional slums arising in towns from the decay of existing structures and there are spontaneous slums created by squatters on illegally acquired lands (Agbola, 1987: 89). Fourchard, 2003 cited some of the reasons for the occurrence of slums to include lack of urban renewal and urban sprawl especially in migratory paths. Fourchard, 2003 further categorise three types of slum in Ibadan according to their age, location and size. The first category is the inner city area and is the oldest type of slum and has the lowest quality residence and the highest population density in the city. In the 19th century, large compounds for extended families and warrior lineages constituted this part of the city. With the development of the town, the core area described by Mabogunje, (1962: 56-77) as "growth by fission" compounds were

broken up into a number of separate housing units. The second type of slums comprises squatter settlements found at the margins of the planned town. The planned city has witnessed the decay of some parts of its area in the past twenty years and the development of a few slums at its margins. The third type is the development of unplanned urbanisation along the major roads of the city from the 1970s to the 1990s, which has finally given birth to notable slums in the north, the east and the south of the city.

There is hardly an area in Ibadan where slums or urban poor neighbourhood referred to as “growth by fission” is not apparent which is a representative of most urban settlements in most Nigerian cities. The well-planned and structured neighbourhood in the metropolitan area similarly have some urban poor neighbourhood traditionally referred to as family compound “agboole” by the core Ibadan indigene or “omo-onile in local parlance. The desire to improve various aspects of housing, living and environmental conditions of different slums and urban poor in Ibadan led to a pilot study called “Upgrading of Core Areas” commissioned in 1984 by the World Bank to the Town Planning Division of the Ministry of Local Government of Oyo State. The Ibadan Metropolitan Planning Authority in collaboration with the Ministry of Lands and Housing of Oyo State decided in 1988 to embark on the urban renewal of Ibadan (Akinyode, 1998:38) as a follow up to the initially embarked project. The city of Ibadan also happen to be among the cities selected for the Urban Basic Service (UBS) programme of the Federal government of Nigeria and UNICEF to tackle the problem of urban poor who are mostly deprived of urban basic services such as water, sanitation, health, education facilities, employment and shelter (FGN-UNICEF, 1997:3). The programme contributes to the alleviation of urban poverty both in terms of income generation and improved access to basic services. All these informed the choice of Ibadan as case study.

The case study area within the city of Ibadan was selected based on the following criteria: availability of data, knowledge and familiarity of the terrain, residential land-use characteristics and heterogeneity of demographic composition. The criteria were selected in an attempt to capture the diversity of households’ electricity usage, demand and consumption across different categories of residential and socio-economic characteristics of the sampled population. These were done in order to analyse household’s access to modern energy services. The availability of digital data (satellite imagery and digital map/data showing building footprints and road/street network of the study area) provides the base map for the study and the platform necessary for the research to take off on time.

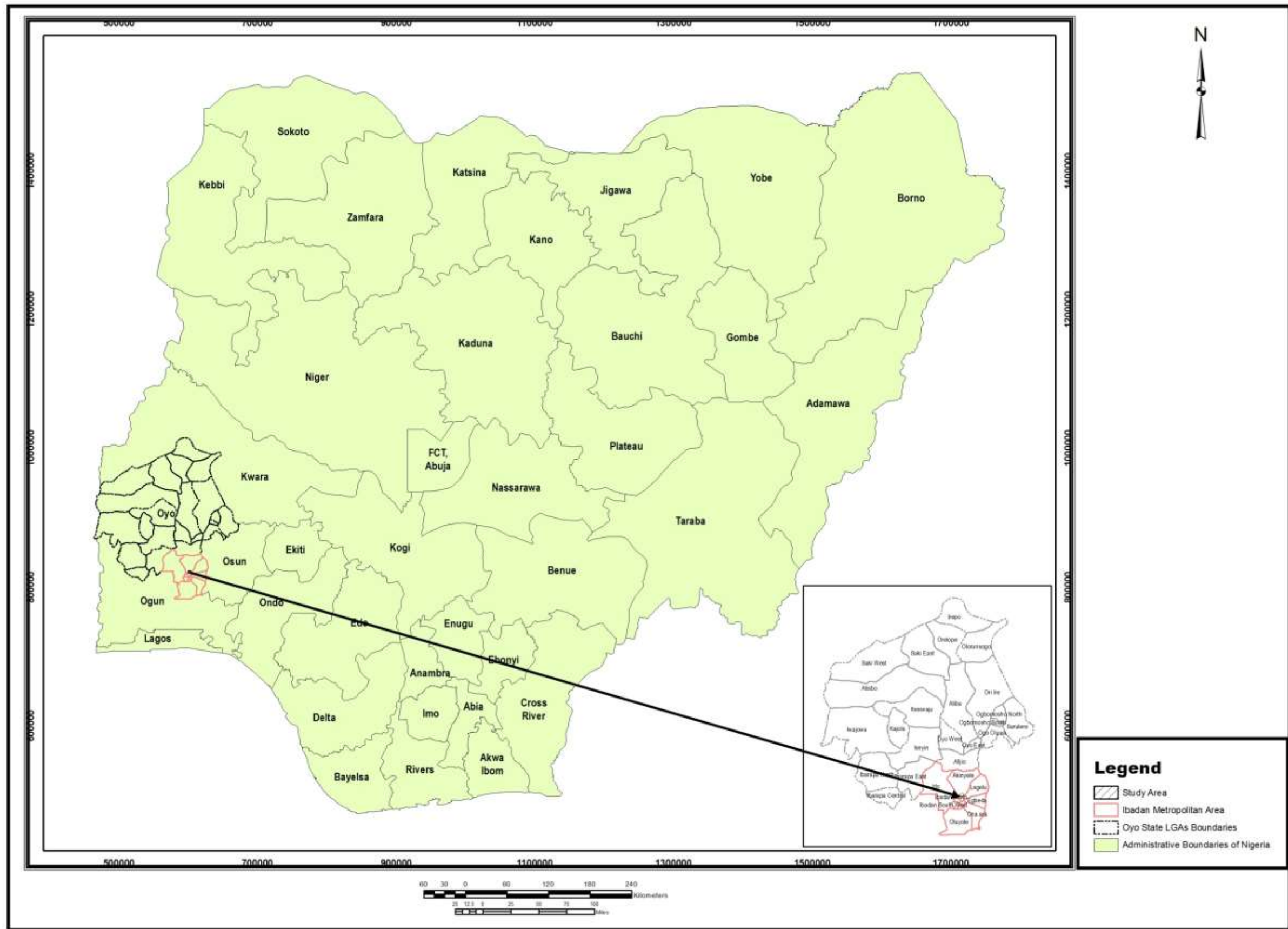


Figure 3.2: The study area: Ibadan, Oyo State, Nigeria

Administering questionnaire, conducting focus group discussion and interviews for this study require great caution, thoughtfulness and diplomacy because of people's perceptions of the state of the power sector, the sensitive nature of the problem of electricity provision, which is of national interest and the resentment attached to the inadequacy and unreliability of electricity supply. Anonymity of respondents' sampled, key informants interviewed, respondents of focus group were considered, and explanation was given to all participants that the data collected was purely for research purpose (see section 3.8).

3.2.1 Electricity Provider Administrative Units of Service Provision

Ibadan electricity supply is divided into the four administrative district or business units of Dugbe, Monatan, Molete and Ojoo (Figure 3.3). According to the electricity service provider geographical distribution map, the district or business units of the electricity service provider do not follow government administrative units upon which the national population census figures was collated. The research study area is located within Ojoo district/business unit. Each district/business unit is an administrative unit divided into smaller service units/centres. Ojoo business unit/district, for example, is divided into six namely: Akinyele, Ashi, Bashorun, Moniya, Ojoo and Orogun service units/centres. The study sampling area falls under the Ashi service unit of Ojoo business unit/district (see section 3.2.1). Respondents were chosen from the geographic area of Ashi service unit, being the smallest and most manageable unit of the electricity distribution network in Ibadan.

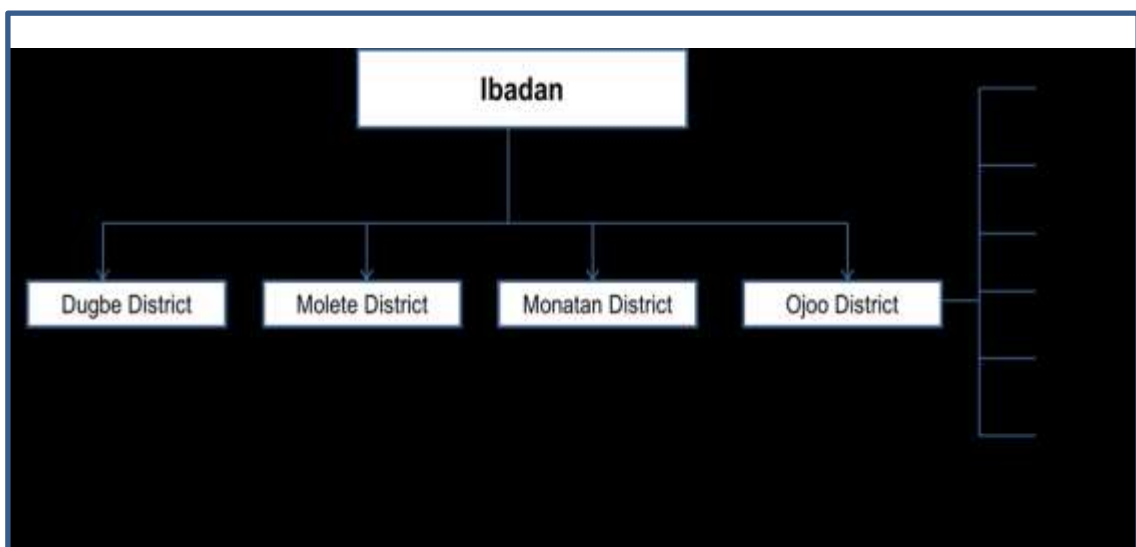


Figure 3.3: Ibadan electricity distribution/supply chain

3.3 Research Design

According to Yin (2003: 21), a research design is viewed as the logical sequence that connects and leads the empirical data to a study's initial research questions and ultimately, to its conclusion". Kitchin and Tate (2000) highlight how a research design structures the collection of evidence that answers research objectives as explicitly as possible. It represents a strategy or procedure for collecting evidence about variable in the conceptual framework (Mitchell, 1983:42). Figure 3.4 illustrates how all elements of the research collaboratively achieve the objectives of this study.

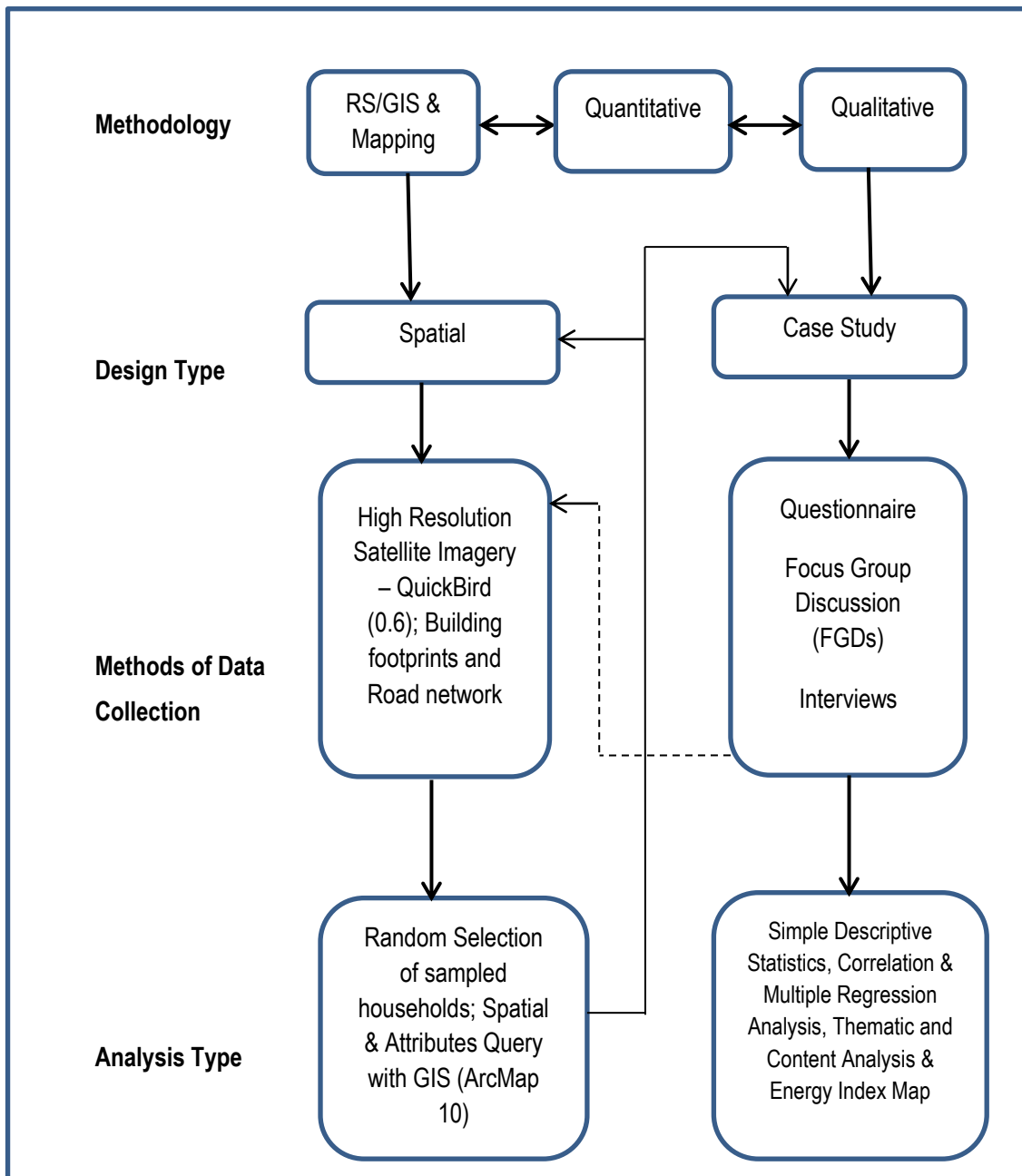


Figure 3.4: Data collection methods and tools for analysis

As stated in section 3.1, the study addresses each of the research objectives by adopting the selection of one or a combination of methods as discussed in the sections that follow. The aim and objectives, and methods used in addressing each objective are summarised in Table 3.1.

Table 3.1 Linking study aim, objectives, methods and analysis

Aim	Objectives	Methods	Analysis
To examine and analyses the causes of energy poverty in Nigeria through a case study of Ibadan, Oyo State, South West, Nigeria.	1. Assess and analyse the delivery of electricity as a way to understanding the spatial issues of demand, supply and consumption in the study area	Literature Survey (reports; publications; journals)	Local, National and International: Focus groups discussion analysis and Interviews transcription particular reference to study area
	2. Compare grid-generated to self-generated electricity, and evaluate their relationship to land-use diversity	Questionnaire GIS Analysis	GIS Analysis (spatial and attribute query); Descriptive Statistics; Correlation and Regression Analysis; Focus groups and Interview transcription and analysis
	3. Integrate social survey-derived variables, such as household income and electricity supplied and consumed to assess and map issues such as energy theft, access and poverty;	Questionnaire GIS Analysis	GIS Analysis (spatial and attribute query); Descriptive Statistics; Correlation and Regression Analysis; Focus groups and Interview transcription and analysis
	4. Investigate and analyse the problems of non-payments and barriers associated with access to electricity	Focus Group Discussion (FGDs) Interview	Descriptive Statistics; Focus groups discussion analysis and Interview transcription

3.4 Data Sources

The study utilised both primary and secondary data. Primary data were obtained from door-to-door household field survey, using personal interviews and survey instrument (questionnaire) designed for the purpose; while secondary data were obtained from different sources identified for the purpose of this study. The secondary data for this study were obtained from the official records of the Central Bank of Nigeria (CBN); Federal Office of Statistics (FOS); National Bureau of Statistics (NBS); Energy Commission of Nigeria (ECN); Power Holding Company of Nigeria (PHCN) Generation, Transmission and Distribution Units; Nigerian Electricity Regulatory Commission (NERC). However, it is imperative to state that there is a paucity of official or secondary data on electricity access and energy poverty in Ibadan that could be used to triangulate the thesis findings. The metadata detailing the different types of data, format and the source of each data for the study are highlighted below in Table 3.2.

Table 3.2: Type of data, format and source (metadata)

Nos	Data	Format	Date Created	Source
1.	High-Resolution Satellite Imagery (0.6m) QuickBird Image	Tagged Image File Format (.tiff) and Erdas Imagine (.img)	September 2010	Geotechnics Services Limited, Ibadan
2.	Customer Information/Billing Database	Ascii (.txt)	September 2010	IT/Billing Department, Power Holding Company of Nigeria, Ibadan District
3.	Road network data	ESRI Shapefile (.shp)	September 2010	Geotechnics Services Limited, Ibadan
4.	Building Footprints	ESRI Shapefile (.shp)	September 2010	Geotechnics Services Limited, Ibadan
5.	Distribution Sub-stations locations	ESRI Shapefile (.shp)	September 2010	Distribution Department, Power Holding Company of Nigeria, Ibadan District
6.	Household Survey	Excel (.xls) and SPSS (.sav)	April 2012 – September 2012	Field survey – Door-to-door household survey through questionnaire, focus group discussion and interviews

3.4.1 Spatial Data

The study utilised two kinds of geographic data; these include spatial and attribute data. These are further classified as primary and secondary data.

3.4.2 Primary Spatial Data

The primary data were obtained and gathered through questionnaire administered during the door-to-door household survey and through the interview of key informant. Copies of the questionnaire were administered to 926 household heads selected across the study area. Each copy of the questionnaire was assigned a unique identifier (ID) and subsequently linked to the respondents' household location that was randomly selected within the ArcGIS environment. Appendix (Three) shows the designed survey instrument (questionnaire) that was administered. Out of the 1200 houses randomly selected for questionnaire administration, 926 copies of the questionnaire were administered, with about 900 copies fully completed and retrieved through a local team of two university graduates

3.4.3 Secondary Spatial Data

The secondary data requirements for the study were identified by drawing up and comparing a table of an ideal world with the actual situation on ground in order to come out with the data required for the study in the Nigerian context. The table provides a guide towards the type and format of the data required for the study. Secondary sources of data can complement research by providing three types of context: geographical, historical, and socio-economic (Clark 2005). The approach identifies the GIS data needs and requirements for the study and avoids the situation of re-inventing the wheel once the source for collecting the data has been identified. The comparison of an ideal situation to the situation on ground in order to identify the missing gaps is illustrated in Table 3. This explains the need for many of the questions included in the questionnaire. The secondary data identified are building footprints, showing residential houses, road network and utility network elements, such as distribution transformer, low and high-tension poles.

3.4.4 Spatially referenced Attribute Data

Attribute data/information were gathered through a household survey and the administration of questionnaire (survey instrument designed for the study). This included socio-economic and demographic data at the household levels using the survey instrument (questionnaire) during the door-to-door household survey. The questionnaire included indices and indicators used in

measuring electricity accessibility, availability, affordability, consumption proportion and self-generation of electricity using different types of petrol/diesel powered generating sets.

Table 3.3: Identifying data requirements for study by comparing ideal world with the situation on ground

NOS	TYPES OF DATA	IDEAL WORLD	REALITY ON GROUND	STUDY
1.	Electric Utility Network Infrastructure	Utility map showing geo-referenced map of electricity network elements/assets (e.g. x,y coordinates of Injection Sub-stations, distribution transformers (DT's), HT and LT poles). Network model as it exists on ground	Analogue map, As built drawings, CAD Drawings etc. Not geo-referenced	Compile a geo-referenced map of the study area showing building footprints, road network, and distribution transformer.
2.	Customers location (Buildings)	Linked to customer information in the customer information system/billing database. Different Categories of customers as residential, commercial and industrial classified	Does not exist in the Billing system or in the utility network data. Not geocoded	Link building footprints to respondents households using assigned unique ID.
3.	Socio-economic (Demographics)	Population categorised based on socio-economic class	Does not exist and where it does, they have not seen the needs to use it for decision making purpose.	Link households surveyed using questionnaire administered to match respondents' location on map using a unique ID.
4.	Land use diversity	Demarcation of different categories of customers based on land use and identify relationships that exist with the utility network, customers etc	The system does not have capability because everything is manual/analogue	Classify and categorise land-use diversity from questionnaire administered across the study area.

3.5 Methods of Data Collection

The research fieldwork is divided into four major data collection techniques and activities, namely:

- The RS and GIS Approach – Spatial data capture from high-resolution QuickBird (0.6m) satellite imagery as a backdrop and spatial analytical techniques of Geographic Information System (GIS).

- Questionnaire administration
- Focus group discussion (FGD)
- Interviews of electricity service provider officials and key informants/willing individual/households

3.5.1 The RS and GIS Approach

The complementary tools and methodologies of remote sensing and Geographic Information System provide the initial raw data for the research to take off. The data included the high-resolution QuickBird (0.6m) satellite imagery, building footprints and road network of the study area. The building footprints and road network feature extraction from the high-resolution QuickBird (0.6m) satellite imagery of the study area was achieved through a process known as “Heads up Digitizing,” which is a method of spatial data capture.

To achieve objectives 2, 3 and 4 (Table 3.1), the GIS mapping was divided into two steps. Step I involved the building footprints and road/street network feature extraction from the high-resolution satellite imagery of the research study area. Step II involved the random selection of about 1200 polygons (building footprints) from the existing five thousand two hundred and sixty three building footprints extracted from the satellite imagery of the study area. The selected sample size constituted about 20-25 per cent of the total building footprints extracted from the satellite imagery. Two separate shapefiles (polygon shapefile for the building footprints and arc shapefile for the road network) were the products of the feature extraction/digitisation. Each building footprint is a polygon feature that represents the actual location of each household on ground. Each was then assigned a unique identifier (ID) to match each questionnaire administered to the building/household it represented on ground and within the GIS environment. The resultant digital datasets of the uniquely identified and randomly selected building footprints and road network inside the ArcGIS provided the initial data for the fieldwork elements of the research to take off and, thus, prepared the stage for the door-to-door survey that followed. The data for the study area are displayed in Figure 3.5. The diagram shows the map of the study area with the satellite imagery at the background overlaid by road network and location of electricity distribution sub-stations, and customers’ locations as building footprints.

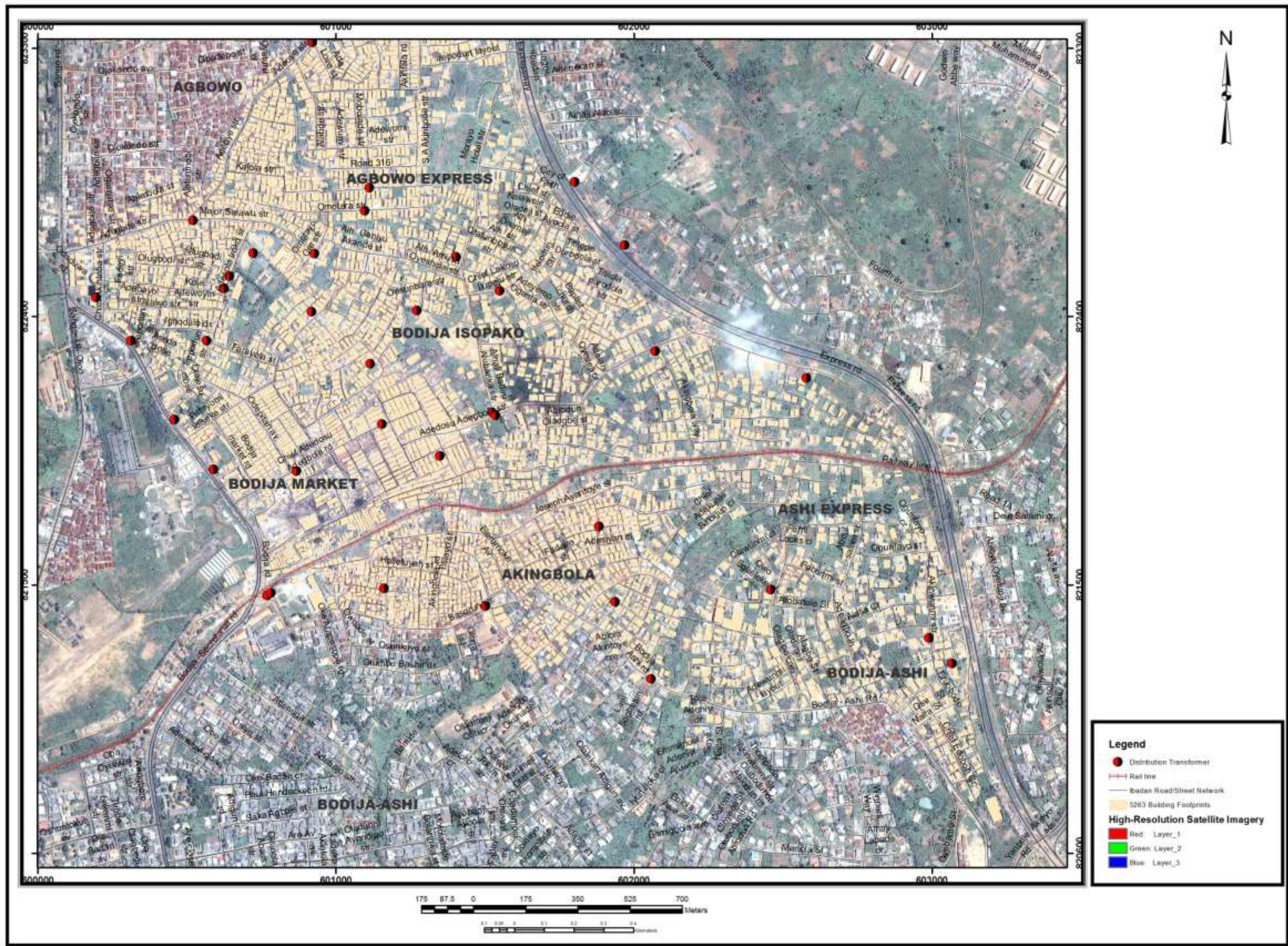


Figure 3.5: Satellite imagery of study area overlaid by the building footprints, distribution transformers and road/street network.

3.5.2 Quantitative and Qualitative Methods of Data Collection

The use of questionnaire as a research technique has been seen as a quantitative strategy, whereas interviews, focus group discussions and observations might be thought of as qualitative techniques. Quantitative approaches are often seen as more scientific and 'objective'. Bryman (1988) argues for a 'best of both worlds' approach and suggests that qualitative and quantitative approaches should be combined. Designing a questionnaire is a complicated task, as it needs to be unambiguous and easy for respondents to comprehend (Major and Savin-Baden, 2010). Questionnaires are advantageous to this kind of research because they are used to collect descriptive and exploratory data about opinions, behaviours and attributes, even though they could also be problematic if they do not collect data that answer research aim and objectives (Saunders et al., 2003:281). Harris and Brown (2010); Brookhart and Durkin (2003) and Lai and Waltman (2008) also suggest the use of structured questionnaires and semi-structured interviews in mixed method studies to generate confirmatory results despite differences in methods of data collection, analysis, and interpretation. While questionnaires can provide evidence of patterns amongst large populations, qualitative interview data often gather more in-depth insights on participant attitudes, thoughts, and actions (Kendall, 2008). Qualitative methods are most effective at providing insights into human environments and individual experiences; they can also effectively investigate social processes. When research is concerned with explaining the environments and experiences as well as social and individual processes, qualitative methodologies provide the best match (Winchester, 2005). A qualitative methodology can be especially effective in giving a voice to the marginalised or silenced (Winchester 2005).

3.5.3 Questionnaire Design and Administration

The questionnaire, printed in a 3-page A4 format, consisted of 42 questions (Appendix Three). The respondents to the questionnaire administered were the household heads. The sampling frame was the houses in the selected residential neighbourhoods. Household surveys offer a more in-depth understanding in analysing household electricity usage and consumption. The objective of the field survey data collection exercise was to obtain information about the individual household from the randomly selected sample households. An understanding of the energy poverty phenomenon as situated in the context of this study to indicate inadequacy and unreliability of electricity provision and the importance of modern energy services provide assistance as reflected in the design of the survey questionnaire. The questionnaire was structured into the following three main categories: (a) household demographic and socio-economic characteristics; (b) grid-supplied electricity; procurement and use (government-supplied

electricity) and (c) off grid-solutions (self-generation of electricity). The data collected from the households were considered sufficient to provide evidence on how inadequate quantity and quality of electricity services contribute to energy poverty. A 6-step approach, which can be visualised in Figure 3.6, was used to design and carry out the field survey.

A number of socio-economic variables were included since socio-economic characteristics are associated with people's perception of impact of infrastructure/facilities (Campbell, 1983). These are age of household heads, marital status, educational qualification, occupation, income, number of persons in the household, ownership status (owner, rented), type of building, and so on. These are necessary to identify the demographic profile of respondents. Educational qualification/achievement is deliberately included as a surrogate for income or socio-economic status (Greenberg et al., 1995).

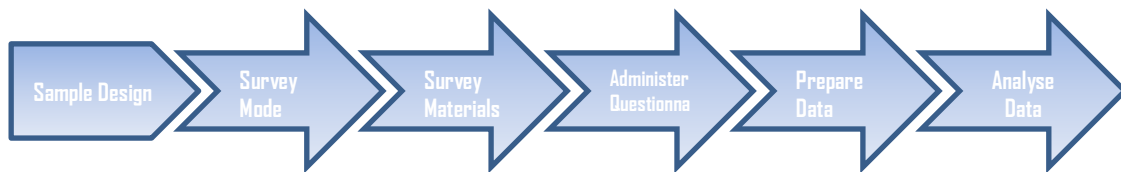


Figure 3.6: Steps in survey design

The sample size for this study consisted 900-1200 households spread across geographic locations of a service unit within the district under which the study area was located. The sample represents above 10 per cent of the total customer population of the service centre located under the district. Furthermore, the questionnaire incorporated specific electricity-related questions on connectivity, availability, quality and reliability. These data were required to understand household response to electricity services through such measures as connectivity barrier; electricity consumption; household expenditure on electricity and self-generated electricity. Two main statistical techniques were used in the research: simple descriptive statistics and multivariate statistical techniques of correlation and multiple regression analysis. The simple descriptive statistics provided an understanding and evidence of patterns of the data captured using a simple descriptive analysis of frequency of occurrence. The multivariate statistical techniques were used to explain the relationship between household socio-economic characteristics, electricity consumption and households' expenditure on the grid and on self-generated electricity.

3.5.4 Sampling Method

The study area is a mix of people of diverse socio-economic backgrounds. According to Saunders et al. (2003:175), purposive sampling is good for small samples that are selected owing to their informative nature. The households sampled were on a mixed urban land-use (residential and commercial) clustered in neighbourhood formations. The households were clustered into three main groups: low, medium and high-income socio-economic groups. Samples were chosen from these clusters in order to capture the heterogeneity of the households' population. The high number of households sampled was based on the fact that the larger the number in the sample, the higher the likelihood of a representative distribution of the population.

A three-stage sampling process using a GIS was used in selecting the respondents sampled. The GIS first stage of the sampling method involved the random selection of 20-25 per cent of 5,263 building footprints extracted from the satellite imagery of the study area (refer to Figure 3.2). The selection resulted in about 1,200 building footprints selected (Figure 3.7). The second stage involved the creation of the centroid of each of the 1,200 building footprints (polygon) selected using the feature to point function in ArcGIS. This was achieved with the "create random point tool" of the ArcGIS software. The third stage involved a point in polygon query and analysis function that was thereafter performed to select all the building footprints (polygons) that contained the 1,200 points features that were randomly selected. The conversion of the building footprints to point in polygon was to ease spatial analysis, cartographic representation and symbolisation. The selected buildings were then assigned a unique identification (ID). These were the households sampled and questionnaire administered (Figure 3.8). This sampling method was used to ensure that the research was manageable without compromising credibility and to provide designs that are spatially well balanced.

The choice of 20-25 per cent of overall buildings was to have more than enough representation knowing full well that some of the buildings that will be randomly selected might be uncompleted buildings, inaccessible buildings, vacant plots, mechanic workshops or markets without supply of electricity, and so on. Each of the households was physically visited when the questionnaire was administered to the household heads (Plates 3.1; 3.2 & 3.3). The data collection was on the socio-economic characteristics of each household, electricity bills received and/or paid (and where available, electric meter readings and sighting of electricity bills); photographs of some of the residential building and types of generators and so on were taken.



Plate 3.1: Household respondent providing answers to questions in the questionnaire
Source: Fieldwork (2012) - Permission granted by the respondent for photograph to be taken



Plate 3.2: Household respondents providing answers to questions in the questionnaire
Source: Fieldwork (2012) - Permission granted by the respondent for photograph to be taken



Plate 3.3: Household respondents providing answers to questions in the questionnaire
Source: Fieldwork (2012) - Permission granted by the respondent for photograph to be taken

3.5.5 Sample Size

The sampling for this study was at the household level. Copies of the questionnaire were administered to a total number of 926 households/respondents with 900 questionnaire fully completed and all questions fully answered. Figure 3.9 shows the location of the respondents/households sampled across space. The overall valid response from the respondents/household sampled is 97 per cent based on the nine hundred and twenty six questionnaire administered. There is no definite convention of an acceptable response rate to validate survey based research, most researchers considered the minimum of 60 per cent to be a reasonable response rate (Robson, 2011). The respondents/households population was a mix of various population segments, such as workers (civil servants - public, private), traders, drivers, students, apprentices, pensioners and other professionals. Electricity meters were single metered household living in a duplex or bungalow; multiple metered households, like block of flats with each household having its own meter; and multiple households connected to a single meter (communal face-to-face housing or Brazilian type). The head of each household that was available, eligible and willing to answer the questions was interviewed. The total number of respondents/households administered constituted about 20 per cent of the population of the study area.

The questionnaire was administered to capture all information that will help examine and analyse electricity provision, the inadequate quantity and unreliable quality of electricity supply and the consequences of energy poverty. Administering the questionnaire involved door-to-door survey of households earlier identified from the random sampling technique. It involved visiting each household identified from the geographical map of the study area and engaging the head of each household in an interactive discussion and systematically asking questions listed in the questionnaire. The respondents cut across the different classes of people living in the study area with a mix of the literate, the semi illiterate and the illiterate, falling in the low, medium and high-income socio-economic groups.

Out of the 1200 households that were randomly selected, 926 households were visited and the questionnaire administered to them. A total number of 37 distribution sub-stations (transformers) were located within the study area, providing electricity to over 5000 households/customers. The study was also able to identify households that were not on the billing database. During the field data collection stage of the study, any respondents that did not show existing PHCN electricity bills was classified as a consumer. This was listed as one of the questions to be answered in the questionnaire administered. All such respondents were red-flagged.



Figure 3.7: 5263 building footprints/houses in the study area

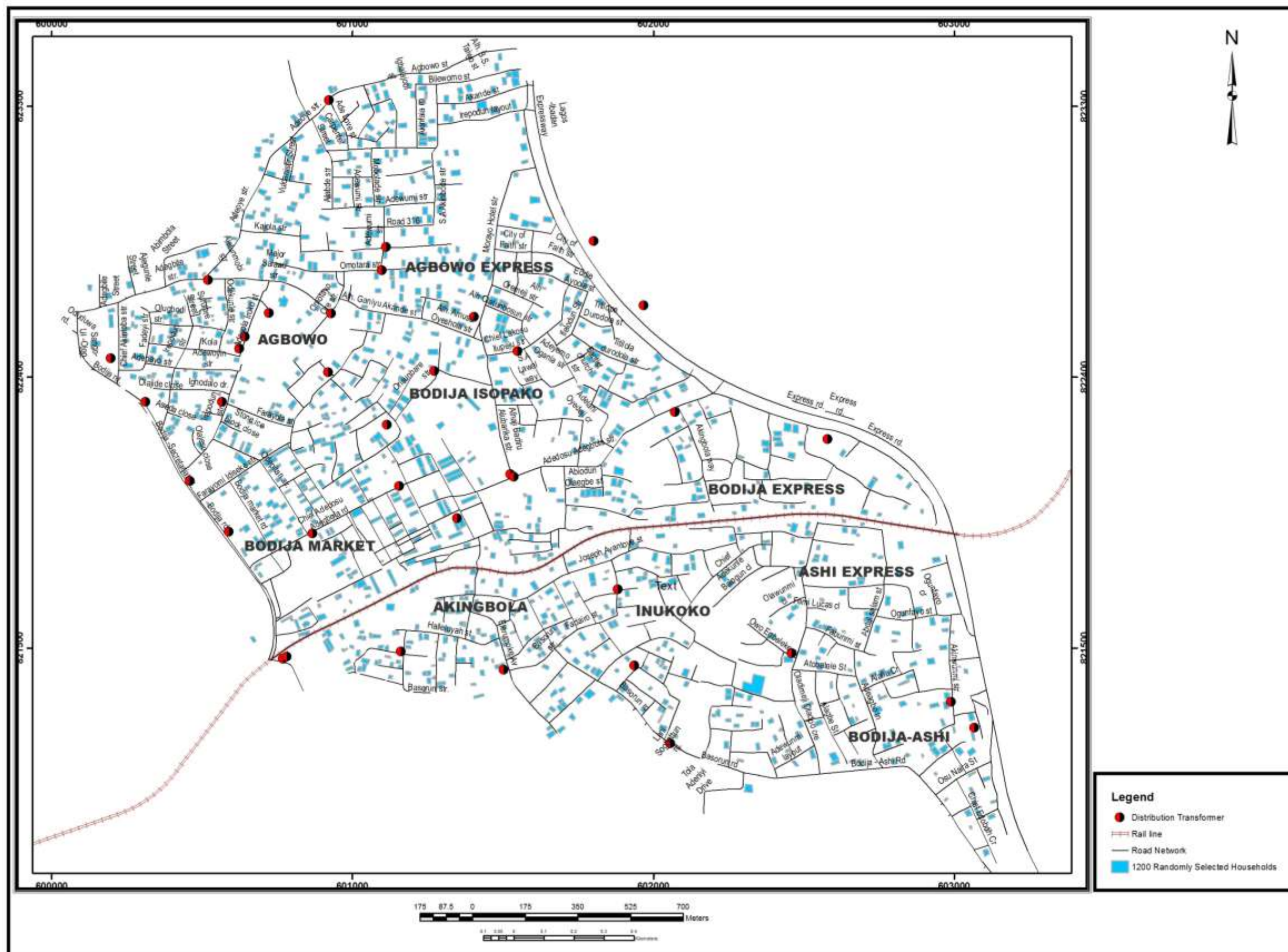


Figure 3.8: 1200 randomly selected building footprints of households for sampling in the study area

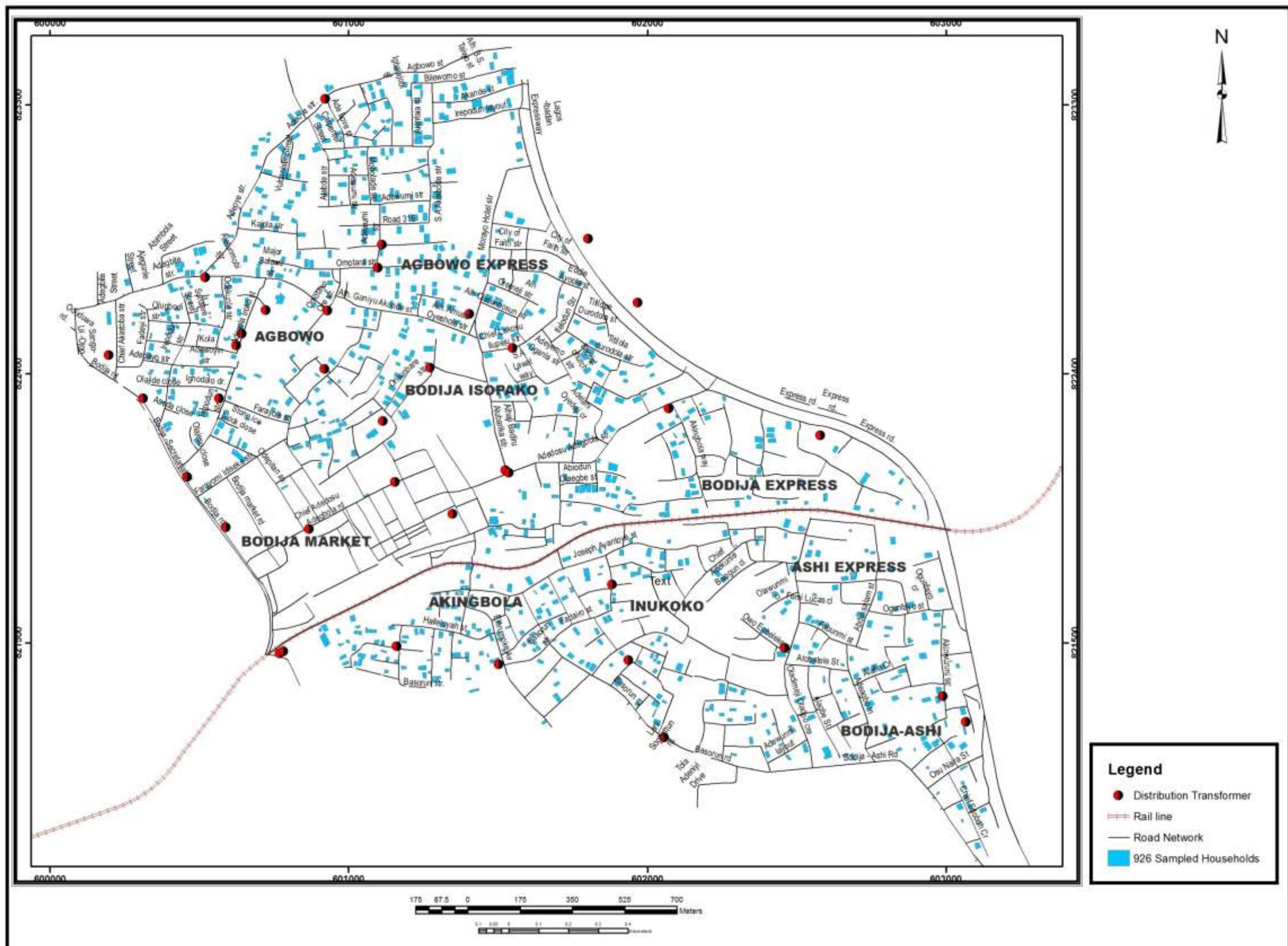


Figure 3.9: 926 sampled households/respondents buildings

3.6 Focus Group Discussions (FGDs) and Interview of Key Informants

Madsen and Adriansen (2004) have supported the use of multiple methods in geographic research as this approach offers unique perspectives in relating society and environment from a geography and resource analysis perspectives. Focus group discussions and interviews were conducted with stakeholders in the study area and electricity service provider officials with the aim of elaborating on and eliciting further information from the participants with reference to access and availability of electricity. A multi-method approach of data capture from researcher memory, field note taking, photographs and audio recordings were employed at different stages of the focus group discussions and interviews. Some precautionary measures were taken to avoid error of omission; error of misinterpretation and error due to assuming that all statements have equal verbal emphasis. One of such precautionary measures taken was the use of an audio recorder to record discussions. The presence of the researcher by moderating and conducting the focus group and interview allowed an understanding that gave a sense of the mood, the enthusiasm, energy and all the things that make conversation dynamic.

The researcher's notes and audio recordings were the tools used in producing the output of both focus group discussions and interviews. The discussions revolved around issues relating to access to electricity, reliability of supply, service delivery, impact of electricity on socio well-being of households, complaints and contentious issues and changes that took place within the electricity sector. The results revealed the interview process to be vital in generating qualitative information from the perspectives of the electricity consumers and government officials, as described in section 3.6.1 and 3.6.2. Some kinds of information would not have been collected through household surveys. Examples of such information and documents gathered during the interview and focus group discussion is the request made by Ifesowapo community to the Oyo State electricity board for the provision of distribution transformer and electrification assistance. Some documents were provided to back up their claims and as a proof of payment made before being connected to the grid. The receipt for payment of distribution transformer as tendered by the community is attached (Appendix Fourteen & Fifteen). The documents gathered during the group discussions were collected for reference to complement the data collected through surveys and interviews. The findings from the group discussions and interviews were enumerated, discussed and analysed to support the quantitative analysis in chapter four and five.

3.6.1 Focus Group Discussion (FGDs)

The focus group discussion is a research technique that collects data through group interaction on a topic predetermined by the researcher (Morgan, 1996:130). According to Lunt and Livingstone (1996:80), the focus group is regarded as an appropriate and efficient data-gathering tool. Focus groups are becoming an increasingly valuable qualitative research tool in human geography subfields (Cameron, 2005). Zeigler et al. (1996), Breen (2006) and Skop (2006) have used focus groups in geographic research. The focus group method in geography is particularly useful when exploring the complex relationship between the social and the physical environment.

Two different focus group discussions were conducted at two different locations (Plates 3.4 & 3.5). The focus group discussions was specifically fixed and took place during the landlords, tenants and residents association monthly meetings in each of the neighbourhood within the study area and in attendance were officers appointed in charge of all electricity-related issues usually referred to as (electricity liaison officers). The first one (Plate 3.4) comprises the Ifesowapo community, while the second one (Plate 3.5) involved those living within the Inukoko community.

Issues relating to connectivity, problems of over-billing arising from obnoxious and contentious estimated billing, irregular and inadequate supply of electricity, non-provision of electricity meters and their non-willingness to pay for electricity were discussed. The focus group discussants and the key informants interviewed complained of paying more for darkness and electricity not consumed. Some of the questions asked during the focus group discussion are highlighted below.

- Are there any barriers or limitations to you connecting to the electricity grid?
- If any, please explain?
- Do you have to pay before being connected to the electricity grid in your neighbourhood?
- To whom? And how much must you pay before getting connection?
- What are the problems your area is encountering in connecting to the electricity grid?
- How often is the supply of electricity and how regular? What do you think are the causes of these?
- How often do you visit the electricity service provider's office (PHCN) to lodge complaints (weekly or monthly)

- Do you think the problem you encounter is peculiar to your neighbourhood alone?
- How do you think the problem can be rectified or what remedy is required?
- Why are people not willing to pay for electricity consumed?
- What will make you more willing to pay for electricity consumption?
- Is there any forum where issues and problems related to electricity are discussed? And how effective is your forum?
- How best do you think the bottleneck of connecting to the grid can be overcome?
- What advice can you provide to government on how they can improve access to electricity that is affordable?



Plate 3.4: A cross-section of the Ifesowapo community comprising house-owners (landlord/landlady), tenants and elders in a group discussion.

Source: Fieldwork (2012) - Permission granted by the focus group individual for photograph to be taken



Plate 3.5: A cross-section of the Inukoko community members during the 2nd focus group discussion

Source: Fieldwork (2012) - Permission granted by the focus group individual for photograph to be taken

3.6.2 Interviews of Key Residential Informants and Officials of the Electricity Service Provider

There are a number of interview styles that could be used in any case study. Therefore, it is very important to take into account the suitability of different types of interviews, such as structured or unstructured interviews. According to Wainwright (1997:999), the interview provides the researcher with an in-depth understanding of the experiences of the interviewee and the meanings within the account of a particular action, process or event. This study adopted an open and unstructured style of interview to corroborate the facts that have been established during the focus group discussions (FGDs) and to seek and further confirm answers to questions that are of public interest and require utmost attention during the FGDs.

Six different officials of the electricity service provider were interviewed. The targeted interviews and FGDs comprise different sets of people identified below and aimed to achieve a consensus among the households. Those interviewed cut across the top management, the middle level officials and the foot soldiers. The interviews were conducted at the offices of the officials of the

electricity service provider, so as to gain access to additional information and have a feel of the office environment and operational activities. One of the clarifications sought during the interview process from a senior officer of the electricity provider-marketing unit is the issue of customers and consumers. According to the official interviewed:

“a customer is a consumer, a known person, an entity with an electrical service address associated with an account number and on a specified tariff class. Customers receive electricity bills on a monthly basis. They are customers because the electricity provider knows they exist and not necessarily, because they pay for electricity regularly consumed. All the above information pertaining to the customer exists in the electricity provider-billing database. Though not all customers are allocated meters, a reason why some are placed on estimated consumption”... “a consumer on the other hand consumed electricity illegally, no electricity bills is received by consumers and as a result do not pay for electricity consumed; does not have any record with the electricity service provider; information about consumers does not exist in the billing database. Most often, their connection does not appear in the electricity distribution and information system”.

The newly released electricity tariff was obtained during the course of the interview (see Table 4.10). The photograph in Plates 3.6 shows an official of the electricity provider being interviewed. Some of the interviewees did not want their photographs taken, while some felt the interview proceedings should not be recorded; so, notes were taken instead. Plates 3.7-3.9 display the different types of metering and connection observed during the fieldwork/questionnaire administration. The officials of the electricity service provider interviewed were service unit managers, distribution engineers, mains inspectors, performance managers and customer service officers (CSO) at the district and Ashi service centre where data collection took place. Three other separate interviews were conducted with residents of the study area, comprising the chairman of Ifesowapo Landlord Association; the person appointed as liaison officer supervising issues related to electricity at Inukoko community and a volunteer school teacher.

Some of the questions asked the electricity service provider officials are itemised below:

1. What are the procedures required to get access and connection to electricity supply?
2. What are the bottlenecks associated with connecting households to source of electricity?
3. What are the impediments to the provision of quality, uninterrupted and reliable power supply?
4. How can you improve on the service provided?
5. How is the response time to customers' complaints?

6. Which neighbourhood is experiencing difficulties?
7. What is the most common type of faults/complaints from customers in this study area?
8. What informs you disconnecting households from the grid?
9. Can I have a look at your faults/complaints register?
10. Is there a forum for feedback from the customers? If 'yes', how do you act on the feedback?
11. What are the limitations to providing better services?
12. Is there a way that you can generate revenue to be independent without government funding?
13. Is there any question or any other thing that you wish to ask or add to this discussion?
14. Why has government failed in providing adequate, reliable and affordable electricity?



Plate 3.6: Interview of the service unit manager

Source: Fieldwork (2012) - Permission granted by the official interviewed for photograph to be taken



Plate 3.7: A typical single-phase prepayment meter connection
Source: Fieldwork (2012) - Permission granted by household for photograph to be taken



Plate 3.8: A typical credit/electromechanical meter connection
Source: Fieldwork (2012) - Permission granted by household for photograph to be taken



Plate 3.9: A typical household without electricity meter and on a direct connection (DC) consumption to the national grid

Source: Fieldwork (2012) - Permission granted by household for photograph to be taken

3.6.3 Consultative Forum

A Power Consumer Assembly (PCA) organised by Nigerian Electricity Regulatory Commission (NERC) to enlighten electricity consumers on the status of the reform programmes in the Nigerian electricity sector was to be attended on the 10th of October but later shifted. The PCA event was hosted in continuation of the commission's ongoing power reforms enlightenment campaign and aimed at providing Nigerians details of the reform process to enable them demand for accountability and transparency in electricity service delivery. A request was made for the media coverage and proceedings of the earlier one conducted prior to the one postponed in order to gather the general public opinion and perceptions on the issues of the erratic nature of electricity supply being experienced by the general populace.

3.7 Methods of Data Analysis

3.7.1 The GIS Data Analysis

Before proceeding with the analysis, all spatial data were prepared and pre-processed into a uniform and compatible format. All spatial data in the GIS database were geo-referenced to a common projection and on the same scale so that they can overlay accurately. All data captured

and generated as shapefiles (.shp) in ArcGIS were referenced to Universal Transverse Mercator (UTM), WGS 84, Zone 32). The GIS mappings and analysis were performed in ArcGIS software version 10, developed by the Environmental System Research Institute (ESRI) located in Redlands California. The links between spatial and descriptive data in a GIS database provide a flexible way of manipulating the data in such a way to facilitate the integration necessary to perform spatial search, attribute queries final product output in form map. Spatial and attribute queries were used to answer questions and produce different thematic maps showing the locations where certain conditions based on criteria specified are met, such as the “where”; “what” and “if analysis”:

1. Where are the households with electricity consumption greater than 150kWh?
2. What are the household sizes with more than 4 members living in a Brazilian type of house with educational qualifications of bachelor’s degree?
3. Where are the households with less than 100000 Naira (₦) income?
4. Where are the households with income greater than 100000 Naira (₦) but less than N250000 Naira (₦)?
5. Where are the locations of households without generating sets?

The final product and result of many types of geographic operation is best visualised as a map, graph, chart or table. Maps are both the raw material and the product of GIS and with the continuous advancement of computer graphic packages to generate maps, especially in the field of Geographical Information Systems (GIS), maps can now be used and presented in more sophisticated ways, for analysis, policy and decision making (Parker and Asencio, 2008). A map plays a vital role in depicting the spatial organisation of events. The results of the final outputs/deliverables are displayed as map and this involves the combination of different types of point, line and polygon features, such as building centroids, road network and building footprints showing respondents’ locations. The combination of the different features used in this analysis is then arranged in layers followed by cartographic design using different map elements to produce the final output in the form of a map. The final map outputs of the deliverables are an energy index map depicted cartographically in the form of thematic (choropleth) map. Three main uses of choropleth maps were derived by Dent (1985) namely: ascertain the actual value associated with a geographical area; understand the geographical pattern of the mapped variable with attention to individual values; and be able to query one choropleth map pattern with another simultaneously. The prevalence of the energy poverty situation in the study area was analysed cartographically and depicted to show the extent of the spatial variations. The last step before

mapping the composite indicators is the classification of the index. Classification is the process of conveniently arranging or systematically grouping data according to one or more characteristics (Kraak and Ormeling, 2010). To classify spatial data require that we make sure that the chosen method gives a clear view and understanding of the mapped phenomenon.

3.7.2 Energy Poverty Index (EPI)

Davis (2003) cites two reasons for mapping poverty, namely to identify where the poor are located and to provide data against which potential causes of poverty can be analysed. This study takes a cue from Davis analytical view of poverty and relates it to energy poverty. In doing so, the quantum of electricity supplied; the proportion of income the average household spends on electricity, and amount of electricity consumed by households were taken into consideration. The EPI was calculated based on the percentage of household monthly expenditure on electricity as against average household income. The income of some of the sampled households was difficult to accurately estimate due to the nature of employment. Household income is an indicator of social class.

The income group classification took into cognisance the minimum wage of ₦18,000 (£72) as stipulated by the three tier of government in Nigeria. This informed categorising households between the basic monthly salary (minimum wage) of ₦18,000 (£72) and ₦50,000 (£200) as the low low-income group using an exchange rate of £1 = ₦250. Therefore, income of respondents in the study area were categorised into four: low low-income, low-income, middle-income and high-income class. The value of the lower-income group is from ₦1 – N50,000 (£0.004 - £200), the value of low-income is from ₦50-0001 – ₦100,000 (£200 - £400), the middle-income is ₦100,000 – ₦250,000 (£400 - £1000) and the high income value is from ₦250,001 (£1000) upwards. It is noteworthy to state here that 60.2 per cent of the respondents are in the lower-income category and 31.4 per cent in the low-income category. The large number of households in lower and low-income category might be responsible for the poor results of associations between income and energy associations in Chapter 5 sections 5.4.1. The number of households in the lower and low-income category is too large and as a result, a lot of the significance difference in income levels is being masked. Those who consume less energy tend to be poorer than those who consume more energy and poverty leads to the consumption of less energy. Therefore, it is a two-dimensional relationship - energy poverty causes household poverty and household poverty underpins energy poverty.

The EPI map provides a geospatial representation and distribution of percentage of households' income expended on electricity (grid and self-generation). The Index map was created by importing and linking the analysed household survey datasets in SPSS using the unique identifier (ID) common to the building footprints of respondents' house location in the ArcGIS environment. An energy poverty index of the study area was mapped based on the household income and expenditure on electricity. The energy index map ranked households sampled in the study neighbourhood by comparing all households to each other based on percentage of households' income expended on grid and self-generation electricity. The EPI provides an insight into energy poverty by using household average income in relation to expenditure on energy. The EPI map was compiled in the ArcGIS environment. The index map allowed the visualisation of the sampled household's location with a view to identifying patterns and trends. The ability to capture a variety of data and establish links between descriptive and spatial data make the GIS valuable for explaining events, predicting outcomes, and planning strategies (Longley et al., 2005). The importance of producing this map is not only to prove that energy poverty exists, but also to show the magnitude of energy poverty and to identify and analyse the locations where it exists.

3.7.3 Questionnaire Analysis with Descriptive and Multivariate Statistical Techniques

Before entering the questionnaire data administered into the Statistical Package for the Social Scientist (SPSS) application software, a coding frame was designed and the questionnaire coded (Saldana, 2009; Robson, 2011) (Appendix Four). The coding frame shows how written (textual) or verbal data have been converted into numeric data for purposes of analysis. It equally provides the path for data entering into the computer system using the SPSS application software. It is a range of numeric codes that are used in "coding" information that represents a single "variable" (for example, average monthly income of households head). In this example, about four unique numbers were included in the coding frame, one for each income class. Numbers were assigned arbitrarily to variables depending on the numbers of answers to each question of the variable. All nominal and ordinal data were re-coded into dummy variables. Dummy variables are used to examine group differences. The dummy variable contains only the values 1 and 0, with a value of 1 indicating that the associated observation has the given categorical value and all cases not falling into that category assume a value of zero. A dummy variable was included in the regression analysis aimed to explain household electricity consumption and to correct the influence of some socio-economic characteristics on electricity consumption. The gender, type of house, house ownership, marital status, education and occupation were recoded as dummy

variables. Household size, age and income were both measured on interval scales. All analyses done are 2-tail tests at either 0.01 or, should that fail, at 0.05 level.

The completed nine hundred copies of the questionnaire administered were entered successfully with variable defined and statistical analyses performed using SPSS application software. The data analysis began with simple descriptive statistics to provide an insight into the data gathered through the frequency of occurrence. The descriptive statistics used were mean, frequency of occurrence and percentage of distributions of variables examined. This was followed by cross-tabulations and multivariate statistics techniques of correlation and multiple regressions analysis for investigating, assessing and predicting the relationship between two or more quantitative variables (independent and dependent variables) which are correlated to each other in varying degree. Cross-tabulations involve the counting of the codes from one variable and comparing with the codes in a second variable (Robson, 2011). The cross-tabulations statistical technique was used to explore households' responses and the pattern of dependent variables against the independent variables of households' socio-economic characteristics. The results of the relationship are presented in chapter five.

The methodology employed sought to understand the relationships between variables in an attempt to provide for more holistic, inclusive studies and models through iterative and stochastic assessment of results of analysis that informs the choice of the model selected. A multiple regression equation that describes the relationship was first created. The correlations between variables were also examined using Pearson's correlation coefficient, which led to insights on the relationships between the variables. The multivariate analysis was used to explore and analyse the relationship between "two or more predictor variables" (Field, 2005:738). The multivariate statistical data analysis was performed on variables of households' expenditure on grid-electricity and self-generated electricity as dependent variables and independent variables, such as age, gender, family size, household size and type, type of building, educational status, occupation and average monthly income. Tabachnick and Fidell (1989) suggest that, for analyses involving multivariate statistics, an appropriate data set composed of values related to a number of variables for a number of subjects is required. Accordingly, appropriate data sets may be organised as a data matrix, a correlation matrix, a variance-covariance matrix, a sum-of-squares and cross products matrix, or a sequence of residuals.

The multivariate regression equations were implicitly expressed as:

$$y = \beta_0 + \beta_1x_1 + \dots + \beta_nx_n + \varepsilon$$

(Foody, 2003)

where:

y = the predicted value on the dependent variable (DV),

β_0 = the y intercept, the value of y when all x s are zero,

$x_1 - x_n$ = the various independent variables (IVs)

$\beta_1 - \beta_n$ = the various coefficients assigned to the independent variables (IVs) during the regression,

ε = an error term.

The regression analysis started with model specification and this entailed the expression of theoretical constructs in mathematical terms and involved setting up the model building activity. Specifically, it was the translation of theoretical constructs into mathematical/statistical forms. The procedure involved systematically adding independent variables, one at a time to produce results that best improve the fit. The results of the regression analysis were assessed at each stage with the successive inclusion of additional independent variables; this informed the choice and reflected the quality of the model chosen. The model chosen thereafter was on the basis of simplicity and credibility and proved very effective with a number of checks that helped determine the realistic nature of the chosen model. The model was selected using forward stepwise regression. The approach sequentially added variable that best improved the goodness of fit of the regression model. In deciding the number of variables to be included in the model, only variables that improved the adjusted r^2 significantly were selected. This was because sequential addition of variables improved the fit; however, not all were significant, as some were inflated. The adjusted r^2 accounts for the selection of only variables that is significant. The correlation between the obtained and predicted values for Y relates the strength of the relationship between the DV and IVs.

3.7.4 Analysis of Focus Group and Interviews Data

The analysis of the qualitative data of focus group and interview is the process of interpreting and understanding the qualitative data that was collected during the fieldwork components of the research. The analysis and interpretation require a great deal of judgment and care, as there is no one best or correct approach to the analysis of qualitative data. One of the advantages of

conducting focus group interviews is the diversity of answers that come from discussions created by the “social interactions’ among participants (Rabiee, 2004). Most methods of focus group discussion and interview analysis are based on transcriptions of information gathered as written (text) or as recorded (audio or video). Sherraden (2001) notes that the detailed coding and analysis of the output from focus group discussions can be very time consuming owing to the quantity of detailed information and the diversity of opinions.

In this study, a systematic manual approach was deployed in transcribing the recorded focus group and interview data into analytic notes for coding. The data analysis encompasses the combination of qualitative content and thematic method of analysis as the two are often used interchangeably. Braun and Clarke (2006) suggest one of the best approaches to analysing focus group and interview results appears to be thematic analysis. Hsieh and Shannon (2005:1278) describe qualitative content analysis as “a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns”. Both types of qualitative data analysis entail a way of seeing the process of coding qualitative information to enable categorisation - themes that emerge from the coding process.

Table 3.4: Phases of content and thematic analysis

Nos	Phase	Description of the Process
1.	Familiarising and reviewing of the data	Transcribing data, reading and re-reading the data, noting down initial ideas.
2.	Organising the data	Organise the data so that they are more manageable and easy to navigate.
3.	Generating initial codes	Coding interesting features of the data in a systemic fashion across the entire data set, collating data relevant to each code.
4.	Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential theme.
5.	Reviewing themes	Checking if themes work in relation to the coded extracts (Level 1), and the entire data set (Level 2), generates a thematic ‘map’ of the analysis.
6.	Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
7.	Interpreting the data in producing the analysis report	This involves attaching meaning and significance to the transcribed data and by considering relationships between themes to determine how they are connected. The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to their search question and literature.

Source: Modified from Braun and Clarke (2006)

Table 3.4 summarises the methods, stages and procedure of analysis and process of identifying themes by the researcher. The results of the transcribed data were used to explain, relate and support the quantitative data gathered during the fieldwork components of the research.

3.8 Ethical Issues

Ethical issues were considered throughout the process of the research from planning (proposal), data collection, questionnaire administration and interviews, analysis to dissemination of findings. Homan (1991) asserts that ethical issues in focus groups are the same as other methods in qualitative research. Healy and Rawlinson (1993:340) describe ethics as simply involving: “explaining adequately the purpose of the investigation, the confidentiality of the responses and the rights of the respondents to comment what is written about them”. Ethical issues relating to this research specifically involved informed consent of research participants and respondents about the purpose, methods and intended uses of the study, as described by Wiles et al. (2005). Ethical implications of the study survey design were carefully taken into consideration in a way that reflected the respect of confidentiality, anonymity and privacy of the research respondents. Other advocates of ethical consideration in geographic research include Frankfort-Nachmias and Nachmias, (1992); Madge (1997b) and Sultana (2007). The researcher made it clear that under no circumstances was the identity of those sampled in the questionnaire administration, focus group and interviews would be revealed. In addition, the researcher sought the consent of the individual households sampled; focus group participants and key informant interviewed before taking their photograph and permission granted before finally photograph were taking. The researcher made it clear to households with no evidence of payment of electricity consumed that we are not reporting the outcome of the survey exercise to anyone knowing fully well that the issue of non-payment could imply energy theft or pilferage.

3.8.1 Confidentiality and Anonymity

Participants were assured of confidentiality and anonymity throughout the research and at no time would sensitive information disclosed. The identities of the participants would remain confidential and information collected treated in strictest confidence.

3.8.2 Informed Consent

Participants were duly informed about the purpose of the research from the outset (Appendix One). Before taking part in the research, participants agreed to endorse a consent form (Appendix Two), out of their own choice, without any pressure or any form of incentive or reward

from the researcher. Answers to questions by the respondents were at their prerogative with no pressure exerted. Efforts were, however, made to let respondents see why their honest and voluntary responses would contribute to the research findings and unbiased outcome of the study results in a way that would ensure the quality and integrity of the research.

3.8.3 Dignity

The dignity of the participants was not compromised during the research. Participants were regularly reminded to opt out if they did not feel comfortable with the research. Conscious efforts were taken to mitigate and avoid any distress to any respondents from the questions in the survey design. Diplomacy was applied to questions like income and non-payments for electricity consumed when put forward to the respondents. This prevented any bias that could affect the outcome of the research findings and results.

3.8.4 No Conflict of Interest

It was emphasised that this research was self-funded and was not in any way linked to any government, non-governmental organisation (NGO) or international organisations and that there was no form of any monetary reward or incentives attached to respondents. The research was purely independent and was not in any way associated with any governmental study and no conflicts of interest were expected to arise from the research. This research was borne out of the researcher desire to understand the causes and consequences of the energy poverty being experienced by a larger percentage of the Nigerian population and to contribute his findings to the body of knowledge. The study involved interviews with people from low class, medium and high classes living within the residential and the commercial land-use density of the study area. Concerted efforts were made to avoid any physical and emotional harm; risk of upset and reputational damage to the respondents and participants.

3.9 Limitations of research methodology and data sources

Before concluding the chapter, it is very important to highlight some of the limitations and difficulties experienced in the course of the research. First, getting consistent information about household composition was very difficult and almost impossible in some cases. Primary data collection of field survey was the only way to locate electricity customers; hence, the need to conduct a door-to-door survey. The questionnaire administration involved door-to-door household survey using simple random sampling methods and visiting each household sampled and

engaging the head of each household in an interactive discussion and systematically asking questions listed in the questionnaire.

The survey targets were respondents across the different classes of people living in the study area. The level of literacy in Nigeria is still very low; a larger percentage of the citizens are illiterate (about 35 million adults) as reported by the Education for All Global Monitoring Report of 2013. The research target respondents was a mix of the literate, the semi illiterate and the illiterate, falling in the low, medium and high-income socio-economic groups.

The fieldwork started with a 2-day training in April 2012 for the two (2) field assistants engaged for the study and a pre-trial/mock administration of the questionnaire. The geographical map of the study area was printed and studied with the field assistants in preparation for the fieldwork. The questionnaire was further reviewed and modified to include questions not initially anticipated in preparation for the commencement of the questionnaire administration of the fieldwork component of the research.

The questionnaires administration took place from around 9am to 5pm during weekdays and from 8am to 4pm on weekends (Saturdays and sometimes Sundays). On the average, it took 20-25 minutes to administer a questionnaire. The fieldwork went well but not without its own challenges owing to some circumstances beyond the researcher's control. There was the problem of literacy and language barrier and the questionnaire had to be translated into local native languages - Yoruba and Pidgin English for some of the respondents. Some of the challenges encountered had to do with the absence of most eligible households' heads at the time of visitation. This usually resulted to re-visiting many of those households on many occasions before the questionnaire could be eventually administered. The fieldwork was carried out during the rainy season and it was difficult administering the questionnaire in the rain, particularly in the months of June and July.

The attitude and disposition of some respondents were unfavourable particularly since the research had to do with electricity provision that is of national concern. However, not all the respondents were comfortable providing information, as they were unsure on the use of information provided. The general belief is that information provided in time past on the country's electricity situation has not yielded any positive result regardless of the fact that government has expended billions of dollars over the years at improving the power sector without any

commensurate outcome. Some of the households were eager to contribute and wanted to know if the electricity services of their community would improve. One major challenge of this research was identifying households to administer the questionnaire among those living in shared and rented apartments within the same residential buildings made up of several multi-nucleated and extended families/households. This had implications in providing adequate answers to some of the questions listed in the questionnaire since they were not homeowners. One of such questions in the questionnaire that was difficult to ascertain is the household disposable income because of the nature of the occupation of some of the household-heads sampled; and, in some cases, some respondents were economical with the truth. There was difficulty in assigning value to income in some of the households sampled because some of the household-heads belonged to the informal sector; they owned businesses and were not salary earners, while some made a living from home-front stores. Therefore, accurately estimating their incomes becomes difficult because the proceeds and profits from their sales monthly were inconsistent. The focus group discussions were on two occasions shifted to another date as a result of poor attendance. The second focus group discussion, after rescheduling for the third time, was almost cancelled, simply because shortly after the commencement of the focus group discussion, it started raining. We had to move to another location for shelter, thanks to the maturity and understanding displayed by the discussants. The interview with the electricity provider's officials was shifted on several occasions owing to duty calls.

3.10 Summary

Geographic Information Systems (GIS) provided the basis for the research methodology adopted for the selection of the sampled households and the spatial analytical processes for the study. The methodology outlines the methods and strategy from data collection to analysis, beginning with understanding the questionnaire designed for the fieldwork exercise. A systematic sampling and random selection of 1200 building footprints from the total number of 5263 buildings identified from the satellite imagery of the study area was achieved. The ArcGIS software provided the platform for the randomly selected building footprints of households sampled using the random select tool. The sampling method was to ensure that the field survey exercise was manageable without compromising credibility such that it provided designs that were spatially and statistically balanced. The selected households were then assigned a unique identification (ID); these were the households sampled and where questionnaire administration took place. The methodology was constrained by the unavailability of the household demographic composition and census data

in a suitable and usable format, thus necessitating the conduct of the door-to-door household survey, focus group discussions (FGDs) and interviews.

The quantitative and qualitative methods of research were employed in the data gathering process in order to gather information on electricity demand, supply and consumption in an interactive discussion from the heads of the randomly selected households, focus group discussants and volunteer residents of the study area. The information gathered on each households sampled was linked to the residential location of each households on the map with the use of a unique identifier for ease of statistical and spatial analysis.

The different type of data analysis using GIS techniques, descriptive and multivariate statistical analysis on quantitative data, thematic and content analysis for the qualitative data were further described. The GIS analysis produced the Energy Poverty Index (EPI) calculated based on the percentage of household monthly expenditure on grid-based and self-generation electricity against average household disposable income. The Energy Poverty Index map provided a geospatial representation and distribution of percentage of households' income expended on electricity (grid and self-generation).

CHAPTER FOUR

THE NATURE OF ELECTRICITY DELIVERY IN NIGERIA AND ITS SPECIFICITY IN THE STUDY AREA

4.1 Introduction

This chapter provides historical background and an overview of the power sector in Nigeria, its past and present challenges and a brief profile of all the agencies involved in the electricity supply chain. The section highlights the two major source of electricity generation, their installed and available capacity and an overview of the current and transition status of the privatisation and reforms programme of the electricity supply industry. The third section presents the results of the fieldwork elements of the research together with a critical analysis and interpretation of their outcomes together with a descriptive summary of the socio-economic and demographic characteristics of the sampled households in the study. The fourth section explores and analyses the pattern of electricity demand, supply and consumption.

4.2 Overview of the Nigerian Power Sector

Electricity supply services in Nigeria date back to 1866 (Hart, 2000), but the development of the Nigerian electricity industry began in 1886 with a 20MW power plant in Ijora, Lagos, under the Public Works Department (PWD). The Europeans established the Nigeria Electricity Supply Company (NESCO) in 1929 as an electric utility company. This resulted in the construction of a hydroelectric power station at Kuru, near Jos, and the installation of more generators in Kaduna, Ibadan, Enugu and Kano, under the same PWD. Throughout this period, electricity was restricted to government quarters and homes of prominent citizens.

The Electricity Corporation of Nigeria (ECN) was established in 1951 through an Act of Parliament, with a mandate to supply electricity to all Nigerians and cater for all the power supply systems in the country. About a decade later, in 1962, the Niger Dam Authority (NDA) was established for the development of hydroelectric power project at Kainji on the River Niger. The NDA was responsible for the construction and maintenance of hydro dams and other works on the River Niger and elsewhere, generating electricity by means of waterpower, improving navigation and promoting fish brines and irrigation (Makoju, 2007). The two establishments, NDA and ECN (now defunct) existed as separate entities until 1972 when they were merged through Decree No. 24 of June 29, 1972 to form a vertically integrated public corporation known as

National Electric Power Authority (NEPA) on January 6, 1973, to consolidate efforts at boosting electricity supply. The new authority was given the monopoly to generate, transmit, distribute and market electricity throughout Nigeria. Electricity generation and distribution has thus become a monopolistic business that only the Federal Government of Nigeria could invest and control, being wholly owned by state.

The electricity sector in the 1970s and 1980s witnessed an uninterrupted supply of electricity. However, during this period, rural areas were not connected to the grid. Thereafter, electricity supply witnessed a downward decline from the late 1980s owing to the government's neglect. All through this period, supply from the hydro power stations in Kainji, Shiroro and Jebba was declining, while electricity consumers were increasing in proportion as a result of increase in population growth and city expansion. Owing to the consequence of obsolete equipment and lack of maintenance, the hydro generating stations started to experience reduction in electricity generation, without any thoughtful effort by the federal government to construct additional power stations. The long years of neglect continued in the electricity sector and, by 1999, Nigeria, with a population of over 100 million, was generating only 1500 megawatts of electricity. Throughout the same period, countries like Iran, South Africa and Indonesia, that had lower population and that were generating the same quantity of electricity with Nigeria in the 1960s, were generating over 30,000 megawatts each.

All through the years of military, rule between 1966 -1979 and the period of civilian rule between 1979 and 1983, access to electricity supply were limited to very few Nigerians. The increasing demand for electricity, arising from population growth, city expansion and industrialisation without corresponding increase in power generation, led to the collapse of the electricity infrastructure in the year 2000 shortly at the commencement of the current democratic rule in 1999. As at 1999, the Nigerian electricity sector had reached the lowest point of its 100-year history. Prior to 1999, between 1989-1999, the power sector did not experience any substantial investment in infrastructural development. Throughout this period, no new electricity generating power plant was built and the existing ones were not properly maintained. Consequently, the power sector was brought to a deplorable state of affairs, with only 19 of the 79 generations units in the country operational and functional with an average daily generation of 1750 megawatts (MW) from the installed capacity of about 5600 MW (Sambo, 2008). Notwithstanding the various efforts of the state-owned utility, Nigerian Electricity Supply Company, (which operated as a monopoly) to manage the sector to provide electricity, it became clear by the late 1990s that the Nigerian

electricity system was failing to meet Nigeria's power needs (Ajayi et al., 2013). The long years of neglect of the power sector resulted in the energy crisis currently experienced in the electricity sector. This prompted President Olusegun Obasanjo, in 2001, to sack the NEPA board and set up a nine-man technical committee to probe the inefficiencies of NEPA.

This signalled the beginning of the current power sector reform. The existence and report of the committee led to the National Electric Power Policy (NEPP) that birthed the Electric Power Sector Reform (EPSR) Act 2005 and the transformation of NEPA into the Power Holding Company of Nigeria (PHCN) with 18 successor companies. The Electric Power Sector Reform (EPSR) Act of 2005 was signed into law on March 11, 2005 to support the electricity sector reform and unlock the opportunities for fresh investments in the sector. The enactment of the Act led to NEPA being transformed into a transition organisation, Power Holding Company of Nigeria (PHCN) Plc., as an investment company for assets, liabilities, personnel, rights and obligations of NEPA in anticipation of the privatisation of successor companies by the Bureau of Public Enterprises (BPE, 2011). The Act forms the basis of the reform agenda and envisions three phases towards competitive market development – restructuring, privatisation and liberalisation (Research and Market, 2010). Privatisation is a policy adopted for reducing the cost structure and size of government in transferring assets and service functions from government to private ownership and control (CPCS, 2011). This is to encourage private sector participation, leveraging best practices and technology to close the huge infrastructure and energy gap.

The passage of the EPSR Act equally led to the establishment of the regulatory agency, the Nigerian Electricity Regulatory Commission (NERC) in 2005 and the unbundling of Power Holding Company of Nigeria (PHCN) into eighteen companies, six generation, one transmission and eleven distribution companies in 2007. Unbundling is a process towards preparing the state-owned monopoly of electricity services for reforms, liberalisation and privatisation and onward transfer of its assets and liabilities to private sector operators through outright sales or concessions. Put differently, it is a process of breaking down of public enterprises into functional units as basis for commercial operations and is specifically applied for the privatisation of utilities that often operate in a condition of monopoly. The Nigerian electricity industry was unbundled into generation, distribution and transmission companies with a view to liberalising the electricity sector from public-driven economy to a private-driven one by encouraging private-sector participation and attracting foreign and local investment into the Nigerian power sector to ensure economic and reliable electricity supply. The six-generation companies were to carry out the

generation function; one transmission company to carry out the transmission function and eleven distribution companies to carry out the distribution function. The evolution of the Nigerian power sector is described below in figure 4.1.

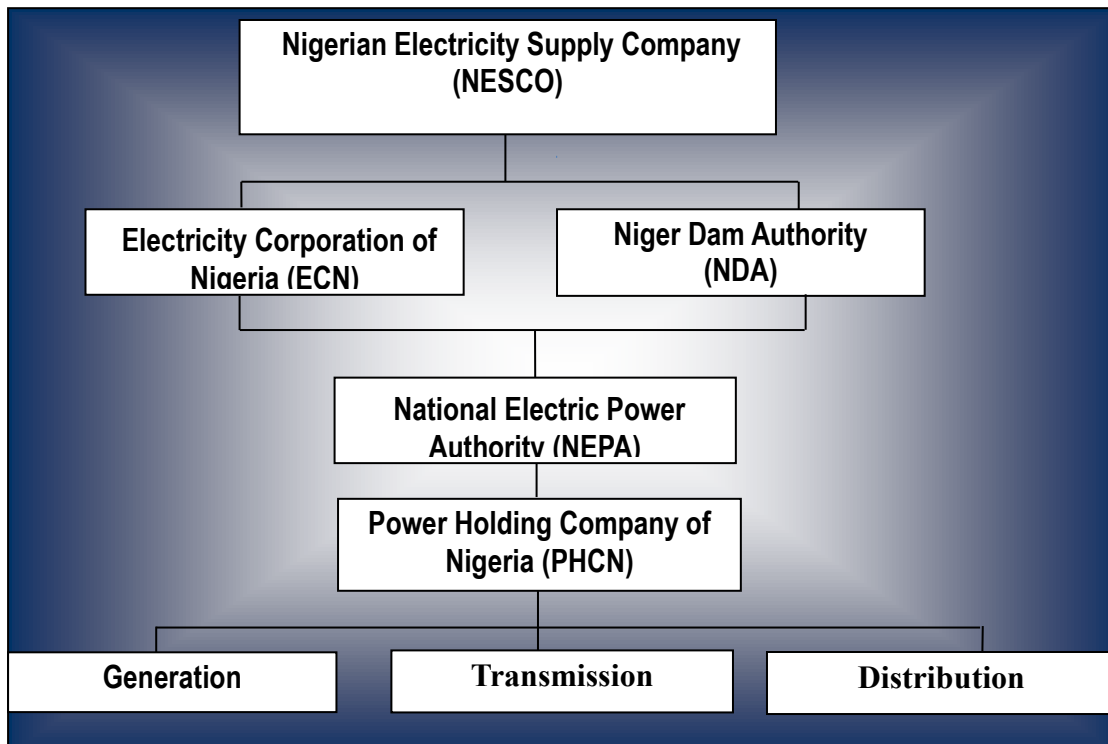


Figure 4.1: The Nigerian Power Sector (Before Privatisation)

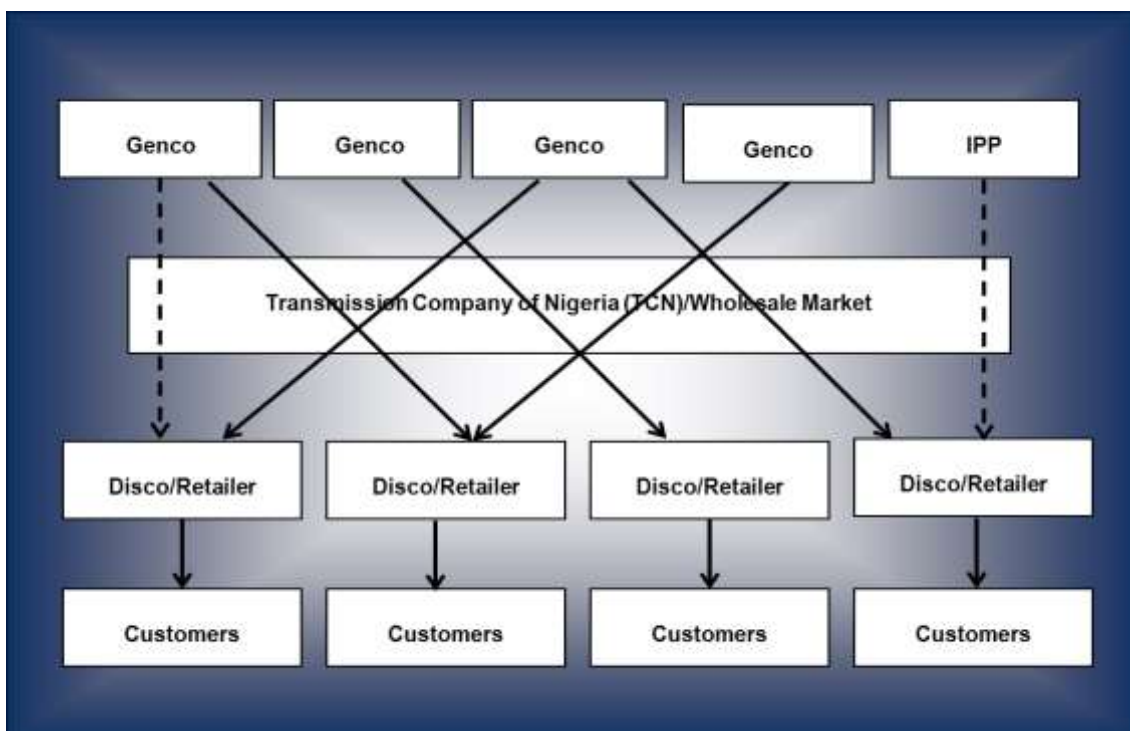


Figure 4.2: The Nigerian Power Sector (After Privatisation).

Source: Compilation of the author's study

The Nigeria Electricity Regulatory Commission (NERC), saddled with responsibility to oversee, coordinate and regulate the activities of the Nigerian Electricity Supply Industry (NESI), promotes competition and private sector participation, setting market rules and designing tariffs and pricing. In addition, it is to establish or approve appropriate operating codes and safety, reliability and quality standards; license and regulate persons engaged in the generation, transmission, system operation, distribution and trading of electricity; and monitor the operation of the electricity market (NERC, 2008; Research and Market, 2010). The NERC was established to facilitate private sector participation in the provisions of electricity services and permit Independent Power Producers (IPPs) to come into Power Purchase Agreements (PPAs). The generation companies are to add additional power into the nations' grid. The NERC has so far licensed 19 independent power companies to generate power in the country together with the unbundled 9 generations, 11 distributions and 1 transmission company. All these were done to prepare the power sector for reforms and privatisation.

The NERC set the electricity tariffs to reflect the cost of capital depreciation and to provide a reasonable rate of return for generation, transmission and distribution companies under NERC's Multi-Year Tariff Order (MYTO). The first set of Tariffs under MYTO 1 was introduced in July 2008. The Tariff Review began because of agitation from Market Participants (licensees in generation, transmission and distribution) and prospective investors who felt that some of the technical and financial considerations in the tariff calculations needed to be re-examined (NERC, 2008). The electricity tariffs and fixed charge have been reviewed upward five times under NERC in the last 10 years on the premise that previous tariffs were not cost effective, hence the need to create platform for the prospective investors/owners to recoup their investment in due course. The tariff has risen from ₦4.50 (£0.017) per kWh in February 2002 to ₦6 (£0.023) per kWh in 2008, to ₦7.80 (£0.03) in January 2011, to ₦12.30 (£0.04) in June 2012, and to the present ₦12.80 (£0.05) in June 2013. The fixed charge has likewise been increased from ₦120 (£0.46) in 2002 to ₦500 (£1.95) and to the present ₦750 (£1.82), starting from June 2013. This used to be a fixed charge and meter maintenance charge (MMC) but now it has been merged to reflect only fixed charge. The fixed charge is a component of customer's monthly electricity bill to enable the electricity distribution companies "Discos" to maintain and recover costs on permanent investments, such as distribution transformers, conductors/cables and electric poles in addition to the maintenance cost and the capacity charge paid to the generating companies (NERC, 2008).

4.2.1 Current Electricity Situation (Installed and Available Capacity)

Electricity generation in Nigeria is achieved through centralised and decentralised (captive power generations) systems. While the centralised system is connected to the national grid for transmission and distribution to the consumers, the decentralised version is usually a standalone system not connected to the national grid. The centralised system consists of both thermal plants (natural gas, fuel oil and diesel) as well as renewable energy-based (large hydropower and central PV) plants. The decentralised system similarly consists of both renewable energy-based and thermal plants. The renewable energy-based decentralised plants are small (small, mini, and micro) hydro power plants and residential PV systems (Akinbami, 2001). Electricity generation includes oil and gas-fuelled thermal power plants and hydropower with hydroelectric generating plants concentrated in the central Nigeria and thermal power plants in Lagos and Delta States. The large hydro plants accounted for about 31.30 per cent of grid electricity generation while natural gas accounted for the balance of 68.30 per cent (World Bank, 2001; ECN, 2006). Although coal fuelled the industrialisation of Nigeria in the early 20th century, most coal mines were abandoned following the Nigerian-Biafran Civil War (1967-1970) (Oguejiofor, 2010).

Grid-electricity is the main source of modern energy services in Nigeria. These services are mainly from thermal or hydro sources, made up of 3 hydro (Kainji, Jebba, Shiroro), and 4 thermal (gas-based) stations (Egbin, Ughelli, Afam, Sapele). Many of these generating power plants in Nigeria are very old; Kainji and Jebba plants were commissioned in 1968 and 1985, respectively and are inadequately maintained and thus susceptible to frequent breakdowns. Between “1979 – 1999”, there was no new investment in the power sector. The sector suffers mass neglect and for a country that was on industrial advancement path, at least 1000 MW is required every year. The installed capacity as at 1999 was 5000 MW and the output was less than 1500 MW due to mismanagement.

Presently, there are 23 grid-connected generating plants in operation in the Nigerian Electricity Supply Industry (NESI), with a total installed capacity of 10,396.0 MW and available capacity of 6,056 MW. The thermal-based generation plants have an installed capacity of 8,457.6 MW (81 per cent of the total) and an available capacity of 4,996 MW (83 per cent of the total). The three major hydropower plants account for 1,938.4 MW of total installed capacity (and an available capacity of 1,060 MW) (Table 4.1). The daily production of 3200-3800 MW in the country shows that a considerable and significant generating capacity has not been added to the transmission grid from the installed capacity. The low electricity generation productions has been regularly

attributed to the cyclic drop in the levels of water at the hydro power stations referred to as “low deep”, which is a cyclic natural phenomenon that occurs during the first quarter of every year as a result of drought together with the insufficient supply of gas to fire the thermal plants.

Table 4.1: Successor generation companies in Nigeria, their names and installed capacities:

S/N	Generation Company	Plant type	Capacity (MW)	Year of commissioning
1	Afam Power Plc (I-V)	Thermal	987.2	1975-1982
2	Egbin Power Plc	Thermal	1,320	1985-1987
3	Kainji/Jebba Hydro Electric Plc	Hydro	1,330	1968, 1976, 1978, 1986
4	Sapele Power Plc	Thermal	1,020	1978-1990
5	Shiroro Hydro Electric Plc	Hydro	600	1990
6	Ughelli Power Plc	Thermal	942	1966-1990

Source: Nigerian Electricity Regulatory Commission (2011)

The demand for electricity continues to increase as the population and economy grow and the Nigerian power sector operates well below its estimated capacity. The Power Holding Company of Nigeria (PHCN) has been incapable of providing minimum acceptable international standards of electricity service in terms of reliability, accessibility and availability for the past three decades (Iwayemi, 2008b). Technical losses account for about 30 per cent of power generated while commercial losses are about 40 per cent of the total revenue collection from electricity supplied (Onagoruwa, 2011), compared to the international norm and acceptable technical losses of 7 and 10 per cent of total electricity generated and commercial losses of 2 per cent (World Bank, 1994; USAID, 2005). This made the Federal Government of Nigeria to enter into an agreement with the United States Trade and Development Agency (USTDA) to conduct studies on how to tackle technical and commercial losses in the power sector (Okeke, 2011). These levels of losses, if not halted, according to Onagoruwa (2011) will continue to make the Nigerian electricity sector unattractive for private-sector participation. Electricity tariff levels in Nigeria is one of the lowest in sub-Saharan Africa (Figure 4.3) making it uncompetitive for private-sector participation (Nnaji, 2012). A large number of the power generating plants in the country is underutilised and not functioning at full capacity (Omachonu and Chiejine, 2009). This informs the setting up of the Niger Delta Power Holding Company (NDPHC), the special purpose vehicle for the National Integrated Power Projects (NIPPs). The NDPHC began its journey in 2004 and has successfully built 10 medium-sized gas-fired power plants with combined capacity of 5,455 MW, scheduled for completion (on-going projects) and privatisation in 2014 (Table 4.2). The National Integrated

Power Project (NIPP) was conceived as a fast-track government-funded initiative to add significant new generation capacity and stabilise Nigeria's electricity supply industry while the private-sector-led structure of the Electric Power Sector Reform Act (EPSRA) of 2005 took effect.

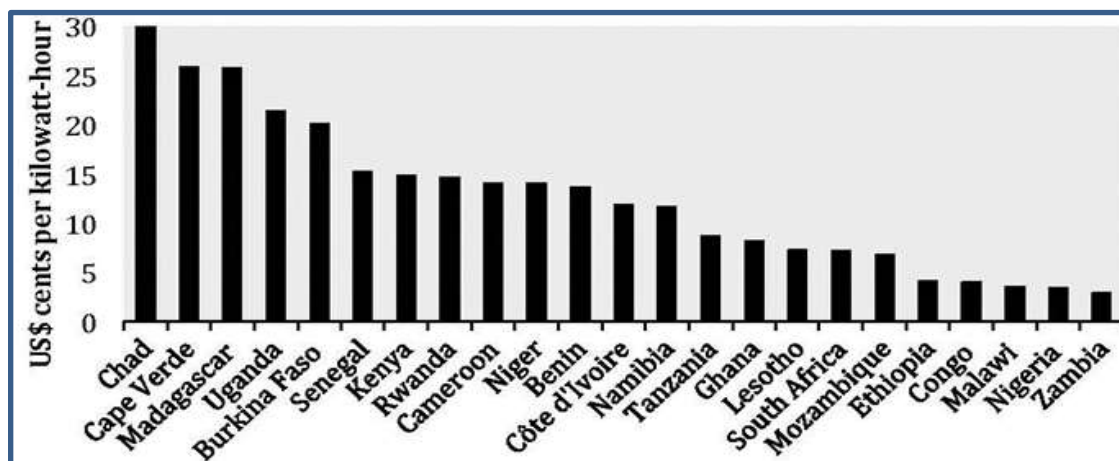


Figure 4.3: Comparison of electricity tariff across Africa
Source: Derived from Eberhard and others (2009)

Table 4.2: Independent power plants (IPPs) and completion status

S/N	National Integrated Power Projects (NIPPs)	Capacity (MW)	Location	Expected completion date as at September 2013
1.	Alaoji Generation Company Nigeria Limited	1,131	Abia	June 2014
2.	Benin Generation Company Limited	508	Edo	December 2013
3.	Calabar Generation Company Limited	634	Cross River	June 2014
4.	Egbema Generation Company Limited	381	Imo	June 2014
5.	Gbarain Generation Company Limited	254	Bayelsa	June 2014
6.	Geregu Generation Company Limited	506	Kogi	May 2013
7.	Ogorode Generation Company Limited	508	Delta	All units commissioned
8.	Olorunsogo Generation Company Limited	754	Ogun	All units commissioned
9.	Omoku Generation Company Limited	265	Rivers	June 2014
10.	Omotosho Generation Company Limited	513	Ondo	All units commissioned

Source: Niger Delta Power Holding Company Limited

The challenging process of implementing reforms was revitalised in August 2010 through the 2010 Power Sector Roadmap, which clearly outlines the government's strategy and actions to undertake comprehensive power sector reform to expand supply, open the door to private investment and address some of the chronic sector issues hampering improvement of service delivery (World Bank, 2014). The roadmap is to provide a complete overhaul of Nigeria's power sector to achieve reliable and quality electricity that is affordable, in a way that the small entrepreneur, the urban poor and rural dwellers will be able to have electricity at the flick of the switch (Nnaji, 2011). The power reforms are expected to develop the energy capacity of the country and solve a myriad of problems related to electricity provision as earlier identified in the World Bank's Energy Sector Management Assistance Programme (ESMAP) (1993). These include inadequate access to infrastructure, low connection rates, insufficient power-generation capacity and utilisation, inadequate funding, ineffective regulation, high aggregate technical and commercial losses and vandalism as well as inadequate transmission and distribution infrastructure (Adenikinju, 1998; Alohan, 2012). According to the Director-General, Bureau of Public Enterprises (BPP) (2013), Nigeria needs about 29,000 megawatts of power to stabilise the electricity needs of the country, which he puts at 40,000MW with an estimated £6.25 billion required annually in the next ten years to make the power sector efficient. The grossly undeniable under-performance of the power sector and the inability to provide adequate and reliable electricity despite the huge investment of about US\$40 billion in the last 16 years to improve the sector informs government decisions to embark on the power sector reform to liberalise and privatise the sector. The explanation put forward by the Western institutions (the World Bank and the IMF) for the implementation of privatisation in Nigeria was that privatisation was the only viable option at the disposal of the Nigerian government to make all the presumed non-performing state-owned enterprises run efficiently (World Bank, 2009). It was envisaged that privatisation would improve operational efficiency of inefficient state-owned enterprises (SOEs), reduce government expenditure and state-role, increase investment and employment as well as ensure job security in Nigeria (Subair & Oke, 2008; Jerome, 2008). While privatisation may be a "viable" alternative global economic policy reform (World Bank, 2007), it is not a blanket solution for the problems of poorly performing state-owned enterprises (Igbuzor, 2003).

The economic principles of deregulation and privatization were first introduced in Nigeria in the 1980s through the policy of structural adjustment programme (SAP) (Adoga, 2008; Jerome, 2008; Adebayo, 2011; Kalejaiye et al., 2013). The commercialisation and privatisation decree No 25 came into force in 1988. The decree made provisions for the commercialisation of Nigerian Public

Enterprises (NEPA and the defunct PHCN inclusive). The decree provided for both full and partial commercialisation and PHCN fell under the category of public enterprises to be commercialised (Adeyemo and Adeleke, 2010). Since then, government monopolies had disappeared in many industries and over 85 public enterprises (PES) in mining, education, health, agriculture, transportation and telecommunication were transferred, either fully or partially to private owners (Jerome, 2008). The lack of growth and capacity to meet the demand of electricity consumers led to a series of reforms projects and policies initiated by the Federal Government. The aims of the reforms were to create an efficient electricity industry, which in turn will boost the Nigerian economy. The recent of these reforms is the restructuring and privatisation of the electricity sector (Chigbue, 2010; Babatunde, 2011). This involved change in the industry structure, with the aim to stimulate competition, choice and promote financial accountability; unbundling into constituent factors; establishing commercial trading arrangement and change in control and/or ownership of the electric utility (Chigbue, 2010). However, the extent of unbundling of the power industry into generation, distribution and transmission industries as dictated by the roadmap are still very inadequate. The reform proposes that a single subsidiary will control the transmission sector leaving the six generating companies and expected independent power producers to sell electricity to the eleven distribution companies. The distribution company will in turn, control the supply of electricity within a designated area. The different sections of the unbundled power sector with its associated advisory and regulatory bodies at the federal level remain too large to be efficiently managed (Babatunde, 2011). The roadmap for power sector reform introduced by the Federal Government to put an end to electricity outages in Nigeria brought hope to Nigerians. However, the power policy strategy presented a number of contending technical and policy issues which left one wondering whether Nigeria is ever going to get it right in the effort to reform her electricity supply industry (Babatunde, 2011).

The Nigerian power sector is riddled and entrenched with corruption and Nigerians are worse off in terms of electricity supply than they were some 16 years ago. Despite the huge investment of about US\$40 billion committed to improve the nation's power sector, there is little or nothing to show for these large investments. It is worth mentioning that no nation had ever moved from developing to been developed by relying on generators to power its economy. The endemic corruption in the executive, the legislature, the Judiciary and even in the anti-corruption agencies, have combined to render ineffective any internally evolved or externally imposed economic policy, such as privatisation (Nigeria Corruption Survey Study Report, 2003). The socio-political, economic and cultural environment of Nigeria is arguably embedded in corruption (Transparency

International Corruption Index Report, 2010). The country's reputation for widespread corruption remains high at 136 out of the 174 countries on Transparency International's 2014 Corruption Perception Index. Corruption has become the norm in Nigeria, a reflection of the poor management of the enormous resources nature has endowed the country with rather than the lack of resources, which have been the bane of the nation's economy and a reflection of the power sector situation.

According to the federal government statistics, over 400,000 barrels of crude oil is being stolen on a daily basis with over US\$14 billion lost to oil theft yearly in the country. What the country loses to oil theft in a year is more than the total amount of Federal allocations in four years to all the 36 states in the country. The excess crude oil account (ECA) setup in 2004 to serve as a stabilisation and savings account to protect planned budgets against revenue shortfall due to volatility in crude oil prices has been depleted (Wallis and Oakley, 2011). According to the Minister of Finance and the Coordinating Minister of the Economy (Okonjo Iweala, 2014), "the ECA is the equivalent of the Sovereign Wealth Fund and aims to insulate the Nigerian economy from external shocks by isolating government expenditures from oil revenues. The ECA have provides strong fiscal buffer to the Nigerian economy and also served as confidence booster to foreign investors. The ECA increase from US\$5.1 billion to US\$20 billion by November 2008 shortly after it was setup due to an increase in crude oil prices at a peak of US\$147 per barrel. The ECA has then fallen from US\$20 billion in 2008 to US\$11.5 billion at the end of 2012 and US\$2.45 billion in December 2014. The reasons adduced are as a result of the declining oil revenues caused by pipeline vandalism, oil theft and production shut-ins". An estimated US\$9 million is lost to vandalism of cable theft and pipelines. The Minister further states that the foreign reserves, which the late President Umaru Musa Yar'Adua Administration grew up to as much as over US\$60 billion, is today standing at US\$34.5 billion. This fall in reserves has been attributed largely to a result of the vicissitudes of the global economy and oil market which caused the CBN to intervene, using some of the reserves, to defend the value of the naira. Akukwe, (2015) in his submission summed up the total probable missing/stolen or unremitted oil funds in last five years to be US\$142.2 billion.

The crude oil has become a curse to Nigeria instead of blessing and it has ruined the capacity to reason, to think and to explore other areas like Agriculture, Science and Technology, Industrialisation, Building and Construction Industry (Odufowokan, 2015). The enormous potential of the proceeds of oil wealth has not been utilised to expand electricity access significantly by

providing the population with access to affordable, reliable, abundant (and preferably clean) electricity (Bazilian et al., 2013). Nigeria has never realised the amount of revenue it received in the last 16 years from the sale of crude oil since the restoration of democracy by the military in 1999. Billions of petrol-dollar have either been wasted or siphoned from the treasury. The most recent is the billions of dollars stolen under the petrol subsidy programme and the missing US\$20 billion scandal in the Nigerian National Petroleum Corporation (NNPC). Nigeria is the only OPEC country that imports refined petroleum products for her daily consumption estimated at 400,000 barrel a day because none of the four refineries is working and the one working is not functioning at optimal capacity. The country sells crude oil at low prices then buy refined at high rates. Many countries like Japan, Italy, Sweden, German France, and Singapore have no oil and yet they have given a good account of themselves in the global economy through commitments, power of critical thinking and dint of hard work. Some third world countries are surviving without oil. Nigeria as a nation has been going through very rough times in the last three decades due to leadership failure and widespread corruption. The commonwealth resources of the country are being mismanaged and billions of naira budgeted and allocated for ministries, departments and government agencies (MDA's) plundered. The political appointees, their cronies, public and civil servants have taken corrupt practices to high unprecedented level and as a result, the country is neck deep in poverty, underdeveloped, socio-political, and economic trepidation.

Adujie (2007) noted that corruption explains why major Nigerian roads are impassable and it is responsible for power failure, while the supply of electricity is erratic despite all the money budgeted and allocated for that sector. Corruption is the reason why Nigerian hospitals lack necessary medical equipment and drugs, despite the yearly budgets that are earmarked for these purposes. It is also the reason why the educational institutions are no longer reckoned with in the international fora. Corruption thrives in Nigeria because it is systemic and is a symptomatic of a structural failure in our polity. The consequences have been widening income inequality and creation of avoidable poverty in a resource-endowed country, which is now classified as the ninth poorest country in the world (United Nations, 2004; Amnesty International, 2009; USAID, 2009). This has created an unnecessarily huge national debt for the Nigerian taxpayers (African Forum and Network on Debt and Development, 2007). Corruption in Nigeria has stifled industrialization and infrastructural provision. Obayelu (2007) notes the importance of infrastructure for economic growth and development cannot be overemphasized. This situation is reflected in insufficiency of electricity supply across the country. One then begin to wonder and ask questions about the budget allocation to the power sector and billions of dollars spent in the

last 16 years towards improving the sector despite the darkness being experienced by the citizens. The high level of corruption within the Nigerian power sector makes structural change inevitable. The problem of power problem in Nigeria cannot be resolved without first tackling corruption. All the above-identified structural defects, leadership failure and widespread corruption gave rise to the energy poverty situation as witnessed in the country (see chapter five).

These worrisome pictures of corruption, inefficiencies, poor management and other negative considerations informed government's decision to embark on privatisation of the power sector. The privatisation of the power sector promised a radical change and is hinged on the fact that it will tackle corruption headlong and bring rapid improvements in the electricity service delivery when handled by the private sector with increased foreign participation. The handing over by the Federal Government to private investors took place on November 1, 2013 in a bid to reverse the dwindling fortunes of the power sector. As the ownership of the electricity generation and distribution companies has been privatised and rights of ownership exchanged hands. The Nigerian citizenry eagerly wait to see what would happen because there are huge problems to overcome. The privatised electricity companies are faced with the enormous challenges of weak electricity grid-network and low generation capacity inherited from the defunct unbundled government-owned Power Holding Company of Nigeria (PHCN).

4.3 Analysis of Electricity Delivery as a way to Understanding the Spatial Issues of Demand, Supply and Consumption in the Study Area

An assessment of the spatial structure of the electricity distribution network was made in order to understand the spatial issues of demand, supply and consumption in the study area. The field research findings, based on the visual assessment, direct observation and analysis of the interviews granted by the distribution engineer referred to as technical engineer (TE) and customer service officer (CSO), revealed the irregularities in the spatial structure of grid-electricity distribution network in the study area. The electricity distribution network was discovered not to follow a consistent spatial structure. The distribution transformer and distribution lines, both the low and high-tension (LT/HT) lines that make up the electrical network elements/assets, do not follow the business/service unit electricity distribution geographical map in the delivery of electricity. There is a criss-crossing of the distribution supply chain with no defined or definite spatial structure. It is pertinent to state that customers located in a particular district or service unit are being supplied electricity from another district or service unit. Put differently, a distribution transformer supplying electricity to a particular district or service unit is located in a different

service unit without the network elements/assets reckoned as part of the particular district where it is located. The distribution/technical engineer (TE) and the customer service officer (CSO) interviewed corroborated the finding that the distribution/supply channel does not follow a defined, consistent and definite spatial structure. The technical engineer (TE) made it clear that the spatial structure of the electricity delivery channel is a long-standing and contentious issue between and across the distribution districts and service units. The CSO also reaffirmed the problem as it related to revenue, for instance, a situation where the district supplies electricity to customers that are not located within the district and are, as such, not the revenue-collecting district of electricity supplied. The geographical maps of the electricity provider that should form the basis of electricity distribution/supply chain for service delivery, network planning and management are still in analogue format and, where digital, it is not planimetric (not geo-referenced and drawn to scale). The implication is that leveraging technologies and using location as a common platform with the use of GIS, supervisory control and data acquisition (SCADA), distribution automation (DA) and smart grid technologies for spatial and network analysis become impossible. This has management and research implications in accurately estimating households' electricity demand, supply and consumption.

The connection of residential buildings and homes to government-provided grid-electricity is for the benefits and enjoyment of the services provided by electricity. Therefore, providing background information on households' grid-connection gives a better understanding of the process of grid-supplied electricity connectivity in the study area. The grid-supplied electricity, as elucidated by the head of the distribution unit referred to as technical engineer (TE) of the electricity service provider, is a process that must follow the utility laid-down regulations. Before households are connected, it is expected that the process of grid-connectivity have been completed with the electricity service provider. This involves obtaining and submitting a "NEPA (PHCN) Form 74" (Appendix Five) upon the payment of an application fee which must be duly certified and stamped by a licensed electrical contractor registered under the Licenced Electrical Contractor Association of Nigeria (LECAN). The electrical wiring and installation of any house must follow the procedures and conform to rules and regulations of engineering standards with the use of appropriate conductor or wire/cable size and materials where applicable. The Electrical Inspectorate Services (EIS) unit of the Federal Ministry of Mines and Power is the regulatory body of the central electrical contractor licensing board under whose authority the LECAN is registered. The LECAN mission statement is "service for human safety and electricity in safe hands". Upon submission of the duly certified and signed application form, a mains inspector (Plate 4.1) in the

inspectorate unit of the technical/distribution department of the electricity service provider is designated to follow up the application process. This involves carrying out a physical check of the applicant building (location) supported with sketch route map to the site and a manually drawn schematic diagram showing how the building are to be connected to the distribution mains of the electricity service provider. In addition, the mains inspector, service unit manager, manager new service, installation inspector and credit control officer (Appendix Six - Eleven) must certify and approve, where necessary, the processing of the application submitted for approval, recommend tariff class and specify the type of electricity meter required to serve the applicant's residential or industrial premises for installation.

The certification procedure is based on the applicant's building plan/structure and anticipated load demand as submitted in the application for grid connection duly certified and stamped by a LECAN-registered electrical contractor on the side of the applicant (Appendix Twelve –Thirteen). This is customarily after the load-carrying capacity of the existing distribution transformer in the applicant's residential area or neighbourhood that will supply electricity to the applicant buildings/premises on the side of the electricity service provider must have been taken into consideration. But, in some cases, for example, if the application required for grid-connection is for a large quantum of electricity to power heavy duty equipment's, appliances/machinery, say, eatery, hotels or saw-mill.



Plate 4.1: Interviewing the electricity service provider mains inspector

Source: Fieldwork (2012) – Permission granted by the mains inspector for photograph to be taken

The mains inspector will first carry out an on-the-spot assessment detailed survey to ascertain the energy load (demand) required and confirm if the existing infrastructure (distribution transformer, LT and HT poles) in the neighbourhood can accommodate the projected energy demand of such customers. In addition, if it cannot, the relief measures required may be that a new transformer should be deployed to serve as a relief to the existing transformer from becoming overloaded. In some instances, some customers prefer to procure all the necessary materials in order to have a dedicated distribution transformer assigned only to them. These types of customers are the one commonly referred to as maximum demand (MD) customers. All these operational processes are done manually and must be completed before any new customers such as households, companies and industries are connected to the national grid. The lack of adequate enforcement, regulations and strict compliance to existing grid-connection processes and procedures resulted in the haphazard and uncontrolled nature of the grid-electricity, as seen in the network of maze of wires and electricity conductor cables criss-crossing each other without any definite structure (Plate 4.2). Therefore, it is imperative to enforce strict compliance and automate their operational processes for efficient and effective network planning and management to meet international standards as found in other parts of the world.



Plate 4.2: A typical haphazard and unstructured connection to the electricity grid
Source: Fieldwork (2012)

Field research also revealed two kinds of fees/payments made by households with respect to grid-electricity connection. The first fee/payment referred to as “electricity development levy” is to be paid to the community or neighbourhood landlords’ association. This is often used to take care

of electricity-related issues or problems arising from broken/damaged poles, damaged cables and faulty transformer as the need arises in the neighbourhood. The electricity development levy is a fee levied amongst households and the overall amount charged varies across community/locality/neighbourhood. The instalment payments of the levy are usually allowed depending on the agreement and understanding reached with the community or landlord association. The second payment that is the most important is the grid-connection fee paid to the electricity service provider before customers are connected to government provided grid-electricity (as previously discussed). It is very clear from the foregoing that the electricity service provider (PHCN) collects grid-electricity connection fee from house-owners before securing connection to the national grid. The payment made by house-owners for grid-electricity connection qualifies the buildings/premises access to electricity supply in addition to the provision and installation of electricity meter by the electricity provider.

4.4 Socio-economic Characteristics of the Study Area

Household energy usage and consumption are highly related and dependent upon socio-demographic characteristics. Empirical studies have shown that energy consumption is strongly related to the socio-demographic characteristics of the household, such as type and size of households, education, age, gender, income, and so on. The socio-economic characteristics of the respondents in the study area were examined with respect to the age, marital status, gender; size of household, type of household; type of residential buildings, educational background, and primary occupation and income of each of them.

4.4.1 Age of Heads of Household

The head of the household is usually defined as “that person who is acknowledged as such by the other members” (United Nations, 1980:70). The household head is normally the breadwinner and the chief economic promoter responsible for the actions of the family. The survey gathered information about the age structure of the household heads/respondents, as described in Table 4.3. It is evident from the data gathered that about 80 per cent of the respondents were within the economically active age population (20-60 years). The age of other household members/occupants may also exert a strong influence on electricity consumption. Age-related growth is typically associated with electricity consumption. The demand for energy generally decreases as age increases; for instance, postnatal energy demand is particularly high.

Table 4.3: Age distribution of heads of household

Age Group	Number of Respondents	%
20-30	76	8.4
31-40	169	18.8
41-50	233	25.9
51-60	240	26.7
61-70	151	16.8
71-80	31	3.4
Total	900	100

Source: Fieldwork (2012)

The Nigeria Demographic and Health Survey (NDHS) implemented by the National Population Commission (NPC) (2008) shows a young age structure with a substantially larger proportion of its population in the younger age groups than in the older age groups for each sex in both urban and rural areas. About 45 per cent of the population is under the age of 15 years, while 4 per cent are aged 65 years and above. The young age structure of the Nigerian population is an indication of a population with high a fertility rate, thereby contributing to the dependency ratio. The proportion of the population in each age group declines as age increases; the lowest age group (0-4) has the largest proportion of the population (17 per cent), while the highest five-year age group (75-79) has the smallest proportion (less than 1 per cent) (NPC, 2008:11). The non-linearity of age and energy relationships will be addressed in Chapter 5. The descriptive analysis of the marital status of the sampled households is shown in Table 4.4.

Table 4.4: Marital status of heads of household

Marital Status	Number of Respondents	%
Single	101	11.2
Married	750	83.3
Divorcee	8	0.9
Separated	10	1.1
Widowed	31	3.4
Total	900	100

Source: Fieldwork (2012)

4.4.2 Gender of Heads of Household

The gender distribution of the respondents' shows the composition of household heads by sex (Table 4.5). The data shows that the households were predominantly headed by men. For every three male headed household, there was one female-headed household in the study area. The

preponderance of male-headed households is not strange because of the predominance of the patriarchal society in most African countries, where the father or eldest male is the head of the household.

Table 4.5: Gender distribution of heads of household

Gender	Number of Respondents	%
Male	682	75.8
Female	218	24.2
Total	900	100

Source: Fieldwork (2012)

The National Population Commission (NPC) (2008) claims that 81 per cent of the households in Nigeria are headed by men and just under one in five (19 per cent) are headed by women. The report further states that female-headed households are more slightly common in urban areas (21 per cent) than in rural areas (19 per cent). Data from the National Population Census figure for 2008 show that males and females are almost equally represented in Nigeria. Males are usually the heads and chief economic promoters of the households. Widowed, divorcee, single parents and single female accounted for the bulk of female-headed households. Most often, households headed by women are the result of widowhood or divorce or single parenthood. However, the challenge of modern times has bestowed on the shoulders of some of these women the status of breadwinners of their homes, the role they usually assume after the death of their husbands or as a result of court dissolution of the marriage. The female-headed households might also be “outside wives”. These are women married to men with several wives. The men live with their original wives and have extra wives outside their homes. The Nigeria Demographic and Health Survey (NDHS) (2008) noted that female-headed households are typically poorer than male-headed households.

Despite the differences in the households’ domestic roles assigned to men and women, evidence has shown that the impact of gaining access to energy affects men and women differently. Empirical studies have shown that women suffer the most energy deprivation, as described in the amount of time and man-hours spent during cooking and gathering fuel wood (Cecelski, 1999; Clancy et al., 2002, Standing, 2013 and Pachauri and Rao, 2013). In most African countries, domestic responsibilities vary across households and are usually based on a division of labour as agreed among households’ members/occupants. The cultural belief is that a man must provide

for his entire household. Women spend longer hours at home than men, most especially when they are not in any paid employment, while some are full-time homemakers, thereby devoting long hours to performing household chores. Empirical studies have shown that women perform multiple roles of wife, mother and supporter in their homes with very limited resources and are in charge of a small part of the disposable household income-especially that which is related to cooking (Ogwumike and Ozughalu, 2014). Nevertheless, women are associated with and responsible for household work as a result of cultural values. Women continue to experience gender inequality in access to and control over resources (Dako-Gyeke et al., 2013). In his study on feminization of poverty in Nigerian Cities, Adepaju (2004) indicate that women are the most affected being marginalised in decision-making process, employment, economic opportunities and access to credit. Statistics on poverty in Nigeria indicates that 70 per cent of poor Nigerians are women with majority of them suffering from illiteracy, high maternal mortality, low income and poverty (CBN/World Bank, 1999). The domestic work particularly those connected to the energy-related activities and services provided by electricity centre on the women. Women are often times involved in domestic energy services delivery for their households and are the most affected both positively and negatively by the energy situation. Domestic energy consumption begins with cooking, although electric cookers were very few and rare in the study area. Electrical appliances that consume electricity, such as washing machines, are used mostly for children clothes and microwaves are predominantly used by women in households with the appliance. The post-natal experience of women using an electric boiler to heat water is also noteworthy.

Women also engage in seasonal income-generating activities with the use of household appliances, such as refrigerators, selling soft drinks, ice blocks and sachet water to complement the household income. The use of household refrigerators by women for small-scale business is to earn additional income to support the household. The implication of this is that women often consume more electricity than men in the household. Plate 4.3 shows a residential building used for commerce by the wife of the household head to earn extra income to support the household. The inadequate supply of electricity frequently results in the purchase of ice blocks by such women. This has negative influence on the profit margins since part of the profit is expended buying ice blocks. Educationally backward women lack the economic empowerment that would enable them to challenge the prevailing situation. The UK Department for International Development (DFID) (2013) advocates financial empowerment for women, particularly those women in the lower class that are the major breadwinners, if Nigeria is to address poverty and inequality. This empowerment could be in form of provision of easy access to finance to boost

their businesses because they are the most financially excluded. The NDHS (2008) asserts that 40 per cent females compared with 28 per cent males have never attended school. Male electricity consumption benefits are more noticeable in terms of leisure and during domestic work, for instance ironing, a role supposedly meant for men.



Plate 4.3: A typical use of residential building for commerce
Source: Fieldwork (2012) - Permission granted for photograph to be taken

4.4.3 Size and Type of Household

Households are heterogeneous units; they typically have different numbers of members. The most basic demographic characteristic of a household is the number of members it comprises. The NDHS (2008) notes that the average household size in Nigeria is 4.4 persons per household. Forty-five per cent of household members are children under age 15, while those between age 15-60 constitute about 50 per cent of the total Nigerian population. The information on the key aspects of household composition is characteristically important because of its association with household welfare. The size of the household is determined by the composition of the people living together and their relationships to one another either by blood, marriage or adoption. There are two major family types, nuclear and extended family. The nuclear family is made up of the father, mother, and their unmarried children; while the extended family is made up of a series of different generations. The number of occupants in a single, nuclear and extended household together with those residing in shared accommodation, affects the energy consumption and

usage pattern. The role of the household and residential family is central in economic analyses because these units are usually the locus of joint decisions regarding consumption, production, labour force participation, savings, and capital formation (Kuznets, 1978; Becker, 1991). The data on the average household size gathered during household surveys is described in Table 4.6. The field survey showed that 65 per cent of those surveyed were nuclear family; 33 per cent were extended; while single family and shared family accounted for the remaining 1.8 and 2.0 per cent, respectively.

Table 4.6: Household size

Household Size	Number of Respondents	%
1 - 4	478	53.1
5 - 7	353	39.2
8 - 10	51	5.7
10 - 12	18	2.0
Total	900	100

Source: Fieldwork (2012)

There were different types of residential housing design in the study area, including single storey Brazilian, two-storey Brazilian type, flats apartments, bungalows and duplexes. The survey results showed that the single-storey Brazilian type, referred to as “downstairs” in local parlance and two-storey Brazilian type were the most popular. The prevalence of the Brazilian type of residential buildings, “face-me-I-face-you,” is a reflection of the socio-economic status of the residents in the study area (Plates 4.4 and 4.5). This type of residential building usually consists of several families and households, both nuclear and extended co-habiting in shared and rented accommodation. The existence of such a large size of families and households in shared residential accommodation often leads to crowding, excessive pressure exerted on social services/infrastructure, and health problems. The occurrence of multiple households in shared accommodation is a result of economic and social challenges in housing affordability. This is common with the low-income earners that cannot afford to rent a single unit bungalow/flat, but are forced to live in multi-room houses where they share the entire infrastructure with other occupants of the house. Some of the challenges that come with shared accommodation include sharing of utility bills and other services provided, such as toilets, bathrooms, and kitchen. The economies of scale for these multiple households in shared accommodation reduces the per capita cost and amount of energy consumption and possibly contribute to overall efficient household energy use.

Table 4.7 provides information on the distribution of different types of residential buildings in the study area.



Plate 4.4: A bungalow face-to-face (multiple family Brazilian type) house
Source: Fieldwork (2012) - Permission granted for photograph to be taken



Plate 4.5: A storey building face-to-face (multiple family Brazilian type) house
Source: Fieldwork (2012) - Permission granted for photograph to be taken

The single unit bungalow (Plate 4.6), flat (Plate 4.7) and duplex (Plate 4.8) residential buildings typify an average nuclear or extended family. The household size in each of these shared residential buildings, their behaviours and their lifestyles determine the energy consumption pattern. Energy usage is resourcefully shared between occupants, so cooling a living space for a

family of five becomes more energy efficient (per person) than cooling the same space for a single occupant. The shared access to services like lighting, cooling, and communication has the tendency to decrease the energy budget share of households' income with increasing occupants. The share of electricity in a small household is greater than that in large families on a per capita basis. A nuclear family consumes less electricity, while large families synergise their energy use on economies of scale. Therefore, household size is a major factor that may affect energy consumption and the subsequent bill to be paid for electricity consumption.

Table 4.7: Type of building occupancy

Type of Building Occupancy	Number of Respondents	%
Face to Face (Downstairs and Storey)	396	44.0
Bungalow (single unit)	210	23.3
Flat	216	24.0
Duplex	78	8.6
Total	900	100

Source: Fieldwork (2012)



Plate 4.6: A bungalow (single unit) house

Source: Fieldwork (2012) - Permission granted for photograph to be taken



Plate 4.7: A four flat house

Source: Fieldwork (2012) - Permission granted for photograph to be taken



Plate 4.8: A duplex house

Source: Fieldwork (2012) - Permission granted for photograph to be taken

The housing ownership structure shows that 50.2 per cent of the respondents were homeowners, while the remaining 49.8 per cent were tenants. Housing satisfies the basic human need for shelter and is a key component of economic growth and development. The research findings shows that residential house ownership is fairly high in the study compared to the 25 per cent home ownership rate in Nigeria reported by NBS (2012). House owners in most instances are able to provide both historical and contemporary information on electricity in the locality, while tenants on the other hand may not be able to provide historical information on electricity regularity and other pertinent information required to assist the research because of their transient characteristics. However, the tenants, because they had lived in several places in the time past were able to compare electricity availability in the study area with that of some other localities where they had lived.

4.4.4 Educational Qualifications

Educational attainment is the most important characteristic of household heads'/members that influences the level of socio-economic development. The level of education of the household head is a key determinant of the lifestyle and societal status that the household enjoys. Educational attainment has a strong effect on electricity consumption. The field research revealed a very high level of literacy among the sampled household heads. Table 4.8 provides an overview of the household heads' educational attainment. The vast majority of the heads of household were educated, with about 90 per cent of their educational attainment above basic primary school level. Individuals of high educational attainment are often associated with better economic outcomes and are highly status conscious. The highly educated households often seek residential locations that satisfy their desires for prestigious dwellings and neighbourhoods comparable to their jobs, incomes as well as their presumed societal status/personality.

The level of education of the household heads usually has implications for electricity consumption based on the type and quality of electrical appliances ownership. The educational qualifications of household heads largely determine the number of domestic electrical appliances owned. An increase in their financial status often leads to the purchase of more domestic electrical appliances and this often leads to an increase in their electricity consumption. It is, therefore, expected that the higher the level of household heads' educational attainment, the more conscious they are of the possibility to purchase energy conservation and efficiency appliances.

Table 4.8: Educational qualifications

Educational Qualification	Number of Respondents	%
None	98	10.9
Pry Six	97	10.8
Secondary	287	31.9
NCE	55	6.1
OND	55	6.1
HND	70	7.8
B.Sc.	164	18.2
PGD	28	3.1
M.Sc.	37	4.1
PhD	9	1.0
Total	900	100

Source: Fieldwork (2012)

The study area had more business owners, as this category of workers accounted for about 48 per cent of the respondents. This was followed by 18 per cent of people who claimed that they worked for private business people/organisation. Civil servants accounted for 18 per cent and the artisans and informal sector business owners accounted for 17 per cent. The civil servants included all categories of workers that work directly or indirectly for the government. The occupational status of household heads is a reflection of the educational attainment.

4.4.5 Income

The head of the household is the breadwinner saddled with the responsibility of generating income for his/her family. A household usually utilises its income to take care of the accommodation, feeding, clothing, education, transportation and utility bills, among many other competing needs. The income earned plays a very crucial role in the housing type, location and neighbourhood preferences of residents. Household income mostly determines which energy carriers and end-use devices are used, as reflected in the electrical appliance ownership. An increase in income will improve the socio-economic conditions of households, thereby allowing them to climb up both the social and energy ladder by desiring more convenient and cleaner energy services provided by electricity. Households enjoy a better quality of life once their financial status improves, often resulting in cleaner energy being consumed, which usually leads to increased mobility, proper cooling, and usage of more electrical appliances and equipment. The implication is that the higher the income of a household, the higher the probability that the

household buys more electrical appliances and the higher the possibility of more electricity consumption.

This study classified household incomes into three socio-economic groups, namely: low, medium and high-income groups. Those in the low-income category have an average monthly income of less or equal to ₦50,000 (£39.06 - £195.31). Those earning between ₦50,001– ₦250,000 (£195.31-£976.56) are in the medium-income group. The high-income group comprises those whose average monthly income is in excess of ₦250,000 (£976.56 - £1953.12). The reason for using an income scale was because of ethical considerations. The majority of the households were low and minimum wage earners, as shown in the distribution of household incomes across the study in Table 4.9. The spatial distribution is indicated in Figure 4.3. Households in the high-income category were found in the medium to low-residential density areas; those in the medium-income category were found in the medium density residential areas; while those in the low-income category were found in the medium to high-residential areas. The combination of education, occupation, and income characterise the socio-economic status of the households in the study. The issue of income and energy relationships will be explored in Chapter 5.

Table 4.9: Average monthly income of heads of household

Average Monthly Income Naira (₦)	Number of Respondents	%
10'000 - 50'000	542	60.2
51'000 - 100'000	283	31.4
101'000 - 250'000	64	7.1
251'000 - 500'000	11	1.2
Total	900	100

Source: Fieldwork (2012)

4.5 Pattern of Energy Consumption

Household energy consumption can be defined as the energy consumed in homes to meet the needs of the householders (UNESCAP, 2002:6). The pattern of household energy consumption represents the stage of welfare as well as the stage of economic development (UNESCAP, 2002:6). The demand for energy by households and the services it provides is essential in achieving basic living requirements. Electricity is the most convenient form of household energy consumption, as it makes the use of electric appliances possible (UNESCAP, 2002:9). Electricity provides a suitable approach of measuring energy services at the household level. Therefore,

appraising patterns of electricity consumption together with the energy services requirements at the household level is based solely on the socio-economic situation of the households. The study revealed that all the households sampled had access to grid-based electricity in a large urban area. Thus, access to electricity was not the problem in the study area. Therefore, analysing the pattern of electricity consumption requires an understanding of the quality of electricity provision, in addition to household electricity demand, supply and consumption.

4.5.1 Electricity Demand in the Study Neighbourhood

Households' energy demand is borne out of the desire to fulfil households' energy services requirements. The numerous services influencing the quality of modern life use electricity as energy source. The main household modern energy services provided by electricity in the sub-Saharan African region can be categorised under five major areas of productive use: lighting, cooling, water heating, entertainment, cooking and miscellaneous. Cooking with electricity is not very common, but the preliminary preparation towards cooking (for example, use of blender, microwave, and refrigeration) involves the use of electricity. Furthermore, heating with electricity is not common in sub-Saharan Africa because of the location of the region in the tropical climate region. Therefore, having unhindered access to services provided by electricity is the desire of most households, as this is required for human social well-being and productivity.

Electricity is used when and where necessary, for lighting, heating, cooling, entertainment and communication devices. Many of the basic needs of modern life are difficult to achieve without electricity. Electrical appliance ownership and usage in homes accounts for a substantial portion of end-use energy, in particular electricity. Households' electrical appliances are noticeable convenience items considered a necessity in most households, and an increasingly significant contributor to energy demand required in achieving households' energy services desire. An understanding of a household's energy services demand becomes necessary when accurately estimating the household's energy demand required to power its domestic appliances.

In this study, field research discovered two distinct periods of household energy demand, the "peak and off-peak" periods. The peak period was when the demand for services provided by electricity was very high. The off-peak period was when the demand was very low, mostly when household members, occupants or residents were at work or away from home. The peak period time was between 6.00 am and 9.00 am and between 18.00 pm and 12.00 pm, while the off-peak time was usually between 10.00 am and 4.00 pm.

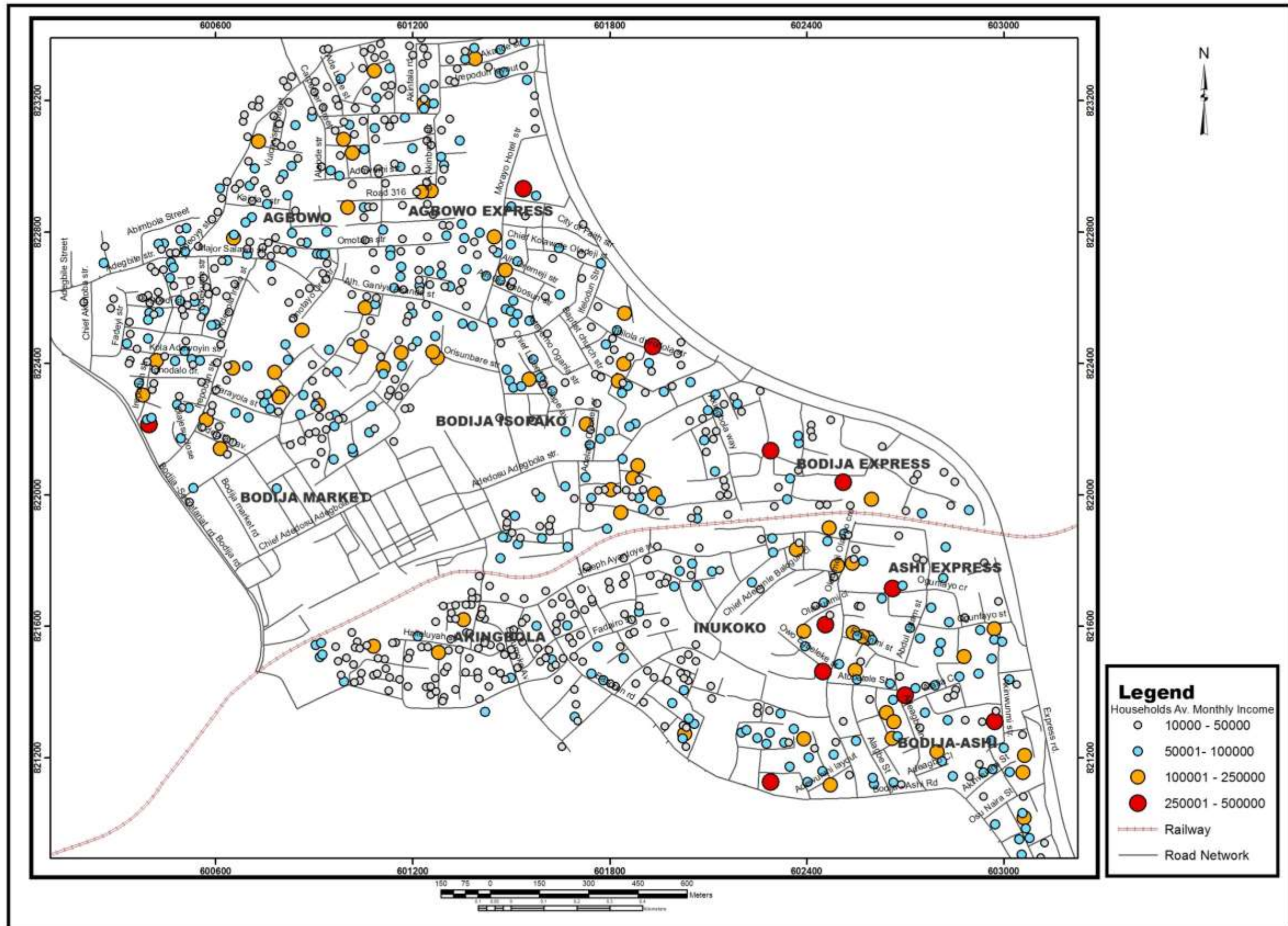


Figure 4.4: The spatial distribution of household average monthly income

Those interviewed made it clear that the demand for energy services in a typical household in the study area started in the morning at about 5.00am to 6.00am for lighting, ironing and water heating demands for baths, bread toasting and use of microwave in some households. The focus group discussant and key informant interviewed indicate that energy demand in the midday was largely for entertainment/recreational activities of those present in the house with the use of electric fan for cooling and, in some cases, air conditioning systems and use of refrigerators for food preservation all around the clock. The statement above was further supported by the fact that some members of the households', like aged/elderly people, children returning from school and women that were full-time homemakers, were always available in the house in the afternoon.

One of the women interviewed shed more light to the fact that availability and usage of electricity in the afternoon, mostly by the full-time homemakers in some households, was to support and contribute to households' income generation, promote economic empowerment and productivity with the use of refrigerators to sell ice blocks, cold soft drinks and sachet/"pure" water. Interviews conducted show that the peak period of electricity demand in the evening starts at about 18.00 pm and peaks at about 20.00 pm. The focus group discussants and key informants interviewed made it clear that the daily electricity demand is usually at its peak in the evenings when every household member was at home. They further explained that energy demand at this period of the day was essentially for lighting and extending hours of the day; cooling to get maximum sleeping comfort; communications and information services (charging of phones/handsets, listening to news); entertainment via watching television and other activities, like the use of washing machines and microwaves in households that had such. The inadequacy of electricity provision during peak periods forced households to switch and shift to other forms of energy besides the use of generators in some inevitable circumstances. The focus group discussants and the key informants interviewed all emphasised the unavailability of electricity during the peak period of electricity demand for energy services provision. The lamentation of many households is that they did not get electricity supply in the evening when its usage was most needed and beneficial. This is evident in Table 4.10 that shows no pronounced period of electricity availability during the day. The use of kerosene/paraffin stoves to heat water and kerosene lamp/lantern for lighting then became critical to fulfilling households' end-use demand and desire for energy services. The switch/shift from electricity to other forms of energy moved many households down the bottom of the energy ladder. The inadequate quantity of electricity often resulted in households selectively using kerosene with other forms of energy in the absence of electricity. The low supply of

electricity, in addition to the problem of distribution infrastructure for electricity, often limited electricity supply to most urban centres.

Table 4.10: Time of the day of electricity supply

Time of the day	Number of Respondents	%
Morning	102	11.3
Noon	21	2.3
Night	266	29.6
Anytime	511	56.8
Total	900	100

Source: Fieldwork (2012)

The use of electricity is an addiction and once electricity is available, demand seems to be continually increasing and never decreasing. Energy demand is growing rapidly in proportion to rising income, as more households and consumers purchase electrical appliances, like refrigerators, air-conditioners, and televisions either for the first time or in addition to the existing ones. Residential land-use also differed in their demand for electricity in the study area. Low-residential areas, comprising highly educated and wealthy people with high-income, tended to acquire more of domestic electrical appliances that required the frequent use of electricity and most likely ended up as high consumers of electricity. The residents of low-residential densities area were likely to consume more electricity compared to the medium and high-density residential areas. Therefore, an understanding of households electricity demand based on location is very important in estimating the quantity of electricity required for supply.

4.5.2 Electricity Supply in the Study Neighbourhood

The desire of every household is to have an uninterrupted electricity supply to meet the demand of household energy services. The regular supply of electricity to households is required to guarantee the services, convenience and comfort provided by electricity. The data on daily hours of electricity supplied to the study area confirmed the unreliability of the electricity supply chain. The results of the average daily cumulative hours of electricity supply as recorded in Table 4.11 is similar to the outcome of the 2015 NOI Polls results where a typical Nigerian households stated they received an average daily cumulative power supply of between 5.4 – 7.1 hours per day. It is pertinent to emphasise that distribution transformers were not metered and, therefore, it was difficult for the electricity provider to accurately estimate the quantum of electricity supplied to a locality or neighbourhood. This implies the electricity provider cannot categorically and

accurately estimate the quantity of electricity supplied and consumed in a particular area neither could it precisely identify such areas where they experience unaccounted energy as a result of energy theft arising from illegal connections, pilferage

Table 4.11: Daily hours of electricity supply

Daily hours of electricity supply	Number of Respondents	%
1 -5	840	93.4
6 - 10	26	2.8
11 -15	20	2.2
16 -20	14	1.5
Total	900	100

Source: Fieldwork (2012)

The results of daily hours of electricity supply indicated that none of the residents in the study area could boast of enjoying uninterrupted 24 hours' electricity supply in a day. A total of 92 per cent of the households could not predict the time of supply, while only 8.1 per cent were able to predict the time of supply. The time of supply could be anytime of the day, according to 56.8 per cent of the respondents. A further 29.6 per cent indicated that the supply was only at night, while 11.3 per cent of the households claimed that they had electricity supply in the morning and 2.3 per cent in the afternoon.

The findings of this study were further compared with the NOI Polls Limited (2013), a Nigerian opinion polling and research organisation working in technical partnership with the Gallup Organisation (USA). It conducts periodic opinion polls and studies on various socio-economic and political issues in Nigeria. The NOI poll initiation was to ascertain the perception of Nigerians on the power sector reforms; it sought to find out the hours of power supply received daily and expenditure on alternative sources of power compared to the previous year. The NOI poll indicated that 42 per cent of the respondents experienced about one to four hours of electricity supply on a daily basis between April and June 2013. Furthermore, 13 per cent of the respondents claimed that they received 15-19 hours of electricity during the same period; as against 20 per cent of the respondents that claimed that they received 10-14 hours of electricity supply. The implication of this is that basic access to electricity is not the issue but the predictability and reliability of the electricity supply is.

The supplies of electricity in the study area were grossly unreliable and services that are best derived from electricity remained elusive. The desire of many households to use quite a number of the electrical appliances for their comfort and enjoyment is often impossible. The fear of incessant damages of household domestic electrical appliances resulting from power surges and voltage fluctuations that are often associated with the erratic supply of electricity is largely responsible. The damage done to households' electrical appliances by the erratic supply of electricity owing to low or fluctuating voltage makes electricity supply sometimes non-usable. The low supply and frequent disruptions of electricity supply that occur at times as much as 10 times within an hour are beyond comprehension. Consequently, most of households' electrical appliances are idle because of fear of damage by power surges and voltage fluctuations. The occurrences of some of these damages to households' electrical appliances in times past are without any form of compensation of any kind from the electricity service provider. This implies that households are consistently deprived of the enjoyment and benefits associated with the services provided by such electrical appliances.

The unavailability and frequent disruptions in electricity provision is the basis of electricity outages that usually lead to blackouts and electricity rationing experienced by households. These are attributed to inadequate generation from electricity generating stations resulting in unannounced load shedding from the national grid, faulty distribution transformers/injection substations, prolonged and intermittent outages which most consumers of electricity in Nigeria have had to contend with over the years. According to the head of the distribution unit, the technical engineer (TE) of the electricity service provider interviewed (Plate 4.9): "load shedding is one of the constraints facing power generation in Nigeria. It is a routine exercise whereby the quantum of electricity available at any particular time is shared among consumers to enable them enjoy some hours of electricity supply however small". Load shedding usually occurs when there is system collapse from the generation and transmission stations, when there is shortfall in gas supply to power-generating stations, when there is the need to replace damaged or obsolete equipment, or when there are activities perpetuated by vandals of power infrastructure leading to marginal supply of electricity. These often resulted in several hours of darkness usually referred to as "blackouts" across the country.



Plate 4.9: Interviewing a senior manager (Technical Engineer) of the electricity service provider
Source: Fieldwork (2012) - Permission granted by the Technical Engineer interviewed for photograph to be taken

Blackouts are a daily occurrence on the national grid network in Nigeria. During the blackout periods, electricity supply is not available to some neighbourhood for several days, sometimes running into weeks and months in some cases. The limited quantum of electricity available is distributed among different categories of customers across the distribution network. According to an official who spoke on the condition of anonymity: “the level of service provision at this point is that preference and priority are usually given to maximum demand customers located in the industrial areas and residential areas known with history of prompt payment of electricity bills”. Another official (general manager) in one of the distribution companies corroborated the above statement thus: “some of our colleagues illicitly divert electricity to companies and individuals who bribe them and in the process deprive several neighbourhoods and consumers of electricity supply”. The medium and high-density residential areas largely suffer the most energy deprivation whenever these situations arise. An official in the distribution unit stated that: “a national load shedding exercise is usually done to preserve the grid system and also ensure a predictable pattern of electricity distribution nationwide”. The lack of proactive approaches and measures towards having a more resilient grid network is a major contribution to frequent system breakdown leading to disruptions of supply of electricity and eventual widespread blackouts experienced across the country.

The frequent system breakdown and near total collapse of the electricity sector in Nigeria is responsible for the mass exodus of many of economic activities that rely on electricity to operate, relocating to neighbouring countries, like the Republic of Benin, Togo and Ghana, where there is regular supply of electricity. The overhead cost incurred in providing self-generated electricity is a major factor that has forced many companies, most especially those in the manufacturing sector, to relocate to neighbouring countries. The inadequacy of electricity generated and supplied has become an albatross to the nation's manufacturing sector. The chairperson, House Committee on Commerce and Industry (2009), speaking under matters of urgent public importance, noted that the inadequate provision of electricity had led to the closure and relocating of several manufacturing companies and industries, such as Dunlop and Michelin to Ghana and other African countries. While attributing the development to constant power failure, he added that: "manufacturers in Nigeria are crying over the power situation in the country which is the real bane of our manufacturing sector".

The focus group discussants and key informant interviewees recounted their observation, as represented in this excerpt: "supply of electricity is habitually relatively stable towards the end of every month when the officials of the electricity provider are about to embark on cash collections and revenue drive, in order to achieve the high revenue targets set by the electricity distribution companies". The focus group discussions revealed some of the arrangements reached by the electricity provider and the landlord associations. For instance, in some neighbourhoods, a one-day-on-one-day-off arrangement was reached but, most times, the electricity service provider did not fulfil its own side of the arrangement. This has often led to many households/neighbourhoods being left in total darkness sometimes for days or weeks and, in some cases, months. Despite the unavailability of electricity provision arising from the frequent blackouts, the electricity provider distributed electricity bills at the end of the month to subscribers/households for payment of electricity not supplied. According to one of the key informants interviewed: "we used to receive ₦2000 (£7.8) and ₦2500 (£9.8) bills before now, and we still pay the same amount during blackouts, when there is no regular supply". One of the focus group discussants confirmed that: "households usually pay a comparatively high price for an energy service of low quality and services neither available nor consumed".

The economic survival of some households in the study area was dependent on electricity availability. Electricity was not available when needed most for commercial activities and, when

available, it was mostly late at night when everybody was fast asleep. The research findings revealed that about 24 per cent of the households sampled depended on electricity supplied from the national grid to earn income for daily survival. These households were artisans and people largely in the informal sector. Artisans such as welders, electricians, hairdressers, and barbers require regular supply of electricity for the welding processes while electricians specialising in house electrical wiring, maintenance and repair of existing or faulty electrical appliances depend daily on a regular and adequate supply of electricity to earn a living. Such people represented about a quarter of the total sampled households, with the implication that, for every four households sampled one such household depended on electricity for income and survival. According to the focus group discussants and key informants interviewed, the inadequate provision of electricity had forced the closure of several small-scale businesses that depend absolutely on regular electricity provision to operate and survive. Some of the affected artisans now look elsewhere for alternative job for survival such as the use of motorcycles as commercial means of transport. The absence of electricity, for instance, has forced quite a number of the male artisans to become commercial motorcyclists, commonly referred to in local parlance as “okada” to earn a living. Adequate provision of electricity is essential in most households work processes and its efficient use can significantly enhance households’ productivity and profitability, which are closely linked to the availability and affordability of reliable energy sources and efficient energy end-use.

The consequence of households’ electricity supply shortfall arising from outages, load shedding and blackouts triggered the need to provide alternative off-grid solutions to compensate for the shortage. These became necessary in order to satisfy households’ energy services desires leading to every household generating its own electricity by purchasing generators. The Vice Chancellor of the University of Lagos, Bello (2013), stated that: “an estimated 6,000 MW is generated via individual and corporate outfits to meet their minimum demands for electricity”. The result of this is an increase in the level of carbon monoxide emitted into the atmosphere with its resultant adverse effect on human health and the environment. The attendant cost of self-generated electricity on households’ disposable income is remarkable because of the limited hours of electricity supplied to households, as recorded during the field survey. Fulfilling households’ desire for energy demand and services is dependent on the availability and reliability of the electricity supplied. The adequate provision of electricity to households will lead to satisfying households’ electricity demand and energy services desire. These will eventually lead

to an increase in electricity consumption and a reduction in the use of other forms of energy. Consequently, an increase in households' electricity consumption will result in an increase in economic activity, productivity, and profitability.

4.5.3 Electricity Consumption in the Study Neighbourhood

The study directly surveyed households to establish their monthly electricity consumption. Energy consumption is primarily confined to each household and differs across households. The variables that influence energy consumption within one household are embedded within the social aspects of everyday life and are also likely to act upon the residents of another. However, households' energy services desires, appliance ownership and usage determine largely the consumption behaviours of households. The electricity consumption and usage patterns of households also vary with the season. To a certain extent, quite a number of electrical appliances are indispensable in fulfilling households' basic energy services desire on a daily basis. The energy consumption of a typical household includes lighting, cooling, entertainment communication and other sundry usage with the use of different types of home appliances. Most households require a great deal of energy for cooling to get maximum comfort during high temperature, necessitating the need to switch on electric fans or air-conditioning system. Households with a large number of idle occupants use more electricity for home-based activities than when they are away from home. The usage pattern of appliances in each household is time-based and varies hourly/daily/weekly. The time of the day, when, where and what activities take place affect electricity consumption.

The data and statistics on residential/household electricity consumption in the study area and Nigeria, at large, are not readily available and not being accurately estimated. According to the customer services manager (CSO) of the maximum demand (MD) unit interviewed (Plate 4.10), "even though most households are physically connected to the grid, it is important to emphasise that less than 40 per cent of electricity consumers have a meter while over 60 per cent are not metered". He stated further that: "about 20 per cent of those that are not metered are not in the database of the electricity provider, while about 8 per cent of customers metered have faulty/non-functional meters". According to NERC (2013), metering accounts for 80 per cent of complaints lodged by electricity consumers in Nigeria. The problem of metering centres on unwholesome electricity metering practices by distribution companies of the defunct Power Holding Company of Nigeria (PHCN).



Plate 4.10: Interviewing the customer services manager (maximum demand) of PHCN
Source: Fieldwork (2012) - Permission granted by the customer service manager (CSO) interviewed for photograph to be taken

The only visible record of energy consumption found in the study area was the electricity bill. The bills are distributed at the end of the month to customers with credit meter and on direct connection (DC) or fixed consumption, while customers with pre-paid meters purchase energy consumed on a “pay-as-you-go” basis. Electricity is sold in kilowatt-hours and the unit price of electricity depends upon the tariff rate of consumption. The electricity tariff is based on a unit energy charge of ₦12.30 (£0.04) per kilowatt-hour (kWh) for residential customers with the exception of customers on lifeline. The tariff rate of residential customers are classified based on type of building, type of meter (single or 3 phase meter) and building usage (either for only residential use or mixed use with commercial activities). The residential electricity tariff rate and structure are described in Table 4.13. There are also standing charges of regular monthly fixed charge of ₦500 and 5 per cent VAT that are not related to electricity consumption. The study made use of household monthly expenditure on grid-electricity as a surrogate to estimate consumption in the absence of data/information on households’ electricity consumption. The Kilowatt-hour is a unit of electricity consumption that is equal to 1,000 watt-hours and universally used as a billing unit for energy supplied to consumers by the electric utilities. The monthly expenditure in naira (₦) was converted to the quantity of electricity consumed in kilowatt-hours (kWh) by dividing with the electricity tariff rate of ₦12.30 (£0.04) for residential customers. The conversion to the quantity of electricity consumption in kilowatt-hours (kWh) was exclusive of the monthly fixed charge and 5 per cent value added tax (VAT).

The field research showed that the average household monthly electricity consumption in the study was about 142 kilowatts-hour (kWh) (Table 4.12). This was very close to the following findings of 140 kWh by Iwayemi (2008) and 150kWh by DFID (2009), WDI (2011) and NBS (2011). The result of this research is likewise very close to the 137 kWh per person reported by Sambo (2009) and Research and Markets (2011). The low level of electricity consumption can be attributed to the inadequate supply of electricity in quantity required to meet households' daily energy demand and needs in addition to the inefficiencies in transmission and distribution infrastructure. The per capita electricity consumption translates to 1,704 kWh per year compared to the 4000 kWh recommended by UNDP. The huge deficit implies that the majority of the households live far below the 4000 kWh levels required for achieving a decent standard of human existence (UNDP, 2010). The low electricity consumption is an indication that households cannot efficiently and effectively promote and achieve a healthy standard of living required for economic growth.

Table 4.12: Energy consumption in kilowatts per hour (kWh)

Electricity Consumption (kWh)	Number of Respondents	%
0	11	1.2
1 -100	129	14.3
101 -150	452	50.2
151 - 200	207	23
201 - 250	95	10.6
251 - 300	6	0.7
Total	900	100

Source: Fieldwork (2012)

Many factors are responsible for the low level of households' electricity consumption. Among the factors are insufficient generation capacity; lack of optimum utilisation of the existing generation capacity; inadequate supply of electricity; unreliability of the distribution network; ageing infrastructure. In addition, are load shedding resulting in frequent interruptions of supply; lack of grid discipline and poor grid management; unbalancing of the electricity demand, supply and consumption; and lack of investment in maintenance and expansion programmes on existing power plants. The separate interviews conducted for some household members, officials of the electricity service providers, and the focus group discussions further confirmed the above statements.

S/No	TARIFF	OLD CODE	NEW CODE	CUSTOMERS DEMAND LEVELS	DESRRIPTION	FIXED CHARGE (₦/Month)	ENERGY CHARGE (₦/Month)	REMARKS
1.1	Residential	R1	R1	<5KVA	Life-line i.e. <50KWh(Rural Area)	0.00	4.00	A customer who uses his/her premises exclusively as a residence-house, flat or multi-strayed house
1.2		R2	R2	>5KVA <15KVA	Single and 3-Phase	500.00	12.30	
1.3		R3		>15KVA <45KVA				
1.4		R4	R3	>45KVA <500KVA	LV MD Customers	18,764.00	23.40	
1.5		R5	R4	>500KVA <20MVA	HV MD Customers (11kV/33kV)	117,267.00	23.40	
2.1	Commercial	C1	C1	>5KVA <15KVA	Single and 3-Phase	500.00	15.48	A customer who uses his/her premises for any purpose other than exclusively as a residence or as a factory for manufacturing goods
2.2		C2		>15KVA <45KVA				
2.3		C3	C2	>45KVA <500KVA	LV MD Customers	17,010.00	21.75	
2.4		C4	C3	>500KVA <2MVA	HV MD Customers (11kV/33kV)	106,311.00	21.75	
3.1	Industrial	D1	D1	>5KVA <15KVA	Single and 3-Phase	500.00	17.55	A customer who uses his/her premises for manufacturing goods including welding and ironmongery
3.2		D2		>15KVA <45KVA				
3.3		D3	D2	>45KVA <500KVA	LV MD Customers	104,600.00	22.80	
3.4		D4	D3	>500KVA <2MVA	HV MD Customers (11kV/33kV)	106,311.00	22.80	
3.5		D5		>2MVA				
4.1	Special	A1	A1	>15KVA <45KVA	Single and 3-Phase	500.00	16.80	Customers such as Agriculture and Agro Allied Industries, Water Boards, Religious Houses, Govt and Teaching Hospitals, Govt Research Institutes and Educational Establishments.
4.2		A2	A2	>45KVA <500KVA	LV MD Customers	33,594.00	16.80	
4.3		A3	A3	>500KVA <2MVA	HV MD Customers (11kV/33kV)	44,875.00	16.80	
4.4		A4		>2MVA				
5.1	Street Lighting	S1	S1	1-phase, 3-phase	Single and 3-Phase	500.00	12.90	Street Lightings

Table 4.13: The electricity tariff structure

Source: Nigerian Electricity Regulatory Commission (NERC) (2008)

Furthermore, the spatial analysis of the resultant electricity consumption datasets showed no significant, discernable pattern of consumption across the residential densities in the study area. It only revealed some high levels of electricity consumption in the area with low residential densities (Figure 4.4). This could be attributed to longer hours of daily supply of electricity; and preference and priority given to low-density residential areas owing to the high number of educated people with a history of regular payment, leading to increase in revenue generation and collection from people living in such areas by the electricity provider. The randomisation of the sampled households might also be one of the responsible factors. The non-provision of meters (pre-paid and credit meters) leading to the placement of the majority of households on direct connection (DC) consumption, might be another factor that accounted for the non-discernable and distinguishable pattern of consumption in the study neighbourhood. The non-discernable consumption pattern is at contrast with the residential densities assumption, that high-income earners and households with high educational qualifications living in the low-density area consume more electricity compared with other households in other residential densities. Therefore, estimating households' energy consumption pattern requires setting up the baseline of energy consumption to inform and provide information on household electricity consumption and usage pattern.

4.7 Summary

The chapter provides an overview of the electricity industry, nature of electricity delivery and the power sector reform in Nigeria. It further depicts the characteristics of electricity delivery in the study area, presents a descriptive summary of the socio-economic and demography characteristics of the households, and analyse the delivery and pattern of electricity consumption in the study area. This was followed by the characteristics of electricity demand, supply and consumed at the households level in relation to the electricity service provision as specified in the objective one of the research.

The chapter analyse the responses obtained from the door-to-door household survey, focus group discussions and key informant interviews. The findings show that about 80 per cent of the household heads were the chief economic promoters of the households and were within the economically active age of 20-60 years of age. The patriarchal structure was the most common in the study area, with a high level of literacy above basic primary school education. The majority of them belonged to the formal and informal sectors of the economy categorised into the lower, low, medium and high-income classes.

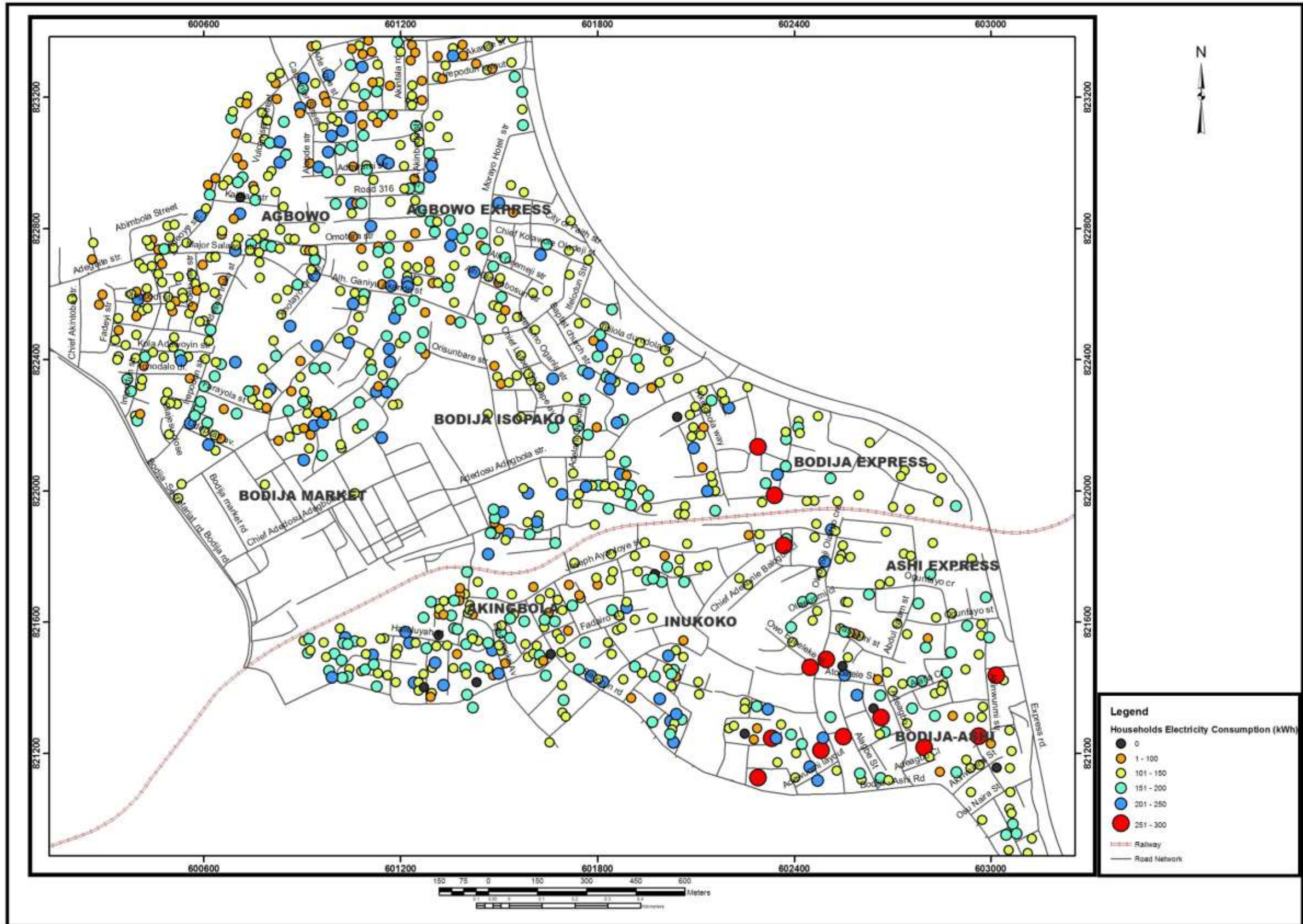


Figure 4.5: The spatial distribution of household electricity consumption

The research investigated and analysed the pattern of electricity demand, supply and consumption. The findings indicated that all the households were connected to the national grid, with per capita electricity consumption of 142 kWh. The results further showed that households' electricity consumption had not been accurately estimated owing to the non-provision of electricity meters to most of the households. The low electricity consumption is an indication that all the households in the study area lived far below the 4,000 kWh required for achieving a decent standard of human existence. The demand for electricity to fulfil households' energy services desire, along with the pattern of energy consumption, is such that electricity was mainly used for lighting, cooling, communication, entertainment and sparingly for cooking. The unavailability and irregular supply of electricity, in addition to the contentious issue of arbitrary estimated billing leading to customer dissatisfaction, was the highpoint of grid-electricity supply and households' energy consumption in the area. Notwithstanding the huge investment in the electricity industry in Nigeria, the utility provider has not been able to meet the basic electricity requirements of the economy, resulting in electricity demand outstripping supply thereby creating a significant energy gap with unserved demand.

CHAPTER FIVE

THE IMPLICATIONS OF THE NATURE OF ELECTRICITY DELIVERY IN NIGERIA AND ENERGY POVERTY IN URBAN IBADAN

5.1 Introduction

This chapter presents the analysis of the fieldwork elements of the research in order to understand the underlying social processes and the implications of the nature of electricity delivery for energy poverty in the study area. The first section provides an overview of energy poverty situation in Nigeria. The second section compares grid-supplied to self-generated electricity and evaluates the implications of electricity delivery characteristics. The third section provides a multivariate analysis of cross tabulations and multiple regression analysis to ascertain the different factors that could explain the relationship between electricity consumptions, households' expenditure and socio-economic characteristics. The fourth section of the chapter focuses on the barriers associated with access to electricity and the analysis of the problem of non-payment. The last section provides an assessment of the nature and implication of the energy poverty nexus in the Nigerian context.

5.2 Energy Poverty Situation in Nigeria

Energy poverty is central to meeting human basic needs and improving household's living standards. Households require energy for the essential services of cooking, lighting, heating, communication and entertainment in order to satisfy basic human needs. According to UNDP (2000:3), lack of choice in accessing adequate, reliable, good quality, safe and environmentally benign energy services to sustain economic and human development is the way in which energy poverty manifests itself. Household access to electricity services in Nigeria is very low. An estimated 100 million Nigerians are without access to electricity, while the remaining 50 million receive low, irregular, intermittent and unreliable supply. Households' electricity access in Nigeria strongly reflects the country's high level of poverty. Table 5.1 and 5.2 present the socio-economic and poverty profile of the country. Nigeria have weak electricity power infrastructure and by extension, all urban areas and cities in the country suffer from frequent power interruptions as a result of inadequate electricity supply due to problems earlier identified in chapter four. Electricity access challenges are compounded by structural challenges, such as insufficient generation capacity and unreliability of electricity supply (World Bank, 2008).

Table 5.1: Nigeria's socio-economic indicators

Population living in poverty (1980)	17 million
Population living in poverty (2010)	112 million
Access to electricity	40 per cent
Number of households without electricity	15.3 million
Number of black-outs per day	28
Electricity consumption per capita	150 kWh
Percentage of population dependent on biomass	72 per cent

Source: Nigeria's Poverty Profile 2010 - National Bureau of Statistics; Little Green Data Book 2011

Table 5.2: Poverty level in Nigeria (million)

Year	Estimated population	Population in poverty	Poverty incidence (%)
1980	65.0	17.1	27.2
1985	75.0	34.7	46.3
1992	91.5	39.2	42.7
1996	102.3	67.1	65.6
2004	126.3	68.7	54.4
2010	163.016	112.47	69.0

Source: National Bureau of Statistics – Nigeria Poverty Profile 2010

The infrastructure challenge in Nigeria includes both generation capacities in existing power plants and the country's transmission and distribution (T&D) network. Nigeria's daily electricity generating output currently hovers between 3500 - 4000 megawatts for a population of about 170 million people. The daily output of about 4000 megawatts of electricity generated in the country is equated to the needs of 4 states of the 36 states of Nigeria and the Federal Capital, Abuja. Lagos State has an estimated electricity demand of about 1,500 megawatts, while the other three states share the remaining 2,500 megawatts, leaving the remaining 32 states and the Federal Capital Territory in total darkness. Electricity supplies in Nigeria are grossly unreliable; hence, services that are best derived from electricity remain elusive. Access to electricity is a prerequisite of reducing poverty. People without such access are constrained to a life of poverty. The wide electricity gap and poverty in comparative regional terms is apparent in per capita electricity

consumption in Nigeria. As presented in Table 5.3, Nigeria's per capita electricity consumption is amongst the lowest in the world and far lower than that of many other African countries.

Table 5.3: Energy and installed capacity per capita – International comparison

Country	Population (Million)	Installed Capacity (MW)	Energy Per Capita (kWh)	Installed Capacity Per Capita (W)	Estimated Peak Load Per Capita
USA	293	1,017,000	12,343	3,470	2,776
Germany	83	115,000	6,366	1,392	1,114
UK	60	76,300	5,680	1,265	1,012
South Africa	43	44,650	4,705	1,046	837
Brazil	179	44,650	2,189	480	384
China	1,300	338,300	1,200	260	209
India	1,086	124,000	520	114	91
Ghana	21	1,762	309	85	68
Nigeria	167	4,750	166	28	27

Source: Draft Final Report - Volume 1 - National Load Demand Forecast. January 2009:75

The deficit and gap that exists has contributed to the acute and perennial energy poverty experienced across the country. Per capita electricity consumption has been around 150 kWh (DFID, 2009; WDI, 2011). Poor electricity supply is the greatest infrastructure problem confronting every household and the business sector. The resultant effects of the years of neglect of the electricity sector by previous governments seriously contributed to the problem experienced across the country, resulting in many households lacking access to substantive quantity and reliable grid electricity. Despite the fact that energy is considered a basic need, urban poor households continue to largely rely on unsafe, unhealthy kerosene (paraffin), biomass or coal and associated appliances as sources of energy for cooking and lighting, which are the two primaries and most energy intensive domestic activities upon which households are entrapped in poverty. The demand for fuel wood is very high with estimates of about 113 million representing 72 per cent of the population consists of about 20 million households depending solely on fuel wood for cooking; making it the most commonly used form of cooking energy (Sambo, 2008a; NBS, 2011; IEA, 2012). The burning of firewood, besides contributing to the build-up of greenhouse gases (GHGs) that cause climate change, causes 95,300 deaths yearly in Nigeria from the smoke from traditional biomass stoves. According to Balouga (2012:34), there is a lack of “coherence and consistency in the enforcement of government policy in the household energy sector, which has resulted [in] the high demand for fuel wood in Nigeria in recent times”. The over-dependence and preference for fuel wood in the country has been attributed to its availability and affordability

compared to the other sources of energy (Maconachie et al., 2009). The future supply of fuel wood in Nigeria (particularly the northern region) is unsustainable, because the country's forest resources are decreasing at an alarming rate (FAO, 2010; 2011). The unsafe and unhealthy use of these energy cause major ill health through indoor air pollution arising from combustion in poorly ventilated spaces and use of inefficient appliances in the absence of electricity. Electricity service provision is an important constraint that influences a household's choice to use electricity. The availability of electricity in urban areas is a catalyst for people to switch from traditional to modern fuels. It provides access to essential services of the basic needs of modern life. Nevertheless in urban areas, people need more energy than just electricity for lighting and energy-dense cooking fuels; they also need energy to run cottage industries, which contribute 50 per cent of GDP in sub-Saharan Africa (Meagher and Mohammed-Bello, 1996).

The performance of the power sector remains poor, in comparison with other developing economies notwithstanding the huge endowment in energy resources and the enormous investment in the provision of electricity infrastructure (Iwuamadi and Dike, 2012). This assertion was confirmed by a World Bank assessment study conducted on energy development in Nigeria, which compared the country's performance in the power sector with those of 20 other developing countries. The study revealed that the electricity sector in Nigeria had the highest percentage of system losses at 33 - 41 per cent; the lowest generating capacity factor at 20 per cent; the lowest average revenue at £0.97 kWh; the lowest rate of return at 8 per cent and the lowest average accounts receivable period of 15 months (World Bank, 1993).

The disruption of electricity supply occurs very frequently because of ageing infrastructure, technical (system) failures, and the recurring shortage of gas and low water level in power generation plants. The typical Nigerian firm experiences power failure or voltage fluctuations about seven times per week, each lasting for about two hours, without the benefit of warning (Adenikinju, 2005). Available statistics from the National Control Centre shows that a total of 139 system collapses were recorded in five years, with 124 cases of the system collapse recorded between 2009 and 2012, indicating the fragile state of the country's electricity supply infrastructure (Simon, 2014). A breakdown of the statistics shows that a total of 24 system collapses were recorded in the 2012. Fifteen of these were a total system collapse while 9 were partial, an average of two (2) system collapses per month as against 19 total collapses in 2011, 39 in 2010 and 42 in 2009 (Simon, 2014). Ferguson et al., (2002) identified the increasing incidence of power shortages as responsible for the dwindling growth of most developing

countries and this is not unconnected with the inability to develop new generating capacity, as hydropower has been the only source of power, thereby diminishing electricity supply severely during droughts.

The erratic nature, poor quality and unreliability of electricity supply in Nigeria led to the continuous increase in the use of self-generation gasoline-powered generating sets. Self-generation is a decentralised off-grid solution of electricity provision using petrol or diesel-powered generators, inverters and solar panels. A portable electric power generator (PPG) is a gasoline or diesel-powered device that provides temporary electrical power up to certain wattage, designed for outdoor use (Adefeso et al., 2012). Users often place generators near or in their homes owing to generator theft and noise nuisance to neighbours (Ashmore and Dimitroulopoulou, 2009). The Manufacturers Association of Nigeria (MAN)(2013) and World Bank (2013) reported that self-generation of electricity from diesel and petrol generators is conservatively estimated at a minimum of 6000 Megawatts (MW), which is almost twice the average output from the grid. Furthermore, an estimated half of the population, particularly those in the rural areas that constitute the majority of the country's poor, have no connection whatsoever to the grid. The consequence of this vast gap between demand and supply is that, although the current regulated electricity tariff is just ₦12.80/kWh (£0.05), the "poor households", particularly those at the bottom of the social ladder, currently pay more than ₦80/kWh (£0.31) burning candles and kerosene. The manufacturers pay in excess of ₦60/kWh (£0.23) on diesel or LPFO generation, while everyone else pays around ₦50 - 70/kWh (£0.19 - £0.27) on self-generation using gasoline-powered (diesel or petrol) generating sets (MAN, 2013). The overall cost of unreliable electricity supply has caused Nigerians to spend on self-generated electricity 5-10 times as much as what they spend on grid-electricity (MAN, 2013; World Bank, 2013). The cost of providing alternative self-generated electricity is high and at the detriment of other household needs together with the adverse effects on human health and the environment.

According to Baumert et al. (2005:41), almost 61 per cent of total anthropogenic greenhouse gas (GHG) emissions (and almost 75 per cent of carbon monoxide [CO] emissions) come from energy-related activities, with the majority coming from fossil-fuel combustion. The release of carbon monoxide (CO), referred to as "silent killer", indiscriminate emission of toxic substances and poisonous gases into the environment could lead to blood poisoning and lung cancer. The frequent use of different kinds of gasoline-powered (diesel and petrol) generators by both the informal and formal sectors of the economy is a major risk of air pollution, as reported by the

International Agency for Research on Cancer's (IARC, 2013), the cancer agency of the World Health Organisation (WHO). Carbon monoxide (CO) is a colourless, odourless, tasteless, non-irritating and toxic gas produced primarily during the incomplete combustion of carbonaceous fuels and substances (Min et al., 2009). The fumes, soot, carbon monoxide (CO) and other poisonous gases released into the environment are a major cause of lungs, blood and central nervous system (CNS) related diseases. The severity of carbon monoxide poisoning is responsible for the death of more than 50 per cent of the fatal poisonings reported in many countries (Eberhardt, 2006). The incessant use of portable power generators (PPGs) in the urban areas of India increased the indoor concentration of CO (Lawrence et al., 2004). The US Consumer Product Safety Commission avers that five out of 104 deaths caused by generator carbon monoxide (CO) poisoning were associated with a generator placed outside the home near open windows, doors, or vents (Marcy and Ascon, 2004). The effects of exposure to high concentrations of CO resulted in a number of deaths in Nigeria, where more than 60 people suffocated to death in 2008 (Adefeso, 2010). The evidence that emissions from some kerosene-using devices emit substances that may impair lung functions and increase infectious illness (including tuberculosis) and asthma risks has been documented in the literature. The emission associated with the indoor use of kerosene stoves and lanterns, the accidental fire explosions and poisoning has been linked to lung infection, asthma, tuberculosis and cancer (WHO, 2010).

According to the progress report on the roadmap for power sector reform, Nigeria has emerged as the country with the biggest gap between supply and demand for electricity in the world. Figure 5.1 shows the annual average electricity demand and supply forecast. The low level of access to modern energy, particularly electricity, has played a major role in the high incidence of poverty in Nigeria; only 40 per cent of the total population currently has access to electricity and less than 10 per cent of the rural areas have access. According to Global Energy Assessment (GEA), (2012:53) "access to modern forms of energy is essential to overcoming poverty, promoting economic growth and employment opportunities, supporting the provision of social services, and, in general, promoting sustainable human development". The lack of electricity exacerbates poverty and contributes to its perpetration, as it precludes most industrial activities and the jobs they create (IEA, 2002). Access to electricity is a prerequisite of reducing poverty. People without access to electricity are constrained to a life of poverty. Poverty alleviation and the achievement of the MDGs will not be possible as long as there are millions of people who do not have adequate and reliable access to electricity. Poverty includes concepts of low-income and inequality as well as limited access to services (such as access to cleaner energy options),

opportunities and social exclusion, which are often intimately linked to inequality (GEA, 2012:160). A recent research by World Bank (2010) showed that there was only slight reduction in the level of poverty in Nigeria, moving from 48 to 46 per cent. This was based on the definition of poverty from Nigeria's National Bureau of Statistics on an estimate of what it takes to support daily consumption of 3,000 calories plus other necessary expenditures. However, using the World Bank definition of poverty as living on less than US\$1.25 a day in purchasing power parity terms, the Nigerian poverty rate rose from 63 per cent in 2004 to 68 per cent in 2010. According to the report, poverty rate in the country is not reducing, despite growth of the economy. The report revealed that income inequality was yet to be overcome, while further revealing that benefit of economic growth was not spreading sufficiently. The report further states that poverty rate could only reduce in the country if income inequality is reduced by 100 per cent. Furthermore, a recent study by the McKinsey Global Institute (2014) indicates (129 million Nigerians) 74 per cent of the population live below the economic empowerment line. The report further breakdown the estimates to represent 81 per cent of rural citizens (69 million people) and 68 per cent of the urban population (60 million people) live below the economic empowerment line.

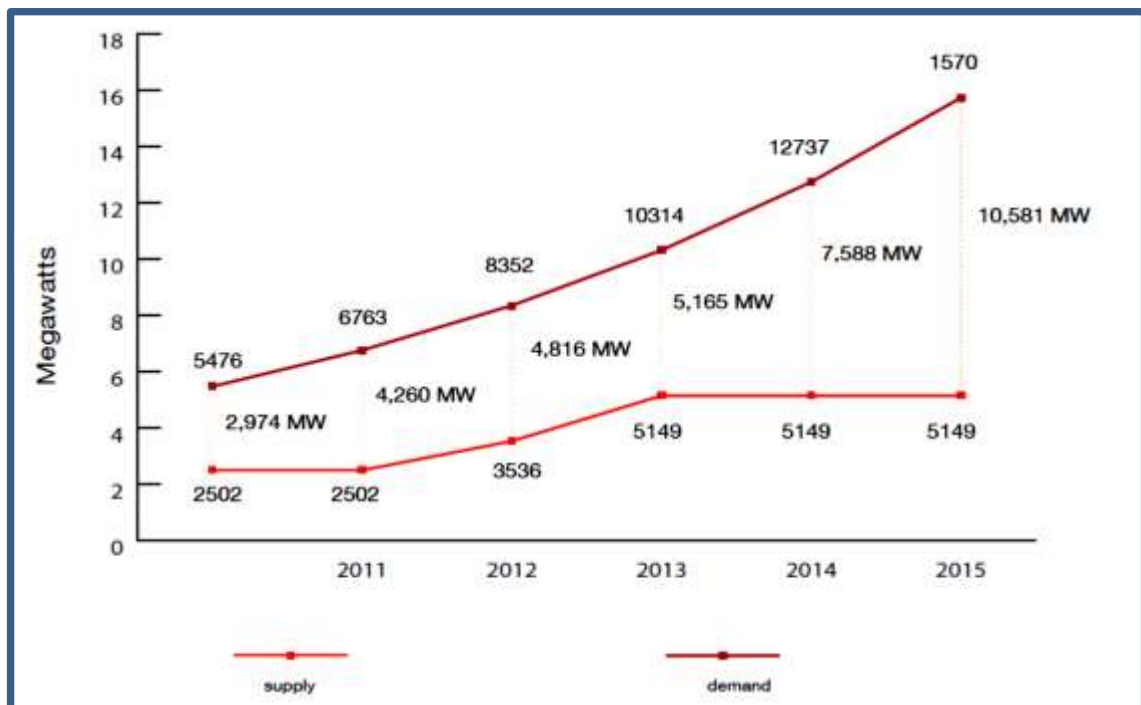


Figure 5.1: Annual average electricity demand and supply forecast in Nigeria

Source: CIA World fact book, <http://sweetcrudereport.com>, ECN, All Africa

5.3 Evaluate the Implications of Electricity Delivery Characteristics and Compare Grid-supplied to Self-generated Electricity

The adequacy, quality and reliability of electricity supply determines to a large extent the level of households electricity consumption and these are variables that provide the data required in evaluating the implications of the nature of electricity delivery in the study area. The results of the field research and data analysis from the questionnaire administered, focus group discussion and key informants interviewed showed that 98 per cent of the households in the study neighbourhood were connected to the nation's utility grid, while the remaining 2 per cent were disconnected due to non-payment of electricity consumed. The daily hours of electricity supply to the study area provided an insight into the inadequate provision of electricity supply in substantial quantity (refer to Table 4.11). The focus group discussants and key informants interviewed further confirmed the inadequacy and unreliability of the quality of electricity service provision. The data showed that access to grid-electricity was not the problem in the study area but the quality and reliability of electricity delivered through the grid network.

The electric power delivery system consists of generation, transmission and distribution system ("the grid") and is an extraordinarily complex network of wires, transformers, and associated equipment and control software designed to transmit electricity from where it is generated, usually in centralized power plants, to commercial, residential, and industrial users. Grid-electricity provision is primarily the electricity supply from centralised distribution mains of the nation's utility grid network; while self-generation, also known as "captive or embedded" power generation, is an off-grid solution of decentralised electricity provision using gasoline-powered (diesel or petrol) generators, inverters, solar panels, and so on. Therefore, a comparative analysis of grid-electricity to self-generated electricity requires the use of the following variables and criteria of reliability, capacity, cost, maintenance and environmental impacts/implications (Table 5.4).

It is imperative and noteworthy to expose the presence and ownership of large quantity of generating sets in the study neighbourhood as an indication of the insufficient provision of electricity. The results of the fieldwork revealed that 71 per cent of the households sampled in the study neighbourhood used various kinds and types of gasoline-powered (petrol/diesel) generators to supplement and compensate the inadequacy of the grid-electricity supply. Generator ownership in the study area is similar to the findings of the NOI Polls conducted in January 2015 where an average of 77.5 per cent of Nigerians relied on the purchase of and use of alternative

sources of power, such as generators, inverters and solar. The ownership of generating sets across households in the study area is described in Table 5.5. The unavailability and irregularity of grid-electricity supply frequently resulted in households providing alternative off-grid self-generation of electricity to compensate for the shortfall of the grid-electricity provision. The numbers of hours these generating sets are put to use on a daily basis, as illustrated in Table 5.6, lent credence to the increasing desire to satisfy the demand for modern energy services.

Table 5.4: Comparison between grid-electricity and self-generated electricity

Nos	Comparison parameters	Grid-electricity	Self-generation electricity
1.	Reliability	Reliable when available to end users (households) in sufficient quantity and quality	Reliable as an alternative in the absence of grid-Electricity
2.	Cost	Costs are low (grid is an economic saver)	High cost (not cost Effective)
3.	Capacity (Energy storage)	Unlimited	Limited
4.	Maintenance	No maintenance is required except in some cases	Maintenance required
5.	Environmental impacts/implications	No environmental impact/implications at the consumers point of access	Health and safety hazards through the release of carbon monoxide (CO) and poisonous gases into the environment leading to noise, air, water pollution and environmental degradation

Source: Fieldwork (2012)

Table 5.5: Type of household generator ownership

Generator Ratings	No of Respondents	%
No generator	259	28.8
650VA	425	47.2
1.2 – 2.5KVA	192	21.3
2.5 – 5KVA	15	1.7
Above 5KVA	5	1.0
Total	900	100

Source: Fieldwork (2012)

Table 5.6: Number of hours of daily usage of generators

No of hours of generator usage daily	No of Respondents	%
1 – 5	428	47.5
6 – 10	197	21.9
11 -15	15	1.6
16 – 20	1	.1
No generator	259	28.8
Total	900	100

Source: Fieldwork (2012)

The percentage of households' monthly expenditure on grid-electricity was compared to the percentage of households' monthly expenditure on self-generation of electricity. The result of data analysis of households' expenditure on grid-electricity facilitated the calculations of the percentage of household income expended on grid-electricity compared to self-generation. It was evident from the analysed data that none of the households in the study neighbourhood spent above 10 per cent of their disposable income on grid-electricity, as presented in Table 5.7. However, about 65 per cent of the sampled households spent above 10 per cent of their income to provide an alternative off-grid solution in the desire for modern energy services, as illustrated in Table 5.8.

Table 5.7: Summary of households' expenditure on grid-electricity

Percentage of Household Expenditure on grid-electricity over Household Income	Number of Respondents	%
0	11	1.2
1 - 5	768	85.3
6 -10	121	13.4
Total	900	100

Source: Fieldwork (2012)

The estimated monthly expenditure of an average households disposable in income providing alternative off grid-solutions of self-generation using petrol and diesel-powered generators was between ₦15,000 (£58.75) and ₦50,000 (£195), as compared to ₦1,000 (£3.90) to ₦5,000 (£19.53) paid for monthly consumption of grid-electricity supplied. The field data analysis shows that about 62 per cent of the households sampled spent 10 - 30 per cent of their income on self-generated electricity, while 3 per cent spent above 30 per cent of their disposable income on self-generation (Figure 5.2). This implies the poor reliability of the grid exert undue pressure on

households' disposable income. The expenditures on grid-based electricity were far lower and cheaper than the expenditures on self-generated electricity using generating sets.

Table 5.8: Summary of households' expenditure on self-generated electricity

Percentage of Household Expenditure on self-generated electricity over Household Income	Number of Respondents	%
0 (No generator)	259	28.8
1 -10	62	6.9
11 -20	233	25.9
21 – 30	325	36.1
31 – 40	11	1.2
41 – 50	1	0.1
51 – 60	9	1
Total	900	100

Source: Fieldwork (2012)

The most commonly used generating set in the study neighbourhood is the Tiger 650VA model, commonly referred to as “I better pass my neighbour” (Plate 5.1). This type of generator is affordable and fit the income profile of quite a number of Nigerians. The Tiger 650VA is sold for ₦12, 500 (£51.87) and 2.5KVA (TG950) (Plate 5.2) costs ₦28, 000 (£109.37). The study revealed that 68 per cent of the households used generators with power ratings between 650VA - 2.5KVA and 3 per cent of households used generating sets above 2.5KVA (see Table 5.5). The Tiger 650VA generator can easily power a television set (TV), DVD/VCD player, one or two fans and a few lighting points, while the TG950 can power a fridge in addition. This implies they are used mostly to provide lighting for illuminating the house, extending the hours of the day for homework (education), recreation (watch TV) and communications (charge phones/handsets). In every four households sampled, at least three owned a generator and used generator as an alternative source to grid-electricity. The data revealed that high-capacity generating set ownership was only common amongst the medium and high-income earners, while low capacity generating sets were common with low-income earners.



Plate 5.1: “I better pass my neighbour” generator (Tiger 650VA)
Source: Fieldwork (2012)



Plate 5.2: A typical 2.5KVA type of generator (TG950)
Source: Fieldwork (2012)

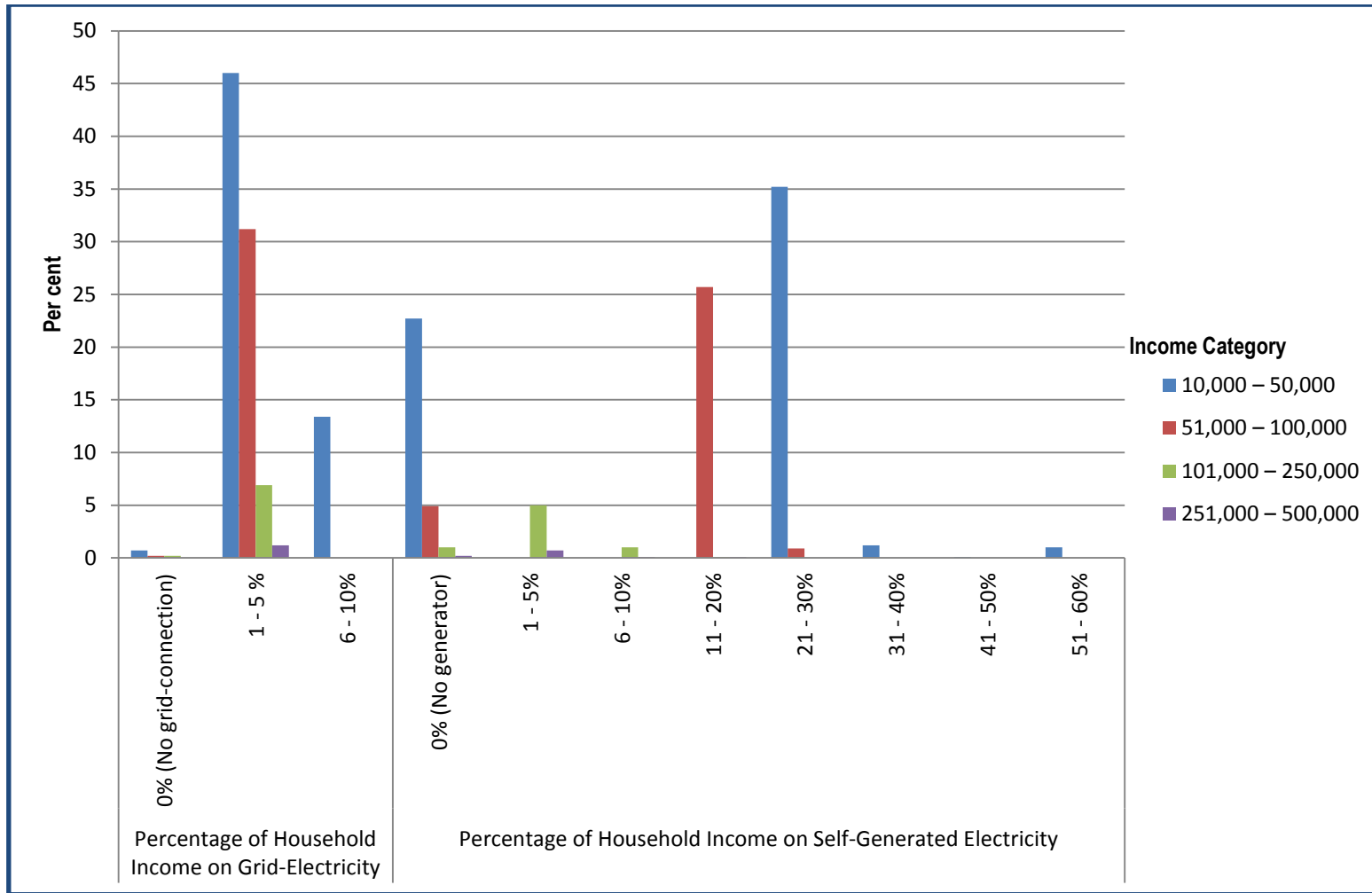


Figure 5.2: Percentage of household income on grid and self-generated electricity by income category

The daily usage of generators by households in the study area was habitually 4–7 hours. Amongst the 29 per cent of households without generators, quite a larger number of those households fell within the low-income earners, while some were equally among the middle to high-income earners. However, owning a generating set might be due largely to economic reasons or a matter of preference. The analysis of the field data showed that 57 per cent of the sampled households had one generating set, 10 per cent had two generating sets, 3 per cent had three generating sets, while less than 1 per cent had four generating sets. These results are very close to the results of the opinion poll conducted across households by the NOI Polls Limited (2013), which showed that most Nigerians rely on alternative sources of generating electricity for their domestic and business uses. The NOI poll findings indicated that, at least, eight out of every ten Nigerians sampled (about 81 per cent) generate their own power supply through alternative sources to compensate for irregular power supply. A combined average of 69 per cent said they experienced increase in their spending on alternative power supply compared to the previous year. Therefore, the cost of fuelling, servicing and maintenance of generating sets represents a significant part of household monthly budgets and expenditure. The cost implication associated with self-generation and maintenance of a generating set made life unbearable for an average resident of the study area particularly the poor urban households. Many of the residents whose means of livelihood depend on electricity continually resorted to power generating sets to drive their businesses as captured during focus group discussions and interviews granted. It is noteworthy that there is no cost of maintenance attached to grid-electricity supply except occasional situations of damage from heavy rain or storm, resulting in network disruptions from faulty distribution transformer, damaged/faulty cables, and damaged/broken electricity low/high-tension poles (LT/HT poles). This forms a critical highlight of the focus group discussion among the Ifesowapo residents/landlord association whereby they have to impose levy and contribute money among themselves in solving such damages.

The use of generators, as earlier stated, is to compensate for the inadequacy of grid-electricity. The voltage capacity of electrical appliances that can be powered by available generating sets in each household is limited and subject to the power/output ratings of the generators. One of the many advantages of grid-electricity identified by those interviewed is that grid-electricity have no restrictions nor limitations to the quantity and voltage-carrying capacity of home electrical appliances that can be powered at once, compared to the use of generators. Thus, the energy storage and the load-carrying capacity of households' electrical appliances with the use of grid-electricity are unlimited. Under normal circumstances, grid-based electricity produces nearly triple

the power capacity of off-grid self-generation except in some cases of low supply of electricity arising from power drop or voltage fluctuations probably as a result of a fault on the grid network.

This excerpt represents the view of the focus group discussants and those interviewed on the foregoing finding: “the low capacity generators cannot power appliances like electric boilers, electric irons, heaters and air conditioners that are high power consuming appliances”. It is imperative to state that generators lower than 2.5KVA cannot power major electrical appliances, like pumping machine, air conditioning system, and deep freezer. The popularity of generating sets amongst the informal sector of the economy and small and medium-scale (SMEs) businesses, such as electrical work, beauty/barbers salon, small business centres, is very high because the survival of such businesses depends largely on a constant supply of electricity.

The frequency of poor quality and unreliability of electricity supply persistently increase the households and artisans' expenditures on generators usage. This worsens the economic conditions of a larger percentage of households and those engaged in the informal sector to earn a living. The large ownership and incessant use of generators by larger percentage of the households in the study area substantiates the “fuel generator economy” depiction of Nigeria and is a pointer to the failure of the public energy service delivery system in the country. The description of Nigeria as a fuel generator economy gives an indication of the nation as one of the country contributing to human-induced climate change. The carbon monoxide (CO) released from the gasoline powered generators has an important indirect effect on global warming. The reaction of carbon monoxide with hydroxyl (OH) radicals reduces the abundance of OH in the atmosphere. The OH radicals in the atmosphere reduce the lifetimes of greenhouse gases, like carbon monoxide and methane and indirectly increase the global warming potential of the gases. The emission and rising levels of carbon dioxide in the earth's atmosphere is the major cause of global warming and both atmospheric CO₂ and climate change are accelerating. The use of generators, at times around-the-clock, with the associated noise nuisance and air pollution, is a major concern for people living around, particularly its attendant environment-related issues. The resultant noise with the incessant use of generators has deprived some households a sound sleep. It has also deprived some households the help and rescue action that could have arisen from their neighbours during unforeseen emergency or armed robbery attack. The release of carbon monoxide fumes from generators into the atmosphere is a major risk of air pollution through indiscriminate emission of poisonous gases and particulates that could lead to blood poisoning and lung cancer, as reported by the International Agency for Research on Cancer's

(IARC's), the cancer agency of the World Health Organisation (WHO). The higher the number of generator users the greater the consequences for the environment and human health, especially in terms of air and noise pollution, carbon monoxide emissions and effluent discharges from the generators into the environment.

The use of renewable solar photovoltaic (PV) systems is a recent phenomenon in Nigeria and many of the households are yet to adopt it. Many Nigerian households are not fortunate enough to have climate-friendly power backup systems, instead relying on inefficient petrol/diesel generators. The study shows that only 3.6 per cent households in the study neighbourhood use solar powered alternative energy source. The acceptance of solar energy is still relatively low and the reasons adduced for its low adoption is its perceived high cost of installation and maintenance. In an ideal situation, grid-electricity provision is far better than self-generation of electricity where electricity is adequate and reliable.

5.4 Analysis of the Relationship between Household Electricity Consumption, Household Expenditure and Socio-economic Characteristics

Two types of multivariate statistical techniques (cross tabulations and multiple regressions analysis) were used to explain the relationship between household socio-economic characteristics, electricity consumption and households' expenditure on the grid-based and self-generated electricity. Cross tabulations were used to examine the relationship between two or more variables. The measure of association test for nominal variables is Phi /Cramer's V. Phi is recommended for simple two by two cell tables and Cramer's V for tables with more rows and columns. The test result has a value between 0 and 1. To interpret this, a value near 0 means there is a very weak relationship between the two variables, while a value close to 1 means there is a very strong association between the two variables. The datasets were further analysed using multiple regression and correlation analysis to establish any linear relationships in the data and to produce summary statistics to explain the variations in the dependent variables. The variations in the electricity consumption in terms of households' expenditure on grid-based electricity and the variation in the self-generated electricity were of interest in this analysis; hence, the two variables were taken to be the dependent variables. However, the socio-economic characteristics, such as age, gender, family size, household size and type, type of building, educational status, occupation and average monthly income, were the independent variables. For the purpose of analysis and interpretation, nominal and ordinal variables were coded into dummy variables, as dummy variables coding is useful for examining group differences. The variables gender, type of house,

house ownership, marital status, education and occupation were nominal data, while household size was ordinal data. Age and income were both measured on interval scales. The dummy variable contained only the values 1 and 0, with a value of 1 indicating that the associated observation was categorical value and all cases that did not fall into that category assumed a value of zero. All analyses done were 2-tail tests at either 0.01 or 0.05 confidence level.

The multiple regression models were implicitly expressed as:

$$Y = f(x_1, x_2, \dots, x_9, \varepsilon)$$

where,

Y = Household monthly expenditure on grid-electricity in Naira (₦)

x_1 = Income (₦)

x_2 = educational status (Dummy variables)

x_3 = family size (number)

x_4 = occupation (Dummy variables)

x_5 = age (years)

x_6 = gender (Dummy variables)

x_7 = marital status (Dummy variables)

x_8 = type of residential buildings (Dummy variables)

x_9 = house ownership (Dummy variables)

ε = error term

5.4.1 Analysis of the Relationship between Household Expenditure on Grid-electricity and Socio-economic Characteristics

The analysis of the relationship between socio-economic characteristics and household expenditure on grid-electricity was aimed at assessing the relationships and predicting the influence of households' socio-economic characteristics on grid-electricity consumption. The results of the cross tabulation showing the associations/relationships of each of the socio-economic variables with households' consumption/expenditure on grid-electricity are presented in the following order (in table 5.4; a-j). It is important to state here that the uncertainties of data and the resultant estimated billing arising from non-provision of meters to accurately measure households' energy consumption might be a factor that contributes significantly to the results of

the statistical analysis of the thesis data. The data collected on energy use has limitations; it was collected by surveys with sample sizes too small to provide data for individual cities or to see how energy use varies among income groups

a) Gender

The results in table 5.9a show that 38 per cent of male and 15 per cent of female headed households expend between ₦2001 - ₦3000 (£8 - £12) on grid-electricity, while 31 per cent of male headed households and 7 per cent female headed households spend between ₦3000 – ₦5000 (£12 – £20) among the sampled households. The Cramer's V value 0.134 indicates the presence of a weak association between the two variables (gender and households' expenditure on grid-electricity). However, there is a significant relationship ($p < 0.003$). One would have expected a more noticeable increase in female headed households because women tend to stay more at home and use more of electricity for households domestic chores but the results proved otherwise probably as a result of the fact that the patriarchal structure where the father is the head of the household was the most common in the study area.

Table 5.9a: Gender and Household expenditure on Grid-electricity (₦)

	Household Expenditure on Grid-Electricity (₦)					Total
	1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3000 - 5000	5 = 5001 - 10000	
Gender 1 = Male	6 .7%	31 3.4%	343 38.1%	275 30.6%	27 3.0%	682 75.8%
2 = Female	5 .6%	14 1.6%	134 14.9%	59 6.6%	6 .7%	218 24.2%
Total	11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal	Cramer's V		Value .134	Approx. Sig. .003		

b) Age

Table 5.9b shows an increase in household expenditure on grid-electricity with age. There is an increase in households' expenditures on grid-electricity from the productive age 20 – 30 until age 51 - 60 and then begins to decrease. The increase is more noticeable and highest at age 51 – 60 with 27 per cent of sampled households' in this category. There is a linear relationship of

household expenditure on grid-electricity with an increase in age from 20 – 60. Thus, an increase in age correspondingly leads to an increase in household expenditure on grid-electricity consumption. The Cramer's V value 0.104 indicates a weak association between the two variables but the relationship is statistically significant ($p < 0.006$). On the contrary, the result is at variance with the notion that people of old age especially retirees tend to remain in their homes and use more energy for heating and cooling than young and middle-aged people who go to work or school daily.

Table 5.9b: Age and Household expenditure on Grid-electricity (₦)

		Household Expenditure on Grid-Electricity (₦)					Total
		1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3000 - 5000	5 = 5001 - 10000	
Age	1 = 20 -30	3 .3%	4 .4%	51 5.7%	15 1.7%	3 .3%	76 8.4%
	2 = 31 - 40	1 .1%	13 1.4%	101 11.2%	46 5.1%	8 .9%	169 18.8%
	3 = 41 - 50	2 .2%	9 1.0%	126 14.0%	86 9.6%	10 1.1%	233 25.9%
	4 = 51 - 60	5 .6%	9 1.0%	113 12.6%	106 11.8%	7 .8%	240 26.7%
	5 = 61 - 70	0 .0%	8 .9%	72 8.0%	66 7.3%	5 .6%	151 16.8%
	6 = 71 - 80	0 .0%	2 .2%	14 1.6%	15 1.7%	0 .0%	31 3.4%
Total		11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal		Cramer's V		Value .104	Approx. Sig. .006		

c) Marital Status

The results show that married people expenditure on grid-electricity constitutes more than 80 per cent of the total respondents sampled with an expenditure ranging from N2001 (£8) to N5000 (£20) on grid-electricity. The Cramer's V value 0.057 indicates a little or no association between the two variables (marital status and households' expenditure on grid-electricity). The $p < 0.771$ indicates there is no significant association between the two variables. Therefore, marital status

has no influence on households' expenditure on grid-electricity. The result is unexpected because being married is likely to lead to higher family size, which is expected to lead to an increase in electricity consumption and households' expenditure on electricity.

Table 5.9c: Marital Status and Household expenditure on Grid-electricity (₦)

		Household Expenditure on Grid-Electricity					Total
		1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3000 - 5000	5 = 5001 - 10000	
Marital Status	1 = Single	1 .1%	6 .7%	62 6.9%	28 3.1%	4 .4%	101 11.2%
	2 = Married	10 1.1%	36 4.0%	389 43.2%	287 31.9%	28 3.1%	750 83.3%
	3 = Divorced	0 .0%	0 .0%	5 .6%	2 .2%	1 .1%	8 .9%
	4 = Separated	0 .0%	0 .0%	5 .6%	5 .6%	0 .0%	10 1.1%
	5 = Widowed	0 .0%	3 .3%	16 1.8%	12 1.3%	0 .0%	31 3.4%
Total		11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal		Value Cramer's V			Approx. Sig. .0771		

d) Household Size

Table 5.9d indicates the results of households' size and households' expenditure on grid-electricity. The result shows that as households' increases in size their expenditure on grid-electricity decreases. About 53 per cent of Households with 1 - 4 members spend between ₦2001 – ₦5000 (£8 – £20) compared to 39 per cent of households with 5 -7 members. This could be as a result of economies of scale whereby large families synergise their energy use, which possibly contribute to overall efficient household energy use and consequently lead to reduction of expenditure. The general belief is that larger households use more appliances and energy than smaller households do. However, on a per capita basis, smaller households tend to use more energy than larger ones. This implies the total number of people in a household is a major factor that may affect energy consumption and the subsequent expenditure for grid-electricity

consumption. The Cramer's V value 0.098 indicates the presence of a weak association between the two variables (number of people per household and expenditure on grid-electricity), however, there is a significant relationship ($p < 0.011$).

Table 5.9d: Household Size and Household expenditure on Grid-electricity (₦)

	Household Expenditure on Grid-Electricity (₦)					Total
	1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3001 - 5000	5 = 5001 - 10000	
Household Size 1 = 1 - 4	7 .8%	28 3.1%	282 31.3%	145 16.1%	16 1.8%	478 53.1%
2 = 5 - 7	4 .4%	15 1.7%	164 18.2%	156 17.3%	14 1.6%	353 39.2%
3 = 8 - 10	0 .0%	2 .2%	20 2.2%	27 3.0%	2 .2%	51 5.7%
4 = 11-12	0 .0%	0 .0%	11 1.2%	6 .7%	1 .1%	18 2.0%
Total	11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal	Cramer's V		Value .098	Approx. Sig. .011		

e) Household Type

The table 5.9e shows that 52 per cent of the household type of nuclear family composition spends between ₦2001 – ₦5000 (£8 – £20) on grid-electricity. However, 36 per cent of the extended family household type spend same amount on grid-electricity. The Cramer's V value 0.070 indicates a little or no association and there is no significant relationship ($p < 0.359$) between the two variables (household type and expenditure on grid-electricity).

f) Type of Building

The sampled households living in a face-to-face (Brazilian upstairs and bungalow) spend more on grid-electricity (table 5.9f). This could be alluded to the fact that a large number of families and households are living together in shared and rented accommodation where there are several rooms with different sizes. The more rooms the more energy consumption and probably more households' electrical appliances with higher levels of overall expenditure. The occurrence of

multiple households in shared accommodation is a result of economic and social challenges in housing affordability.

Table 5.9e: Household Type and Household expenditure on Grid-electricity (₺)

	Household Expenditure on Grid-Electricity					Total
	1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3001 - 5000	5 = 5001 - 10000	
Household Type 1 = Nuclear	8 .9%	35 3.9%	318 35.3%	202 22.4%	22 2.4%	585 65.0%
2 = Extended	3 .3%	10 1.1%	148 16.4%	126 14.0%	10 1.1%	297 33.0%
3 = Single	0 .0%	0 .0%	11 1.2%	4 .4%	1 .1%	16 1.8%
4 = Shared	0 .0%	0 .0%	0 .0%	2 .2%	0 .0%	2 .2%
Total	11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal		Value Cramer's V		Approx. Sig. .359		

Table 5.9f: Type of Building and Household expenditure on Grid-electricity (₺)

	Household Expenditure on Grid-Electricity					Total
	1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3000 - 5000	5 = 5001 - 10000	
Type of Building 1 = Face to Face (Brazilian type)	6 .7%	23 2.6%	245 27.2%	114 12.7%	8 .9%	396 44.0%
2 = Face to face (Brazilian Bungalow)	3 .3%	7 .8%	104 11.6%	88 9.8%	8 .9%	210 23.3%
3 = Flat	1 .1%	11 1.2%	100 11.1%	92 10.2%	12 1.3%	216 24.0%
4 = Duplex	1 .1%	4 .4%	28 3.1%	40 4.4%	5 .6%	78 8.7%
Total	11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal		Value Cramer's V		Approx. Sig. .001		

This type of cohabitation is particularly common among the lower and low-income earners that cannot afford to rent a single unit bungalow/flat, but are forced to live in multi-room houses where they share the entire infrastructure with other occupants of the house. It is expected that the economies of scale for these multiple households in shared accommodation will reduce the per capita cost and amount of energy consumption and possibly contribute to overall efficient household energy use. It is imperative to state here that there is no control of energy usage and consumption among these people from diverse background and with different lifestyles cohabiting together. The Cramer's V value 0.117 indicates a weak association between the two variables. However, there is a significant relationship ($p < 0.001$) between the two variables (number of people per household and expenditure on grid-electricity).

g) Occupation

The result of table 5.9h indicates 43 per cent of the business owners spend between ₦2,001 – ₦5,000 (£8 - £20) on grid-electricity. The Cramer's V value 0.117 indicates the presence of a weak association between the two variables. The result shows there is a significant relationship between the two variables (occupation and expenditure on grid-electricity) ($p < 0.001$).

Table 5.9h: Occupation and Households' expenditure on grid-electricity.

		Household Expenditure on Grid-Electricity (₦)					Total
		1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3000 - 5000	5 = 5001 – 10000	
Occupation	1 = Civil Servants	4 .4%	6 .7%	81 9.0%	63 7.0%	6 .7%	160 17.8%
	2 = Private	1 .1%	7 .8%	64 7.1%	80 8.9%	11 1.2%	163 18.1%
	3 = Business Owners	4 .4%	19 2.1%	237 26.3%	154 17.1%	14 1.6%	428 47.6%
	4 = Artisans	2 .2%	13 1.4%	95 10.6%	37 4.1%	2 .2%	149 16.6%
Total		11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal		Cramer's V			Value	Approx. Sig.	
					.117	.001	

h) Educational Qualification

The results indicate 18 per cent of households with secondary level of education spend between ₦2001 – ₦3000 (£8 – £12) and 11 per cent spend between ₦3001 – ₦5000 (£12 – £20) while 8 per cent of households with B.Sc. degree qualification each when compared to other households sampled. The Cramer's V value 0.134 indicates the presence of a weak association between the two variables. There is a significant relationship between the two variables ($p < 0.002$).

Table 5.9g: Educational Qualification and Household expenditure on Grid-electricity (₦)

	Household Expenditure on Grid-Electricity (₦)					Total
	1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3000 - 5000	5 = 5001 - 10000	
Educational Qualification 1 = None	2 .2%	5 .6%	54 6.0%	37 4.1%	0 .0%	98 10.9%
2 = Pry Six	0 .0%	8 .9%	58 6.4%	30 3.3%	1 .1%	97 10.8%
3 = Secondary	5 .6%	13 1.4%	164 18.2%	97 10.8%	7 .8%	286 31.8%
4 = NCE	1 .1%	5 .6%	29 3.2%	19 2.1%	1 .1%	55 6.1%
5 = OND	0 .0%	1 .1%	37 4.1%	16 1.8%	1 .1%	55 6.1%
6 = HND	1 .1%	2 .2%	40 4.4%	25 2.8%	2 .2%	70 7.8%
7 B.Sc.	1 .1%	7 .8%	72 8.0%	72 8.0%	13 1.4%	165 18.3%
8 = PgD	0 .0%	2 .2%	10 1.1%	13 1.4%	3 .3%	28 3.1%
9 = M.Sc.	1 .1%	1 .1%	13 1.4%	18 2.0%	4 .4%	37 4.1%
10 = PhD	0 .0%	1 .1%	0 .0%	7 .8%	1 .1%	9 1.0%
Total	11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal		Cramer's V		Value .134	Approx. Sig. .002	

Therefore, education (or lack of) which normally could have been seen to have a contributing factor does not show any noticeable household pattern of electricity consumption and expenditure. It is noteworthy that the higher the level of education the more likelihood the availability and desire to purchase more of electrical appliances which could ultimately lead to an increase in electricity consumption and overall household expenditure on grid-electricity.

i) Average Monthly Income

Table 5.9j shows the cross tabulation between households average monthly income and households expenditure on grid-electricity. The results show that 39.4 per cent of households at the bottom of the social ladder (lower-income) and 11.9 per cent of the low-income households spend between ₦2000 – ₦3000 (£8 - £12) of income on grid-electricity, while 19.4 per cent and 12.7 per cent spend between ₦3001 – ₦5000 (£12 - £20) monthly on grid-electricity. This implies the urban poor households spend more of their income on grid-electricity. The Cramer's V value 0.175 indicates the presence of a weak association between the two variables. The result revealed there is a significant association between the two variables (average monthly income and households' expenditure on grid-electricity) ($p < 0.001$).

The recent studies by DFID-sponsored Enhancing Financial Innovation and Access (2012), an independent Nigeria-based financial sector development organisation, showed that more than half of the Nigerian population earned less than the monthly minimum wage of ₦18,000 (£70.31). The study further indicated that only 3.6 million Nigerian adults earn above ₦70,000 (£273.43) per month. The National Bureau of Statistics (2013), in its 2010 poverty profile, claims that about 69 per cent of the country's estimated 163 million population live in poverty. The figure is very likely to increase to 71.5 per cent when the 2011 figure is computed. In arriving at the 2010 figure, data from 20 million households with an average of four to six family members were collated for analysis. In relation to this study, the report indicates that households earning below ₦50,000 (£195.31) are poor. This shows that more than 60 per cent of the households samples in this study fall below the category class "poor". The result is very close to the 69 per cent of the national estimates and 68 per cent of the population estimated to live below the income poverty line, according to the UNDP's (2013) Human Development Index Report. The report of the analysis of the research findings of McKinsey Global Institute (2014) estimate that raising incomes and improving access to essential services could reduce the share of Nigerians living below the empowerment line from 74 per cent in 2013 to 32 per cent in 2030. Thus, poverty has barely declined and approximately 130 million Nigerians or about 74 per cent of the country's

population live below the empowerment line. The effects of low-income in poor urban households are compounded by high costs of living. In their study on analysis of determinants of electricity consumption in Nigeria (Ngutsav and Aor, 2014) reiterate that income level which proxies the level of economic activity as well as standard of living is perhaps the most important determinant of electricity demand. The demand for electrical goods and services (e.g. television, refrigerators, air-conditioners etc.), increases as income rises. This puts significant pressure on the demand for electricity for their usage. This implies that a positive correlation exist between income and electricity consumption.

Table 5.9i: Average Monthly Income and Household Expenditure on Grid-Electricity (₦)

		Household Expenditure on Grid-Electricity (₦)					Total
		1 = 0	2 = 500 - 2000	3 = 2001 - 3000	4 = 3000 - 5000	5 = 5001 - 10000	
Av. Monthly Income	1 = 10,000 – 50,000	8 .9%	35 3.9%	355 39.4%	175 19.4%	14 1.6%	587 65.2%
	2 = 51,000 – 100,000	3 .3%	10 1.1%	107 11.9%	114 12.7%	9 1.0%	243 27.0%
	3 = 101,000 – 250,000	0 .0%	0 .0%	13 1.4%	38 4.2%	8 .9%	59 6.6%
	4 = 251,000 – 500,000	0 .0%	0 .0%	2 .2%	7 .8%	2 .2%	11 1.2%
Total		11 1.2%	45 5.0%	477 53.0%	334 37.1%	33 3.7%	900 100.0%
Nominal by Nominal		Cramer's V		Value .175	Approx. Sig. .001		

In addition to the above cross tabulations results, a multiple regression analysis was further conducted to assess the relationships and predict the influence of households' socio-economic characteristics on household expenditure on grid-based consumption. The result gave a low goodness of fit. $r^2 = 0.111$ (11.1per cent) and adjusted $r^2 = 0.104$ but the overall relationship was significant ($F_{7,892} = 15.929$, $P < 0.05$). The results of the regression analysis were not surprising as it returned a very low r^2 . This could be attributed to factors associated with estimated consumption resulting in arbitrary estimated billing as a result of the non-provision of electricity meters to accurately measure consumption at the household level. It was observed that the

constant (1898.08) in the regression model was significant ($t= 36.178$ $p<0.05$). This supports the fact that there is a basic payment made for electricity consumption irrespective of the other variables (or rather when other factors are kept constant). The low r^2 can be attributed to a number of factors; predominantly amongst them is the irregularity and inadequacy of electricity supply and the non-provision of electricity meters to households resulting in estimated billings that are arbitrarily apportioned to consumers without recourse to actual grid-electricity consumption. Therefore, it is very difficult to assert categorically that as households experience increase in income, electricity consumption increases. However, one of the inferences from this low r^2 is that there is no correlation between electricity service delivery in terms of electricity supplied and household expenditure. The number of hours of electricity supplied to households throughout the month did not have a significant relationship on the amount paid for grid-electricity. The abnormality is attributable to the non-provision of electricity meters and the inability to measure accurately the daily, weekly and monthly household electricity consumption.

The regression model is stated as:

$$\text{Grid Consumption} = 1898.08 + 0.003(\text{Income}) - 178(\text{Brazilians}) - 96(\text{Flat}) - 129.77(\text{Tenants}) + 97(\text{Bsc}) + 7(\text{PGD}) + 91(\text{Private})$$

The model shows that an increase in income leads to an increase in grid-electricity consumption by ₦0.003 (£0.000011) of the income. In addition, households living in the Brazilian type of residential house consume ₦178 (£0.69) less than those living in duplex, while households living in flat pay ₦96 (£0.37) less than those living in duplex. Tenants also pay ₦129.97 (£0.50) less than house/property owners do, while those with BSc and PGD pay ₦97 (£0.38) and ₦7 (£0.02) more than those with non-formal education and households in private practice pay ₦91 (£0.35) more than the civil servants. An increase in income is expected to correspond to a more diversified use of home electrical appliances to fulfil households' energy service needs for cooking, heating, lighting, cooling and entertainment. As households experience an increase in income and as those essential necessities have been fulfilled, the desire to acquire additional appliances such as liquefied petroleum gas (LPG), microwave, electric toaster, blender, air conditioning system, home cinema/sound system and refrigeration that require electricity increases.

The results of the correlation analysis are summarised in Table 5.1k. The results showed that gender, age, house ownership, marital status, household size, household type, occupation,

educational status, types of building and monthly income were factors influencing household monthly expenditure on grid-based electricity consumption in the study area. Even though the relationship was not strongly correlated as expected, it existed. The irreconcilable differences witnessed in the study neighbourhood as highlighted by the opinion of the focus group discussants and key informant interviewed in respect of electricity supplied, consumed and households' expenditure on grid-electricity presents a big challenge to this study.

Table 5.10: The correlation between socio-economic variables and household monthly expenditure on grid-electricity

Nos	Socio-economic variables	Household monthly expenditure on Grid-electricity
1.	Gender	-.159
2.	Age	.102
3.	Marital Status	.065
4.	Household Size	.130
5.	Household Type	.073
6.	Type of Building	.210
7.	Ownership Status	-.078
8.	Educational Qualification	.170
9.	Occupation	-.166
10.	Average Monthly Income	.294

Source: Results of analysis computed from fieldwork (2012)

From the above results (table 5.9a – 5.9i and 5.10), the non-provision of electricity meters to most households is a major barrier to accurately measure and estimate electricity consumption across households. This was repeatedly emphasised by the focus group discussants from both Ifesowapo (see plate 3.4) and Inukoko (see plate 3.5) landlord/tenants association and the key informants interviewed. The information obtained from an official of the marketing department of the electricity provider on condition of “anonymity” is that the monthly revenue targets handed to marketers and officials of the commercial unit of the electricity service provider often result in bills arbitrarily assigned to households particularly where customers' do not have functional meters. These frauds according to the official are routinely committed on a monthly basis by the electricity meter readers in an attempt to meet monthly revenue targets.

The problem highlighted above has always resulted in a big backlash from people who feel cheated and frustrated by paying for electricity not supplied nor consumed and services not enjoyed. The complaints and dissatisfactions arising from the rising incidence of arbitrary and

contentious estimated bills were repeatedly emphasised by almost all the focus group discussants and the key informants interviewed. One of the two key informants interviewed is the chairman of the Ifesowapo landlord association - a male, retired civil servant of about 65 years and a volunteered female school teacher of about 60 years. They both expressed their displeasure on the “significant drop” in the electricity supply and the “outrageous” bills distributed that does not commensurate with the amount paid for electricity consumption and the quality of service provided. The highpoint of the focus group discussions and the key informants interviewed is that monthly electricity bill is not a true reflection of electricity neither supplied nor consumed but purely electricity exploitation. Another major disheartening issue highlighted by the focus group discussants and those interviewed was the ₦500 (£1.95) fixed charges added to electricity bill on a monthly basis for meter maintenance, whereas the majority of these households were not metered. Households previously disconnected from service poles still received bills for electricity neither supplied nor consumed. This is contrary to the Electric Power Reform Act Section 1 (4.1) which states that: “every electricity distribution company (Discos) shall issue bills for electricity used at each consumer’s address at regular intervals”

It was noted during the focus group discussions that: “the impact of electricity service delivery felt by consumers has been incessant charges of unjustifiable tariff increases in the name of fixed charge, meter maintenance charge and energy charge. In addition, to the continuous erratic electricity supply occasioned with frequent system collapse that has plagued the country for more than 2 decades”. Another lamentation is the “yearly upward review of the electricity tariff in spite of shortfalls in service delivery”. Nonetheless, the electricity providers distribute some ridiculous bill; that is fraudulent which is totally unfair to us; they can’t supply regular electricity; they can’t give pre-paid meter, yet they bring outrageous bills and we are always forced to pay to avoid disconnection from the grid”. One of the key informants interviewed stated that: “an average household is requested to pay between ₦1,000 (£4) and ₦5,000 (£20) on electricity bills monthly despite only having electricity supply for one or two times a week that lasted for less than four hours and sometimes electricity is supplied only twice or thrice a month”.

The focus group discussants and key informants interviewed lent credence to the problem of estimated billing that habitually arose because a large number of households were without meters while some have obsolete, non-functional analogue, faulty or damaged meters thereby those customers’ on direct connection (DC) consumption (Plate 5.3). The absence of functioning electricity meters makes it very difficult to accurately estimate and measure the monthly electricity

consumption of this category of households/customers, resulting in estimated billing. The resultant estimated electricity bills distributed at the end of the month to these categories of households are based on the electricity provider's comparative judgment of probable consumption. This has always become a contentious issue. The fallout of this contentious bill is what consumers referred to as "outrageous estimated billing". Put different, "outrageous estimated billing" is a situation "whereby households/customers receive electricity bills that cannot be reconciled with the monthly electricity consumption or bills that cannot be accounted for or bills for a billing cycle where electricity supplied was inadequate or never provided". The consequence of the inaccurate electricity consumption billings and outrageous billing pandemonium is that customers are contending with the travail and double tragedy of paying bills higher than electricity consumed and at the same time confronted with inadequate electricity supply and poor service delivery.

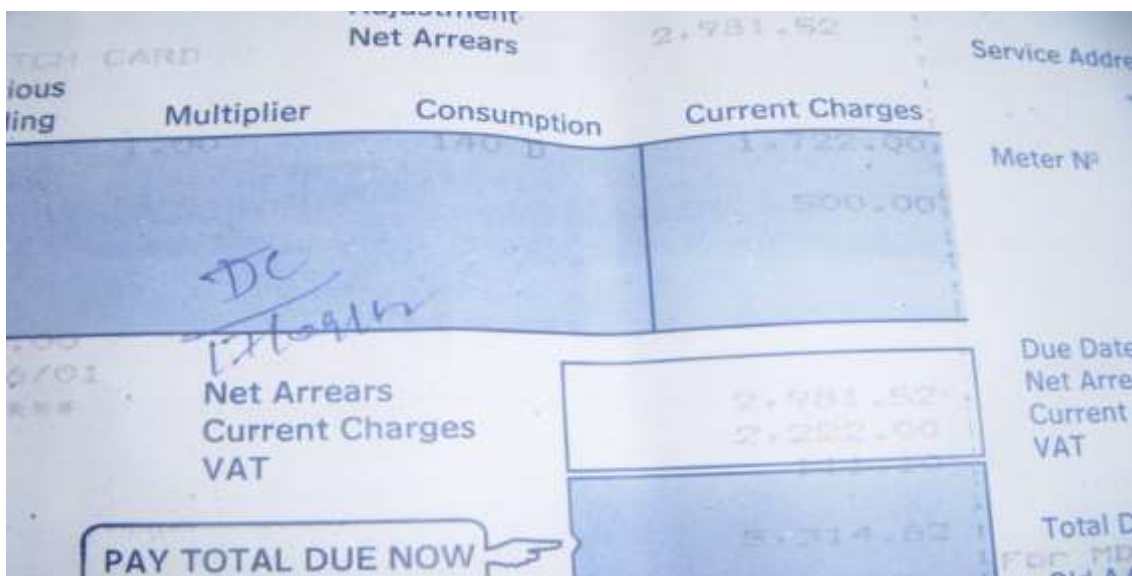


Plate 5.3: Electricity bill of household on direct connection (DC) or fixed consumption
Source: Fieldwork (2012)

During the focus group discussion, participants substantiated the several complaints concerning estimated billing and fraud perpetuated by the meter reader/officials of the electricity provider. According to one of those interviewed: "households with functional meters are indiscriminately allocated and arbitrary assigned outrageous consumption values for energy not consumed instead of reading the meters to determine their actual monthly electricity consumption". These fraudulent activities are regularly perpetrated irrespective of whether consumption takes place or not. The households in this category were those with credit meters. The complaints of these households included the fact that marketers in charge of meter reading do not read meters; and

that, even where they read the meters, the readings do not reflect the exact electricity consumptions. Many of the factors highlighted, besides the unavailability, irregular and erratic nature of electricity supply, make it difficult to state explicitly that, as households' experience a rise in income, their electricity consumption also increases. Thus, it becomes very difficult to relate and compare electricity consumption and expenditure on grid-electricity with households' monthly income. There is an increasing demand by households for basic modern energy services, but households are constantly deprived by the inadequacy and unavailability of electricity.

According to an official interviewed: "statistics have revealed that the problem of estimated billing affects over 60 per cent of the total population of electricity consumers in the country attributable to the non-provision of electricity meters. These people feel cheated paying for darkness and electricity that is never supplied nor consumed". The official further stated that: "this problem does not only cause palpable anger and frustration among electricity customers, it has consistently pitched the people against the electricity service provider (PHCN) and its employees". The most senior official of the electricity provider interviewed noted that: "the low quality, irregularity of electricity supply and the poor performance of electricity service provision is attributable to the under-funding and many years of gross neglect of the power sector by the various successive governments". He stated further that the "failure of the public energy service delivery system in the country is attributable to the monopoly of the power sector by government"...under-utilisation of total installed generation capacity. Furthermore, the insufficient supply of gas to power the thermal stations, vandalism and sabotage through constant destruction of infrastructure, and the menace of corruption that had eaten deep into the system".

According to one of the managers' interviewed: "electricity bills are a function of consumption; the utility billing system is based on energy distributed into any area, and households without meter or where the meter is bad, will have their consumption estimated because such households cannot be allowed to use electricity for free". Another official of the electricity provider, on condition of anonymity further stated that: "the bill distributed to customers without meters is habitually the unaccounted for energy received from the national grid". The unaccounted for energy in kilowatt-hour (kWh) is the unaccounted energy left after customers with functional meters (MD customers, pre-paid customers, and credit/non-MD customers) have been accurately billed based on their actual energy consumption. The remaining unaccounted energy is then shared among customers on direct connection and fixed consumption. The sharing is arbitrarily

distributed among households without meters that are on fixed consumption and direct connection (DC). This type of arbitrary billing is referred to as “estimated billing”. The statement further confirms that energy consumption in kilowatt-hour (kWh) in the study is not a true measure of consumption for households without a meter. The only exception to this contentious issue of arbitrary estimated billing is the households with pre-paid meters where electricity consumed is on a pay-as-you-go/use plan.

Another official from the electricity distribution unit of the provider claimed that: “about 80 per cent of the meters installed within customers premises had been tampered with the involvement of either electrical contractors engaged by households’ owner or meter reader/marketer from the electricity service provider”. “A number of households according to the official bypass their meters through direct connection to the grid, running it through the roof top or ceilings to the electrical loads inside their houses”. He further stated that: “meter tampering is unexpectedly common among the educated elites and very rampant among the low-income “poor” households, especially those living in the densely populated areas formed by the process of compound disintegration referred to as growth by fission” (Mabogunje, 1962). The implication is that metered consumption may be higher than unmetered electricity consumption for such households compared to households with similar characteristics of lifestyle and behaviour. The energy theft or pilferage resulting in commercial losses of revenue experienced by the electricity provider is caused by these categories of households/consumers. The official claims that: “technical and commercial losses are as high as 40 per cent and this implies the electricity distribution company are only able to collect 60 kobo (£0.0023) for every ₦1 (£0.004) of energy provided”. The “unaccounted-for energy” from energy theft by illegal connection always resulted in commercial losses of revenue and a major issue contributing to the problems of estimated billing. The absence of electricity meters and the inaccurate/non-reading of households with credit meters is one of the major causes of the problem of estimated billing.

Despite the fact that Nigerians have accepted the introduction of the pre-paid meters, the majority of the households cannot access the meters. The focus group discussants condemned the delay by the electricity service provider (PHCN) in installing meters in several residential buildings. The questionnaire respondents, the focus group discussants and the key informants interviewed displays their displeasure with the alleged “significant drop” in electricity supply and feel “defrauded” for being made to “pay exorbitantly for electricity that is never supplied”. The general belief by most households is that the electricity provider lack accurate billing management and

the billing system are exploitative. The provision and installation of meters in every household is the only way to stop the huge metering gap that leads to arbitrary estimated billing. Furthermore, the provision of pre-paid meters will guarantee a pay-as-you-consume approach in each household. It will also facilitate adequate monitoring of electricity consumed, effective management of appliances usage and promote energy efficiency appliances in every household. On the part of the electricity provider, it will reduce energy theft and commercial losses of revenue. The lack of baseline data and an efficient customer database that can identify customers based on their location is also a major problem for the electricity service provider. These shortcomings have both management and research implications to inform decision towards policy making for effective and efficient service delivery, operational planning and resource management.

5.4.2 Analysis of the Relationship between Household Expenditure on Self-generation of Electricity and Socio-economic Characteristics

The relationship between household expenditure on self-generation using generating sets and the socio-economic factors in the study area is shown in Table 5.2. The analysis revealed that socio-economic factors, such as age, gender, marital status, house ownership status and occupation were negatively and poorly correlated with the households' expenditure on self-generation and, therefore, were not factors that influenced household expenditure on self-generation of electricity. Household expenditure on generator maintenance and servicing, rating of generating sets, type of fuel, possession of a master's degree and income contributed significantly to the household expenditure on self-generation of electricity.

a) Gender

The large percentage of the patriarchy male-headed households that forms the dominance of most households in the study area is a reflection of the results of table 5.10i. The Cramer's V value 0.111 indicates the presence of a weak association between the two variables. The result revealed there is a significant relationship between the two variables (gender and households' expenditure on grid-electricity) ($p < 0.024$).

b) Age

The result of table 5.12b shows an increase of households' expenditure on self-generated with age from age 20 – 60 and then a decline in expenditure from age 61 and above. The increase in household expenditure was more noticeable from age 41 to 60. The Cramer's V value 0.162 revealed the presence of a weak association between the two variables and $p < 0.232$ indicates

there is no significant relationship between the two variables (age and households' expenditure on grid-electricity).

Table 5.11a: Gender and Households Monthly Expenditure on Self-generated (₦)

		Households Monthly Expenditure on Self-generated (₦)					Total
		1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Gender	1 = Male	178 19.8%	7 .8%	480 53.3%	15 1.7%	2 .2%	682 75.8%
	2 = Female	81 9.0%	2 .2%	133 14.8%	2 .2%	0 .0%	218 24.2%
Total		259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal		Value Cramer's V			Approx. Sig. .024		

Table 5.11b: Age and Total Amount Spent Monthly on Self-generated (₦)

		Total Amount Spent of Self-generated (₦)					Total
		1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Age	1 = 20 -30	21 2.3%	3 .3%	51 5.7%	1 .1%	0 .0%	76 8.4%
	2 = 31 - 40	50 5.6%	1 .1%	114 12.7%	4 .4%	0 .0%	169 18.8%
	3 = 41 - 50	57 6.3%	3 .3%	166 18.4%	6 .7%	1 .1%	233 25.9%
	4 = 51 - 60	65 7.2%	0 .0%	170 18.9%	5 .6%	0 .0%	240 26.7%
	5 = 61 - 70	54 6.0%	2 .2%	94 10.4%	0 .0%	1 .1%	151 16.8%
	6 = 71 - 80	12 1.3%	0 .0%	18 2.0%	1 .1%	0 .0%	31 3.4%
Total		259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal		Value Cramer's V			Approx. Sig. .232		

c) Marital Status

The results shows that 57 per cent of those married among the sampled households expended between ₦10,001 – ₦20,000 (£40 – £80) on self-generated electricity. The Cramer's V value 0.067 indicates the presence of a little or no association between the two variables. The result further revealed there is no significant relationship between the two variables (marital status and households' expenditure on grid-electricity) ($p < 0.434$).

Table 5.11c: Marital Status and Households Monthly Expenditure on Self-generated (₦)

		Households Monthly Expenditure on Self-generated (₦)					Total
		1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Marital Status	1 = Single	22 2.4%	3 .3%	72 8.0%	4 .4%	0 .0%	101 11.2%
	2 = Married	218 24.2%	6 .7%	511 56.8%	13 1.4%	2 .2%	750 83.3%
	3 = Divorced	2 .2%	0 .0%	6 .7%	0 .0%	0 .0%	8 .9%
	4 = Separated	2 .2%	0 .0%	8 .9%	0 .0%	0 .0%	10 1.1%
	5 = Widowed	15 1.7%	0 .0%	16 1.8%	0 .0%	0 .0%	31 3.4%
Total		259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal		Value Cramer's V			Approx. Sig. .434		

d) Household Size

The result of table 5.11d shows that as the number of occupants in each household increases their expenditure on self-generation of electricity decreases. About 37 per cent of Households with 1 - 4 members spend between ₦2001 – ₦5000 (£8 – £20) compared to 28 per cent of households with 5 -7 members. This could be attributable to the economies of scale factor whereby large families synergise their energy use, which possibly contribute to overall efficient household energy use and consequently lead to reduction of expenditure. The larger the sizes of

a household, the more domestic electrical appliances and the more energy they consume than smaller households. However, on a per capita basis, smaller households tend to use more energy than larger ones. This implies the total number of people in a household could be determinant factor that may affect households' expenditure on self-generated electricity. The Cramer's V value 0.123 is however unexpected as it indicates the presence of a little or no association between the two variables. The result revealed there is no significant relationship between the two variables (household size and households' expenditure on grid-electricity) ($p < 0.314$).

Table 5.11d: Household Size and Households Monthly Expenditure on Self-generated (₦)

	Households Monthly Expenditure on Self-generated (₦)					Total
	1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Household Size 1 = 1 - 4	143 15.9%	4 .4%	320 35.6%	10 1.1%	1 .1%	478 53.1%
2 = 5 - 7	94 10.4%	5 .6%	248 27.6%	6 .7%	0 .0%	353 39.2%
3 = 8 - 10	15 1.7%	0 .0%	35 3.9%	0 .0%	1 .1%	51 5.7%
4 = 11-12	7 .8%	0 .0%	10 1.1%	1 .1%	0 .0%	18 2.0%
Total	259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal		Value Cramer's V		Approx. Sig.		
		.123		.314		

e) Household Type

The result shows that 44 per cent of the nuclear family household type and 23 per cent of extended household type expends between ₦10,001 – ₦20,000 (£40 - £80) of their monthly income on self-generated. The Cramer's V value 0.325 indicates the presence of a moderate positive association between the two variables and a significant relationship ($p < 0.001$) exists between the two variables (household type and households' expenditure on grid-electricity).

Table 5.11e: Household Type and Households Monthly Expenditure on Self-generated (₦)

	Households Monthly Expenditure on Self-generated (₦)					Total
	1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Household Type 1 = Nuclear	174 19.3%	5 .6%	396 44.0%	9 1.0%	1 .1%	585 65.0%
2 = Extended	81 9.0%	4 .4%	205 22.8%	6 .7%	1 .1%	297 33.0%
3 = Single	4 .4%	0 .0%	12 1.3%	0 .0%	0 .0%	16 1.8%
4 = Shared	0 .0%	0 .0%	0 .0%	2 .2%	0 .0%	2 .2%
Total	259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal	Cramer's V		Value .325	Approx. Sig. .001		

f) Type of Building

The Cramer's V value 0.282 indicates the presence of a weak positive association between the two variables. The result revealed there is a significant association between the two variables (type of building and households' expenditure on grid-electricity) ($p < 0.001$).

g) Educational Qualifications

Table 5.10q shows 22 per cent of households with secondary educational qualification spent ₦10,001 – ₦20,000 (£40 - £80) of their income on self-generation followed by 14 per cent of households with B.Sc. qualification. The Cramer's V value 0.394 indicates there is a moderate positive association between the two variables (educational qualifications and households' expenditure on grid-electricity) and there is a significant relationship between the two variables ($p < 0.001$).

Table 5.11f: Type of Building and Total Amount Spent Monthly on Self-generated (₺)

	Total Amount Spent Monthly on Self-generated (₺)					Total
	1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Type of Building						
1 = Face to Face (Brazilian type)	159 17.7%	5 .6%	231 25.7%	1 .1%	0 .0%	396 44.0%
2 = Bungalow	51 5.7%	2 .2%	144 16.0%	12 1.3%	1 .1%	210 23.3%
3 = Flat	39 4.3%	1 .1%	172 19.1%	4 .4%	0 .0%	216 24.0%
4 = Duplex	10 1.1%	1 .1%	66 7.3%	0 .0%	1 .1%	78 8.7%
Total	259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal		Cramer's V		Value	Approx. Sig.	
				.282	.001	

Table 5.11g: Educational Qualifications and Households Monthly Expenditure on Self-generated

		Households Monthly Expenditure on Self-generated (₦)					Total
		1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Educational Qualification	1 = None	49 5.4%	1 .1%	47 5.2%	1 .1%	0 .0%	98 10.9%
	2 = Pry Six	41 4.6%	1 .1%	55 6.1%	0 .0%	0 .0%	97 10.8%
	3 = Secondary	87 9.7%	1 .1%	197 21.9%	1 .1%	0 .0%	286 31.8%
	4 = NCE	15 1.7%	2 .2%	38 4.2%	0 .0%	0 .0%	55 6.1%
	5 = OND	14 1.6%	0 .0%	41 4.6%	0 .0%	0 .0%	55 6.1%
	6 = HND	13 1.4%	1 .1%	56 6.2%	0 .0%	0 .0%	70 7.8%
	7 B.Sc.	30 3.3%	2 .2%	126 14.0%	6 .7%	1 .1%	165 18.3%
	8 = PgD	7 .8%	1 .1%	16 1.8%	4 .4%	0 .0%	28 3.1%
	9 = M.Sc.	2 .2%	0 .0%	31 3.4%	4 .4%	0 .0%	37 4.1%
	10 = PhD	1 .1%	0 .0%	6 .7%	1 .1%	1 .1%	9 1.0%
Total		259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal		Cramer's V		Value .394	Approx. Sig. .001		

h) Number of Generators

The results of table 5.10r indicate 56 per cent of the sampled households in the study area have one generating set while about 29 per cent of the households sampled do not have generators. The Cramer's V value 0.513 indicates a moderately association between the two variables (number of generators and households' expenditure on grid-electricity) and a significant relationship ($p < 0.001$) between the two variables.

Table 5.11h: Nos of Generators and Households Monthly Expenditure on Self-generated (₦)

	Households Monthly Expenditure on Self-generated (₦)					Total
	1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Nos of Generator 0	259 28.8%	0 .0%	0 .0%	0 .0%	0 .0%	259 28.8%
1	0 .0%	8 .9%	501 55.7%	8 .9%	0 .0%	517 57.4%
2	0 .0%	0 .0%	83 9.2%	9 1.0%	2 .2%	94 10.4%
3	0 .0%	1 .1%	26 2.9%	0 .0%	0 .0%	27 3.0%
4	0 .0%	0 .0%	3 .3%	0 .0%	0 .0%	3 .3%
Total	259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
		Value		Approx. Sig.		
Nominal by Nominal Cramer's V		.513		.001		

i) Ratings of Generators (Kva)

Table 5.10s shows that 46 per cent of households using 650 -1200 Kva generating sets spend between ₦10,000 – ₦20,000 (£40 - £80) of their income on self-generation while 21 per cent of households sampled spend same amount using generating sets with capacity rating between 1200 – 2500 Kva. The Cramer's V value 0.587 indicates the presence of a moderately high association between the two variables. This result revealed a significant relationship ($p < 0.001$) between the two variables (generator ratings and households' expenditure on grid-electricity).

Table 5.11i: Ratings of Generators and Households Expenditure Monthly on Self-generated (₦)

		Households Expenditure Monthly on Self-generated (₦)					Total
		1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Ratings of generator (Kva)	0	259 28.8%	0 .0%	0 .0%	0 .0%	0 .0%	259 28.8%
	1 = 650 -1200	0 .0%	7 .8%	417 46.3%	1 .1%	0 .0%	425 47.2%
	2 = 1201 – 2500	0 .0%	1 .1%	185 20.6%	4 .4%	2 .2%	192 21.3%
	3 = 2501 – 5000	0 .0%	1 .1%	8 .9%	6 .7%	0 .0%	15 1.7%
	4 = Above 5001	0 .0%	0 .0%	3 .3%	6 .7%	0 .0%	9 1.0%
Total		259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
		Value		Approx. Sig.			
Nominal by Nominal Cramer's V		.587		.001			

j) Occupation

Table 5.10t show that 31 per cent business owners spend between ₦10,000 – ₦20,000 (£40 - £80) on self-generation using generating sets followed by 13.4 per cent of civil servants and 13.2 per cent of those in private business. The Cramer's V value 0.206 indicates the presence of a weak association between the two variables. The result revealed there is a significant relationship between the two variables (occupation and households' expenditure on grid-electricity) ($p < 0.001$).

Table 5.11j: Occupation and Households Expenditure Monthly on Self-generated (N)

		Households Expenditure Monthly on Self-generated (N)					Total
		1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Occupation	1 = Civil Servants	34 3.8%	1 .1%	121 13.4%	4 .4%	0 .0%	160 17.8%
	2 = Private	32 3.6%	1 .1%	119 13.2%	10 1.1%	1 .1%	163 18.1%
	3 = Business Owners	141 15.7%	5 .6%	278 30.9%	3 .3%	1 .1%	428 47.6%
	4 = Artisans	52 5.8%	2 .2%	95 10.6%	0 .0%	0 .0%	149 16.6%
Total		259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0%
Nominal by Nominal		Cramer's V			Value .206	Approx. Sig. .001	

k) Income

The result of table 5.10v indicates 57 per cent of the households in the lower-income category of and 30 per cent of households in the low-income category expend between N10,001 – N20,000 (£40 - £80) of their income on self-generation using different types of generating sets. This is exclusive of households without generators. The amount expended by these two categories of households represents between 25 – 60 per cent of their monthly income. The implication is that most of the urban poor households' disposable income is being spent on their daily energy needs via self-generation of electricity. This represents an opportunity cost at the expense of other households' needs and in so doing increases poverty. The Cramer's V value 0.350 indicates the presence of a moderate positive association between the two variables (average monthly income and households' expenditure on grid-electricity) and the relationship is statistically significant ($p < 0.001$).

Table 5.11k: Income and Households Expenditure Monthly on Self-generated Electricity ₦

		Households Expenditure Monthly on Self-generated (₦)					Total
		1 = No Generator	2 = 1000 – 10,000	3 = 10,001 – 20,000	4 = 20,001 – 30,000	5 = 30,001 – 50,000	
Av. Monthly Income (N)	1 = 10,000 – 50,000	209 23.2%	8 .9%	367 40.8%	3 .3%	0 .0%	587 65.2%
	2 = 51,000 – 100,000	41 4.6%	1 .1%	195 21.7%	6 .7%	0 .0%	243 27.0%
	3 = 101,000 – 250,000	7 .8%	0 .0%	44 4.9%	7 .8%	1 .1%	59 6.6%
	4 = 251,000 – 500,000	2 .2%	0 .0%	7 .8%	1 .1%	1 .1%	11 1.2%
Total		259 28.8%	9 1.0%	613 68.1%	17 1.9%	2 .2%	900 100.0 %
Nominal by Nominal		Value Cramer's V		Approx. Sig. .001			

Furthermore, a multiple regression analysis was carried out and the result produces a regression model that was significant, which means that there was a significant relationship between household expenditure on self-generation of electricity and socio-economic characteristics. The goodness of fit of the regression model $r^2 = 0.966$ (96.6per cent) and adjusted $r^2 = 0.965$. This relationship was significant ($F_{11,873} = 2230.88$, $P < 0.05$) and standard error of 1144.66. There was a strong correlation ($r = 0.770$) between those who had more than one generator and the rating of the generator. This implies that households with more than one generator tend to buy higher-rating generator in addition to small generating sets to complement the smaller ones. There was also a positive correlation between income and generator ownership, even though it was not as strong as expected $r = 0.188$. Furthermore, to avoid the problem of multicollinearity, “price of petroleum products/fuel (petrol/diesel)” was recoded as a nominal variable to “type of fuel” since this had a linear relationship with another variable in the datasets. In addition, “generator rating” was included with reference to households without generator.

The interaction between income and generator rating was included in the regression analysis and the regression model is given as:

$$\text{Self-generation} = 96.7 + 1.7(\text{Amount spent on servicing}) - 448(\text{Msc}) - 259(\text{Household 5-7}) + 9413(\text{Type of fuel}) + 11035(\text{GenRating1}) + 10143(\text{GenRating2}) + 10197(\text{GenRating3}) + 15775(\text{GenRating4}) + 0.16(\text{IncomeGenRating2}) + 0.02(\text{IncomeGenRating3}) + 0.051(\text{IncomeGenRating4})$$

Table 5.12: The correlation between socio-economic variables and household monthly expenditure on self-generated electricity

Nos	Socio-economic Variables	Household monthly expenditure on Self-generated
1.	Age	-.030
2.	Household Size	.039
3.	Household Type	.057
4.	Type of Building	.241
5.	Educational Qualification	.311
6.	No of generators	.770
7.	Rating of generators	.814
8.	Daily hours of generator usage	.736
9.	Expenditure on generators servicing and maintenance	.988
10.	Average Monthly Income	.289

Source: Results of analysis computed from fieldwork (2012)

Among the sampled respondents, there was a correlation between average monthly income and household total monthly expenditure on the grid and self-generated electricity. Although the correlation coefficient was weak, it was positive ($r=0.302$ and $r^2=0.373$, $P<0.05$). The result showed that the average income might influence expenses/budget on the total grid and self-generated electricity. The result was not unexpected because increases in income will likely lead to additional purchases of households' electrical appliances, which will also lead to an increase in both electricity consumption and household expenditure on grid electricity and self-generated. The poor reliability of the grid has often resulted in households providing alternative energy source to satisfy their energy services demand and desire. Therefore, it is not surprising to see households using a mix of energy sources from traditional to transitional and modern energy source to satisfy their energy demand and desires as the need arises. The unavailability and inadequate supply of electricity consistently forced households down the energy ladder resulting

in the use of kerosene stoves, lantern and candles to meet the basic cooking and lighting needs in the absence of generating sets.

The results of table 5.11a – 11k and 5.12 shows that the ownership of generating sets irrespective of socio-economic status cut across households and income as a determinants affected the type, kind and ratings of generators. Some households had high power-rating generators, while at the same time possessed one or more additional generating sets with low-power ratings. The ownership of more than one generating set, as clarified among the key informants interviewed, is to complement one another and provide a backup in order to prolong the lifespan of the generator. The use of generating sets is restricted to the voltage/power-carrying capacity and the power ratings of the electrical appliances in the households. Most households used the generators mostly to illuminate their houses (lighting), cooling with electric fans, and for recreational purposes (watching of television). The power rating of households generating sets is another factor that affects household expenditure on self-generation of electricity. It is pertinent to state that as the rating of the generator increases the amount spent on self-generation also increase. In addition, as the number of hours generator usage increases, households' expenditure on self-generation and maintenance and servicing of generating sets also increases. The higher the power rating of generating sets, the higher the cost of fuelling and the higher the maintenance/servicing costs. An increase in the pump price of petrol and diesel will equally lead to an increase on households' expenditure on self-generation of electricity using petrol or diesel powered generators. Therefore, the continuous hike/rise in the prices of petroleum products will influence negatively households' disposable income and expenditure, which will, in turn, affect other basic needs of life. The price of petroleum products appears to have an influence over households' choices and spending patterns. The chairman of the Ifesowapo landlord/tenants association reiterate the fact that despite government efforts at subsidising petroleum products (petrol and kerosene), the fraud perpetrated by the independent oil marketers often results in artificial scarcity and frequent hike in the prices of the products. This has not permitted households, particularly those at the bottom of the social ladder, to enjoy the benefits of the subsidy. The uproar, violent protests and condemnation that accompany the attempt to remove the subsidy is because it could further impoverish the economic well-being of the common Nigerian. This usually has a negative effect on the disposable income of households as more income is expended on self-generation of electricity and maintenance of generators.

The focus group discussions revealed that: “unavailability of electricity supply determines the frequency of usage of generating sets and invariably determines its prolonged existence. The erratic electricity supply has often times led many children of households without generators to visit neighbouring households to watch important programmes on television”. These children would otherwise have to pay money at viewing centres to watch such interesting programmes, such as the English premier, LA-Liga or UEFA champions’ league whenever there is power outage. Most often, the benefits that accompany the provision of energy services are lacking. The focus group discussants noted that the volume and diversity of using generators in powering household appliances is restricted to the voltage-carrying capacity or power ratings of the generators and that of households electrical appliances required to power. The FGD revealed that: “at such instances, the high energy consuming home appliances must be switched off before or when using the low power ratings generators”. This illustrates how households could be rational in their decisions and diversify their energy profile.

Furthermore, households in the medium and high-income categories are more likely to have more electrical appliances in their houses that consume more electricity than the low-income earners. Generating sets that can power high energy-consuming appliances are very expensive and only found in the residence of high-income earners. The type of generators (Tiger 650VA and TG 950) common among households in the study area cannot power high energy-usage household appliances, such as pumping machines, refrigerators, washing machines/clothes dryer, pressing irons and air-conditioning system. One of the volunteered women interviewed who happens to be a school teacher (Plate 5.4) asserted that for her to use the TG 950 generator to pump water, she had to switch off all other electrical appliances in the house, whereas there are no such limitations with grid-electricity. Another example of serious concern given by the woman is that: “women of households without generators or those with low generating capacity (Tiger 650VA) are habitually forced to draw water from water wells in the absence of electricity supply”. In addition, appliances, like refrigerators, which are available almost in all households, require 24 hours’ constant supply of electricity for food preservation. Refrigeration provides cold storage required to keep food fresh and prevent any wastage. According to one of the key informants interviewed: “most often times such food items meant for storage in the refrigerator got spoilt due to frequent power outage combined with low voltage”. These necessitate frequent visitations to the market by women because they are afraid of keeping large volume of food stored in the refrigerator due to the low quality and irregularity in electricity supply. Most households whose generators can power their refrigerators are continually forced to use the generator and, in most cases, for a longer

period of time for food and groceries storage and preservation. This, according to those interviewed, usually has a significant effect on household disposable income, the longer the duration of switching on the generator, the larger the quantity of petrol/diesel consumed by the generator. Running the generator for a longer period is at the expense of other household basic needs.

The multiplier effects of the poor reliability of the grid resulting in self-generation of electricity by a large number of households are enormous as they adversely affect household disposable income and the environment at large. The poor reliability of the grid usually forced many households to spend a significant proportion of their disposable income powering their generators especially when there is an increase or hike in the prices of petroleum products and during the artificial scarcity of petroleum products created by the petroleum/oil marketers. The adversity is usually more evident on households' disposable income during such times as it represents an opportunity cost borne out of the desire for modern energy services at the expense of other household's basic needs. The degradation effects on the environment also becomes more prominent because the higher the percentage of generator users the greater the consequences on the environment and on human health, especially in terms of air, noise and water pollution, carbon monoxide (CO) emission, and effluent discharges from the generators into the environment.



Plate 5.4: Interviewing of one of the female volunteers

Source: Fieldwork (2012) – Permission granted for photograph to be taken

Households' residential density is a key segment of the urban spatial structure. According to Carter (1972), the categories used in identifying residential areas/neighbourhoods have been grouped into two, namely: environmental features/characteristics of residential areas and socio-economic structure of residential areas. The categorisation of residential areas in the study is based on the socio-economic structure, composition and aggregation of residential buildings. This is characterised by the total number of houses within an acre representing the density and a reflection of the socio-economic status of people within the area. The study area was grouped and classified into three residential densities as illustrated in Figure 5.3.

The pattern of clustering of the buildings in the study clearly distinguished households' residential densities with the high-resolution satellite imagery of the study area. The high-resolution satellite imagery provides a bird eye-view and a backdrop to the households' residential densities in the study area. Therefore, analysing the spatial distribution of socio-economic variables, such as income, education, occupation, size of household and household expenditure on grid-electricity was then made possible. Further analysis and observations from the high-resolution satellite imagery of the study area showed that households in the lower-income category of ₦10,000 to ₦50,000 (£39.06 - £195.31) were within the high-density residential area. Those earning above ₦100,000 (£390.62) were found within the low to medium-density residential areas. However, it is sometimes difficult to establish a clear-cut line of demarcation between the low, medium and high densities residential areas due to the co-habiting nature of people of different social status within and around some residential areas. The results of field survey analysis indicate that the high-income earners were mostly located in low-density residential area of the study (Figure 5.3).

Spatial analysis of datasets on households' energy usage and consumption provides an insight into how energy use varies among income groups and residential densities. The analysis further revealed electricity consumption by households in the low-density residential areas is higher than the medium to high-density residential area (see Figure 4.5). These could be attributed to income as majority of the respondent's households in the high-income category resides within the medium to low-densities residential areas. Other factors that contributed to higher electricity consumption among the high-income and the low-density residential areas are longer duration (hours) of daily supply of electricity and ownership of electricity consuming electrical appliances such as washing machine, microwave etc. Furthermore, one of the officials of the electricity provider interviewed (see plate 4.10) further explained that: "preference and priority are usually given to low-density residential areas due to the high number of educated people and very

important personalities residing within the neighbourhood with a history of regular payment”. According to the official, the longer hours of electricity supply regularly translate to increase in revenue generation and collection from people living in such areas by the electricity provider. This presupposes that the unreliability of electricity supply will worsen for the high-density residential areas, especially where revenues are low among the urban poor households.

5.5 Investigate and analyse the barriers associated with access to electricity and the problems of non-payments of electricity consumed

The focal point of the remarks from the questionnaire administered, focus group discussants and key informants interviewed was the unreliability of supply of electricity to non-provisions of basic infrastructure, like electricity meters, distribution transformers, and distribution service poles. Additionally, the prompt connections of customers to the national grid are some of the highlighted barriers hindering access to electricity by households in the study area. In addition, are the bureaucracy, behavioural attitude and extortion tendencies of some of the electricity officials in the technical (distribution) and marketing units of the electricity service provider before connecting households to the national grid are another difficulty hindering access to electricity connection.

Furthermore, many households suffer neglect when basic infrastructure like distribution transformers break down, becomes faulty, damaged or overloaded. The focus group discussants decried a situation whereby households in a locality or neighbourhood have to impose levies or payments among themselves for the purchase or repair of infrastructure/facilities like transformers, service poles, conductor cables, and power lines that ought to have been provided by the electric provider/utility company. The provision of basic social infrastructure, such as distribution transformers, electric poles and conductor cables, should be the sole responsibility of the electricity provider/utility company.

The inadequacy and unreliability of electricity services provision to meet the energy services needs and desire of households are a major factor affecting the non-payment of electricity consumed by some of the households. The research findings revealed that there was no correlation between electricity supplied to households, the quantity of electricity consumption in kilowatts-hours (kWh) by households and electricity bills distributed to households at the end of the month in monetary terms.

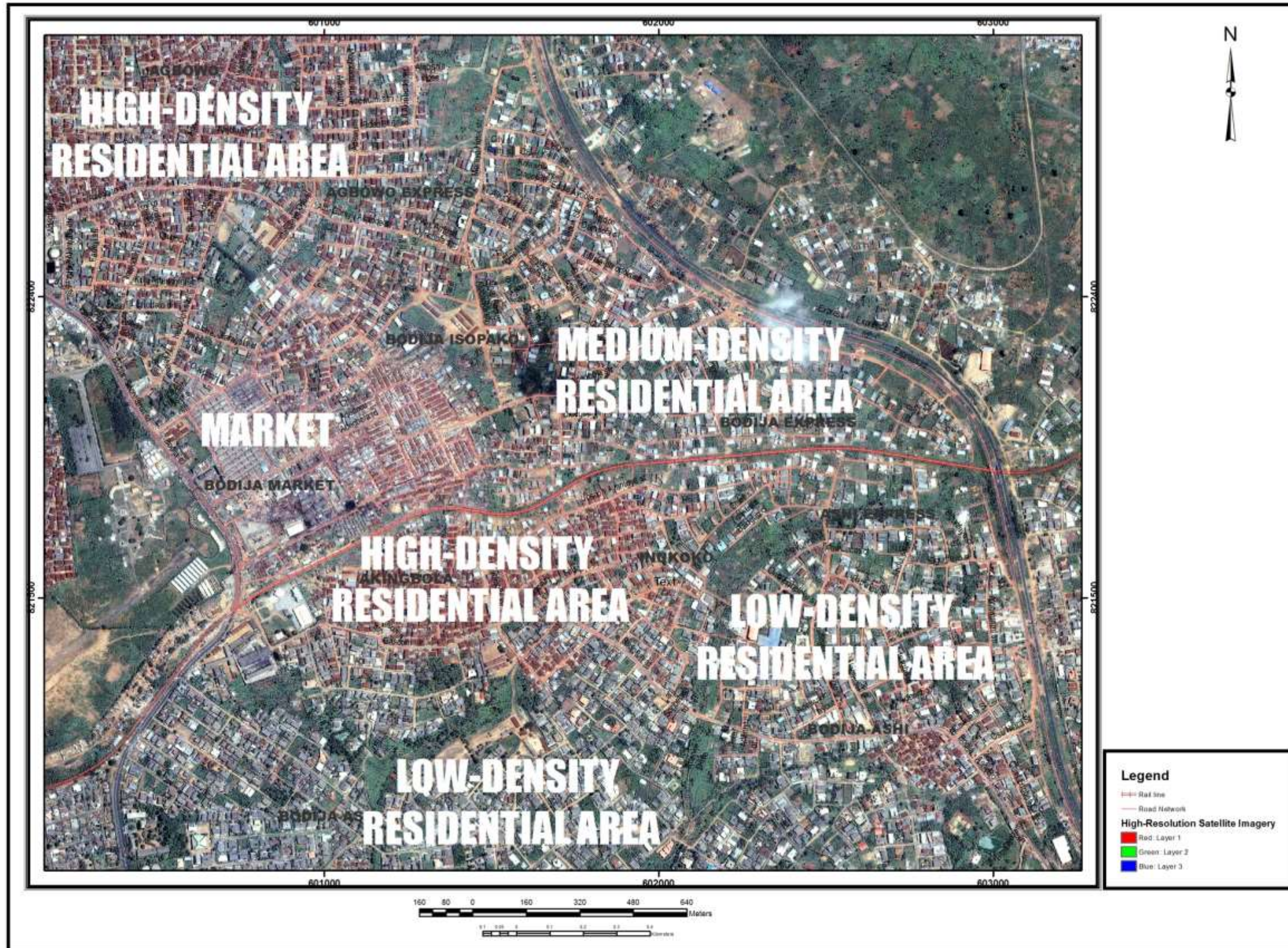


Figure 5.3: Residential Densities of Study Area

The above-mentioned has seriously affected the willingness of households towards payment for electricity consumed. The common concern among the households sampled, the focus group discussants and key informants interviewed was that electricity bills distributed at the end of the month were not a true reflection of the electricity supplied and consumed. The effect of over-billing of customers owing to the non-provision of meters is a major contentious issue. Metering all customers will overcome the problems associated with the frustration of contentious bills arising from estimated billing. Majority of the households sampled showed the readiness and willingness to pay for an improved supply of electricity provided the government could guarantee a regular and uninterrupted supply of electricity; provide electricity meters preferably pre-paid and charge them in a way that is commensurate to the electricity supplied and consumed.

The common consensus reached among the focus group discussants and key informants interviewed is that: “pre-meters should be provided to all households. Meter reader/officials of the electricity provider should accurately read credit meters where available and what are read must be reflected in the electricity bills presented to consumers and not dubious and scandalous bills to already distraught consumers”. The majority of households sampled, focus group discussants and key informants interviewed all expressed the readiness and willingness to pay for quality and an improved electricity provision sustained by efficient service delivery.

5.6 Energy Poverty Assessment in the Study Area

The term “energy poverty nexus” can be described as the connection between the inadequate energy situation and the despairing socio-economic living conditions faced by most people in developing countries. The insufficient and unreliable nature of electricity supply impacts negatively on the social well-being of households, limiting their ability to expand their activities, to be competitive, or to create new socio-economic activities. Electricity is critical for providing basic social services and the lack of reliable and affordable energy services is a major setback in the socio-economic activities and productivity of households. Consequently, the level of energy services availability in households and the estimation of basic electricity needs of a typical household is the most appropriate approach to energy poverty assessment.

The fact that all households are connected to grid-electricity indicates that “access” is not the problem in the study neighbourhood. Rather, it is the limited amount of time of electricity supply and duration of electricity availability that are major impediments towards fulfilling households’

energy services demand, as revealed in the number of hours per day and number of days per week of electricity availability (refer to Table 4.9). The overall importance of sufficiently providing modern energy services for households' productivity in the process of human and economic development cannot be ignored. The results of the research findings revealed an average monthly electricity consumption of 142kWh by households (refer to section 4.2.3). Energy services have noticeable and tangible consequences for the quality of day-to-day life in developing countries. The role played by and the impact of electricity on households' income-generation and spending, education, health, and the environment are unparalleled. The social and economic hardship suffered by most households because of the unavailability of electricity in substantial quantity and reliable quality is the bane of energy poverty in the context of this study. This often resulted in households spending a larger part of their income in providing an alternative off-grid solution (Table 5.13). The high cost of fuelling the generator made life unbearable for average residents in the area while many of the residents whose means of livelihood depended on electricity resorted to power generating sets to drive their businesses.

Table 5.13: Daily household expenditure in Naira (₦) fuelling generating sets

Amount in Naira (₦)	Number of Respondents	%
0 - 1'000	572	63.6
1'001 - 2'000	45	5.0
2'001 - 4'000	12	1.3
Above 4000	12	1.3
No generator	259	28.8
Total	900	100

Source: Fieldwork (2012)

The data analysis showed that, 71 per cent of the households (see Table 4.13) used various kinds of generating set to complement and compensate for the inadequacy of grid-electricity. Most households are bedevilled with the responsibility of generating their own electricity. The hazards of the resultant pollution of the atmosphere and environment with the toxic carbon monoxide that these generators emit to both the human body and the ozone layer cannot be over-emphasised. The monthly household expenditure provided an insight into the financial burden of self-generation of electricity on households' disposable income. The inadequacy of electricity in the required quantity and quality often resulted in many households falling into the

energy poverty category while providing alternative off grid-solution using generators as an alternative source. The attendant cost of using generators is most times unbearable, considering the numbers of hours generating sets are put to use on a daily basis (see Table 4.12).

The price of petroleum products (gasoline and diesel) and the cost of maintenance and servicing of generating sets are part of households' expenditure on self-generation provision. The official pump prices of petrol and diesel at the time of this survey were ₦97 (£0.38) and ₦160 (£0.62) per litre respectively, while electricity consumed by households was billed at ₦12.30 (£0.05) per kilowatt-hour (kWh). This means an increase in the price of petroleum products will result in an increase in households' expenditure on self-generation of electricity and thereby inflict more financial burden on households' income. The lack of adequate provision of electricity in meeting households' energy services demand results in a low standard of living among households in sub-Sahara Africa. The low-income earners are usually the most affected and they always find themselves at the bottom of the energy ladder (refer to Figure 5.2).

The energy-poverty connection shows exactly how an insufficient energy provision constrains the capabilities of the poor and contributes to their misery. The incidence of energy poverty is predominantly high among the poor particularly those with low-income. As one would expect, the proportion and percentage of the household disposable income expended on energy services by the lower and low-income earners (poor families) is greater than that of the high-income households. The difference is evident (refer to Figure 5.2). However, the dissatisfaction caused by the inadequate provision of electricity is felt across all households as revealed in the general comments made by each household in Table 5.14.

Table 5.14: Summary of comments by households

Summary of comments	Number of Respondents	%
No regular Supply/low Voltage	46	5.1
No regular Supply/Inaccurate Bill	802	89.1
No regular Supply/Overloaded Transformer	18	2.0
Regular supply	34	3.8
Total	900	100.0

Source: Fieldwork (2012)

The 3.8 per cent respondents that indicated regular supply of electricity were those households that lived within the locality that experienced unprecedented regular supply from the grid because of increase in the electricity generation at the time of the survey. They were the last set of households to be sampled. The analysis further showed that with adequate and reliable provision of electricity, the percentage of households in the energy poverty level would be insignificant. The sufficient provision of electricity and improved electricity supply will provide adequate access to energy services and significantly improve the living standards and lessen the burden on the disposable income and budgets of poor households.

5.6.2 Nature and Implications of Energy Poverty in the Study Area

The nature of the energy poverty phenomenon varies across countries and the context within which it is being described and defined likewise differs. Nevertheless, it is the lack of access to electricity. However, in the context of this study, it also relates to the inadequate provision of electricity in substantial quantity and reliable quality in fulfilling households' desire for energy services and the resultant households' expenditure on the provision of an alternative off-grid solution. Energy poverty is caused primarily by inadequate provision of electricity, making households to provide an alternative off-grid solution to compensate for the inadequacy in order to satisfy their demand for services provided by electricity. The resultant effect of self-generation of electricity on households' income is the consequences of energy poverty, as described in the energy poverty index map (Figure 5.4). The map provides a geospatial representation of the distribution of percentage of households' income expended on electricity (grid and self-generation).

The energy poverty index (EPI) map of the study was cartographically designed and the output generated based on the percentage of household monthly expenditure on electricity (grid and self-generation) as against average household income. The energy index map ranked the households sampled in the study neighbourhood by comparing all households to one another based on percentage of households' income expended on grid and self-generated electricity. The energy index map further provided an insight into the spatial distribution of energy poverty across the residential densities in the study neighbourhood. Spatial analysis of datasets on households' expenditure on electricity (grid and self-generated) revealed a number of high spending on electricity among the households with no significant pattern across the different residential densities. The EPI shows that households in the lower-income ₦1 – N50,000 (£0.004 - £200) and

low-income category ₦50-0001 – ₦100,000 (£200 - £400) are not only the most energy poor group but also have the highest number of the energy poor households. The high-income group from ₦250,001 (£1000) upwards are not only relatively least energy poor group but have the lowest percentage of expenditure on electricity consumption compared to lower, low and middle-income group ₦100,000 – ₦250,000 (£400 - £1000). The implication is that the middle to high-income households spends a smaller proportion of their household expenditure (income) on electricity, while the urban poor (lower and low-income) households spend a significant amount of their income, in some cases as high as 20–60 per cent on both grid and self-generated electricity.

The insufficient provision of electricity is most critical as the majority of households now rely on inefficient, polluting and health-threatening petroleum products, such as kerosene/paraffin, for lighting and cooking desires or petrol/diesel for self-generation of electricity. Thus, most households are frequently forced lower down the bottom of the energy ladder. This has a negative impact on household disposable income. The resultant effect on school children especially those without generating sets is that they are usually forced to use kerosene/paraffin lamps/lantern or candles to study for longer hours. In contrast, children of households with generators ownership are restricted to the duration of time the generators are switched on. The effect is the lack of motivation and convenience of getting their work done; resulting in decline in the number of hours in achieving improved school performance, as mentioned during the focus group discussions and interviews conducted.

This analysis has demonstrated that the lack of a reliable supply of electricity from the grid and the unavailability of electricity in substantial quantity and reliable quality are key influences on the level of energy poverty experienced in the study area. The level of deprivation, as a consequence of the level of service provision and delivery of electricity, often results in the decline in socio-economic activity within households' and incapacitates people's ability as human beings. The benefits and convenience derived from the services associated with the use of electrical appliances are often times lacking. This implies that households are unable to improve their lot in life and thus fall into the energy poverty category linked to a loss in quality of life. It contributes to poor living conditions and overall health, and exacerbates poverty. The adequacy of quantity and reliability of quality of the energy services individuals enjoy provide a good measure of their well-being; improve productivity and income-earning potential, and contribute to the overall quality of life. Energy poverty can be perceived as a failure to achieve certain basic capabilities, arising in

part from the absence of services provided by electricity. The unavailability and inadequacy of electricity supply culminate in the shortfall and huge deficit of electricity demand, with their attendant effects on the social-well-being of households. Government has not been able to proffer an appreciable solution through policy formulations and implementations to alleviate the suffering of the citizenry, especially as it affects the commercial, social and economic activities of households.

5.7 Summary

The main aim of this chapter was to analyse the underlying social processes and the implications of the nature of electricity delivery for urban energy poverty in the study area, as indicated in research objectives two, three and four. A cross tabulation and multiple regression analysis was conducted to examine, identify and provide explanation in respect of the different socio-economic characteristics that could influence electricity consumption and households' expenditure on the grid and self-generated electricity. The results of the analysis of questionnaire administered, the qualitative analysis of focus group discussion and key informant interviews were used to explain the outcomes of the statistical analysis. The results of the cross tabulations and multiple regression analysis indicated that household income was not the only factor for grid and self-generated electricity consumption. Rather, factors like behaviours, lifestyles and external factors relating to electricity supply played a decisive role too. These external factors are social, economic and cultural forces that drive certain energy use patterns or that shape households' decisions on energy use pattern. These regrettably determine the climbing up or down of households on the energy ladder, resulting in the use of a mix of energy sources in fulfilling households' energy services demand and desires.

The results of the cross tabulations of socio-economic characteristics (independent variables) and dependent variables of household expenditure on grid and self-generated electricity were significant in most cases particularly with gender, age, household size, educational qualifications income, number of generators and ratings of generators. However, this result does not show any distinguishable pattern across the households sampled in the study area. The regression analysis of the data with the 'household expenditure on grid consumption' as dependent variables gave a low goodness of fit $r^2 = 0.111$ (11.1per cent) and adjusted $r^2 = 0.104$ but the overall relationship was significant ($F_{7,892} = 15.929$, $P < 0.05$).

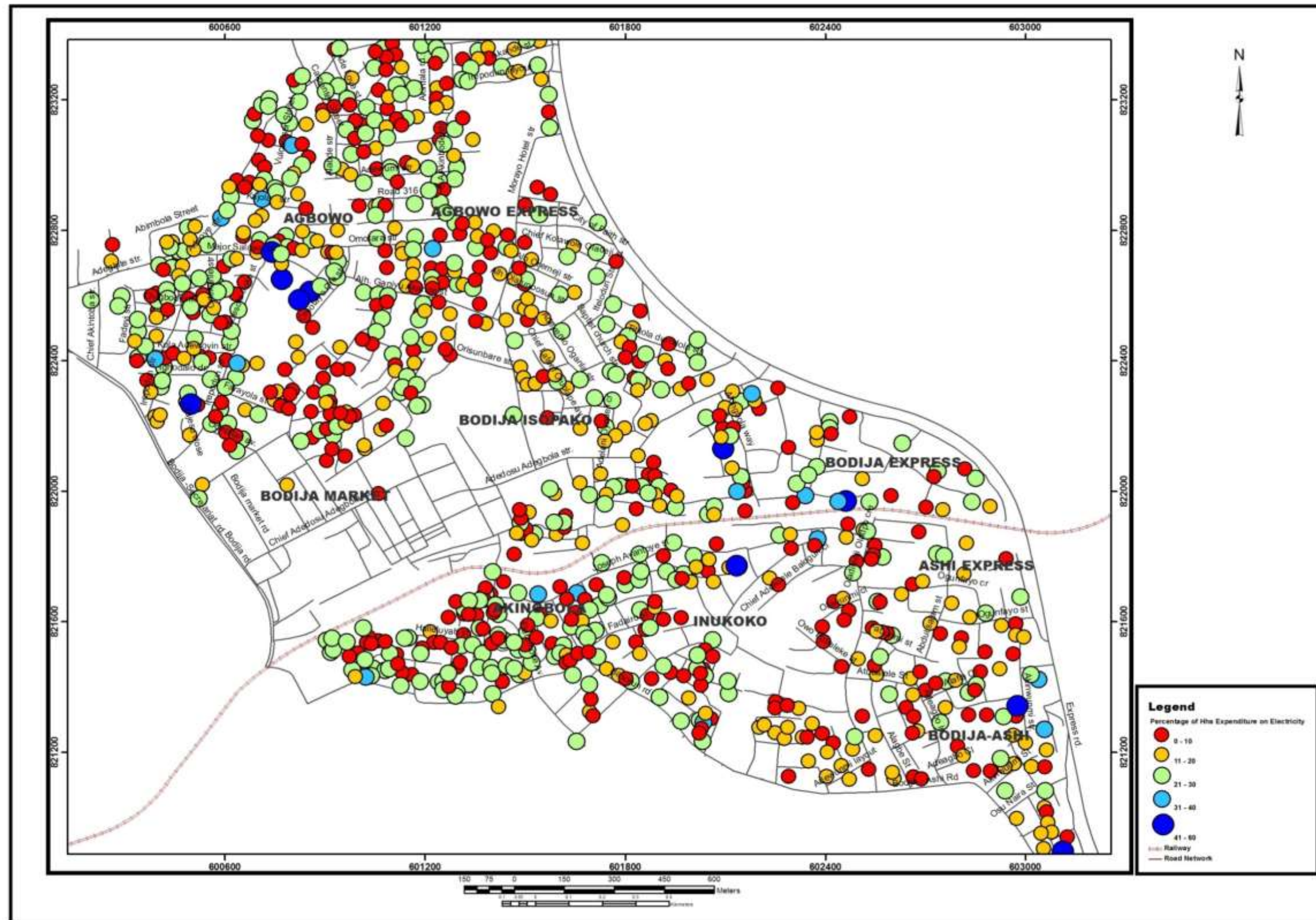


Figure 5.4: Energy poverty index map of the study area

The results of the regression analysis returned a very low r^2 . The low r^2 is attributed to a number of factors; among them is the estimated billing arising from estimated consumption as a result of the non-provision of electricity meters to accurately measure electricity consumption at the residential premises of consumers. The low average consumption of 142kWh grid-based electricity by households contributed to the low r^2 as a result of inadequate provision of electricity. The frequency of generator usage confirmed the unavailability and insufficiency of electricity in the required quantity and quality necessary to promote a basic healthy standard of living and economic growth. The implication of this is that access to electricity and modern energy services was not the problem in the area but the quality and reliability of electricity supply. The result of the regression model of the 'household expenditure on self-generated electricity' was significant, which means that there was a significant relationship between household expenditure on self-generation of electricity and socio-economic characteristics. The analysis returned a very high goodness of fit of the regression model $r^2 = 0.966$ (96.6per cent) and adjusted $r^2 = 0.965$. This relationship was significant ($F_{11,873} = 2230.88$, $P < 0.05$) and the standard error was 1144.66. The outcome of the focus group discussion and interview pointed to the fact that the ownership and use of generators by households did not depend on income; it was a matter of economic reasons or preference.

Households income affects the type, kind and ratings of generators as they come in different shapes, sizes and prices and affordable for many across the economy divide. There was a strong correlation ($r=0.770$) between those who had more than one generator and the rating of the generator. The rating of generating sets was a major variable that affected household expenditure on self-generation of electricity. As the rating of generator increases, households' expenditure on self-generation also increases. An increase in the pump price of petrol and diesel will correspondingly lead to an increase in households' expenditure on self-generation of electricity with a resultant burden on households' disposable income/finances. The unavailability of electricity in the required quantity forces many households down the energy ladder in their quest to fulfil household modern energy services desire, particularly the households without generators.

The three residential densities of the study area were classified based on the socio-economic structures and patterns of clustering of the buildings in the residential areas. The lower and low-income households were within the high-density residential area, while the medium and high-income households were located in the low-density residential area of the study (see Figure 5.1).

The households' energy usage and consumption indicated some high levels of electricity consumption in the area with low-density residential areas than the other medium and high-density residential areas. The willingness to pay for an improved electricity supply spread across all categories of households on the condition that government can provide and guarantee an adequate and reliable supply of electricity.

A comparative analysis of grid-based electricity connection with off-grid self-generated electricity was accentuated. The use of generating sets was very apparent in the study area, indicating that generator ownership has become a necessity. Some households had up to three different generating sets as back up as a result of low quality of electricity, characterised by erratic electricity supply. The findings of the study corroborate the assertion that the Nigeria's economy is a "fuel generator economy" and an indication of the failure of the public energy service delivery system, where households and businesses incur extreme overhead cost in maintaining their generators. The financial burden on the already impoverished households' disposable income from the incessant and daily usage of generating sets is a major contributing factor to the energy poverty in the study area. The study identified grid-electricity provision as an economic lifesaver, not requiring any form of maintenance nor environmental implications or hazard associated with it compared to health and environmental implications of the poisonous gases of carbon monoxide (CO), the associated carbon footprints and effluent discharges that continually accompanies the continual use of generating sets.

This study also confirmed that energy poverty existed in the study area. The degree and magnitude of energy poverty was cartographically represented and the map output presented as energy poverty index map based on percentage of households monthly expenditure on grid and self-generated electricity relative to households' disposable income. The importance of the energy index map is not only to prove that energy poverty exists but also to show the magnitude of energy poverty and identify where it exists. Therefore, the adequate provision of affordable and reliable electricity is essential for households' productivity and economic growth, a requirement for ensuring sustainable development, reduction of emissions of harmful substances and poverty alleviation.

CHAPTER SIX

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter discusses the research findings. It links the findings to previous research in relation to the objectives of the study. The chapter consists of two parts, the discussion and the conclusion. The discussion of the major findings of this research centres on the four research objectives that addressed the aim of the study. The chapter discusses each of these research objectives in turn. Section 6.2 centres on the nature of electricity delivery in the study area based on the research objective one, while section 6.3 discusses the underlying social processes and the implications of the nature of electricity delivery for urban energy poverty around the research objectives two, three and four.

The second part, the conclusion, starts by summarising the key findings of the thesis, with a view to highlighting the policy implications of the research for theory and practice purpose. The contributions and limitations of the research are discussed in section 6.5. Section 6.6 highlights the policy implications and section 6.7 recommends policy options for the strengthening of the national grid in Nigeria to ensure a more efficient and effective electricity service delivery as well as the steps necessary to close the huge infrastructure, energy and metering gaps. The last section (6.8) offers suggestions as to potential areas for future research and gives an indication of further work to be done to expand the scope of this thesis.

6.2 The Nature of Electricity Delivery in the Study Area of Ibadan

6.2.1 Research Objective One: to analyse electricity delivery as a way of understanding the spatial issues of demand, supply and consumption in the study area.

As indicated in chapters four and five, a household's size has a significant influence on energy services and demand is driven by the desire to achieve a decent standard of living and fulfil the basic energy services requirements for socio-economic development. The demand for energy services by households in the study area are predominantly for cooking, lighting, cooling, refrigeration, laundry and ironing, entertainment (recreation and communications) and water heating. These energy services are delivered and satisfied in a number of different ways using

different choices of energy sources, either through traditional biomass or by “modern energy services” delivered by electricity. The research findings indicate that energy services demand varies across households in the study neighbourhood and the same services can be delivered using different energy sources based on choice, affordability and availability. For instance, cooking and water heating are achieved using biomass, kerosene (paraffin) stoves, liquefied natural gas (LPG) and electricity; however, lighting can also be achieved with kerosene lantern, candles and electricity. The use of biomass and kerosene (paraffin) stoves for cooking is common amongst the urban “poor” households, particularly those in the high-density residential areas. Biomass can become an essential commodity during periods of scarcity when there is a hike in the price of kerosene, especially among the urban “poor” households that depend solely on kerosene for cooking. The average family in the middle class and in the wealthy “high-income” class utilises LPG for cooking. The use of biomass for cooking by the middle and high-income classes are mainly for cultural reasons particularly during important anniversaries, such as naming, birthday, wedding and burial ceremonies, which require a large quantity of food.

Electricity is unarguably a more flexible and an efficient means of satisfying the demand for modern energy services and also provides new services, as it allows the use of electrical appliances. However, there are a number of modern energy services demands at the household level that can only be accomplished and delivered through electricity. For instance, the only energy source known to get maximum comfort for cooling as well as refrigeration is electricity. The location of the country in the tropical climate region necessitates the frequent use of electric fans, air conditioning systems and refrigeration for cooling. The position electricity occupies at the top of the energy ladder shows the importance of electricity services in fulfilling human energy services desire. The demand for 24/7 electricity in households are critical because a threshold of modern energy services are vital to fulfilling basic social needs essential for modern lifestyles to promote healthy living and economic prosperity.

Rapid population growth and industrialisation are the major factors that keep increasing the demand for electricity, especially amongst households living in major urban centres. The lack of proactive planning for expansion on the part of the electricity provider contributes to their inability to meet the ever increasing household electricity demand from population growth and city expansion. The failure of the public energy service delivery system has made the services provided by electricity to become a mirage in the study area. The supply of electricity when

available is erratic in nature, characterised by low quality that could not even power household electrical appliances that are essential to fulfilling energy services provision. The damage done to household electrical appliances as a result of low or fluctuating voltage makes the electricity supplied non-usable when available. The low and frequent disruptions in electricity supply has been attributable to low generation capacity as a result of low water level at the hydro stations alongside the insufficient gas supply to the thermal power generation plants have negatively affects electricity supply nationwide. This has resulted in rising incidence of generation failure or system collapse, power outages, blackouts and load shedding.

The challenges of low water level at hydro stations, referred to as “low deep”, shortages of gas supply to power generation plants and the rising incidence of gas pipeline vandalism have continued to limit the power plant generation capacity. Despite the country’s 180 trillion (standard) cubic feet of gas reserves and an estimation of 1.1 million cubic feet of gas wasted daily, the power generation stations that are gas-fired are consistently deprived of about 1.6 billion cubic feet of regular gas supply required per day to fuel the generation stations to function optimally. It is only when electricity is available in the right quantity and reliable quality that the desire to acquire electrical appliances will increase and households can then begin to use all the electrical appliances available and experience an increase in electricity consumption necessary to achieve a decent standard of human existence. The prevailing electricity supply situation is such that most households are without electricity sometimes for days, weeks and months, as outages are becoming more regular with the resultant negative effects on socio-economic activities.

The poor reliability of the grid deprives many households of the benefits of modern energy services and imposed high cost on households’ monthly income by consistently forcing many households in the study area to expend between 25 – 60 per cent of their monthly income on self-generation of electricity. Income is spent on self-generation of electricity at the expense of other households competing basic needs and poverty rises as many of the households at the bottom of the social ladder are further impoverished. In addition, the low-income households, especially those without generators, are forced down the energy ladder to make use of alternative, non-cleaner, energy sources. The extensive and continual use of generators as an alternative off grid-solutions by 71 per cent of households is an indicator of unsatisfied demand for electricity in the study neighbourhood. The small-scale businesses without generators are also adversely affected especially those artisans whose business depends solely on adequate provision of electricity.

This has often resulted in the closure of such businesses thereby forcing the heads of such households that are artisans to look for alternative jobs. The closure of such businesses and loss of patronage as a result of the poor reliability of the grid was substantiated by some of the key informants interviewed and the focus group discussants. A particular key informant interviewed is the chairperson of the commercial motorcyclist “okada” association that grieve over the increasing numbers of male artisans such as welders and electricians that have abandoned their primary source of livelihood to start using motorcycle for commercial purpose to earn a living (refer to section 4.5.2). The artisans such as barbers, hairdressers (beauticians) that could afford generators are compelled to increase the prices of their services to offset the running cost of using generating sets in the absence of grid electricity. The cost of fuelling, servicing and maintenance of generating sets constitutes a financial burden in the day-to-day running of small-scale business that relies on regular supply of electricity for existence. A large number of students struggle to read in the absence of electricity especially those without generators. These types of students have routinely resorted to the use of candles, kerosene lanterns, and battery-powered torch light to study while those with generating sets spend a considerable amount of their student allowance to self-generate electricity at the expense of other basic needs in order to study late into the night. The provision of lighting extends the workday and helps students to study further in the evening. Majority of the households without generators are deprived of the opportunity of watching educative and informative programmes. The extent of deprivation and frustration by the female gender is more noticeable on a daily basis particularly among those households without generators during the household domestic chores and postnatal activities. Households with generating sets are continually spending more of their disposable income on generators to provide modern energy services at the expense of other households’ basic needs. However, households that cannot afford generating sets are recurrently deprived the basic benefits of modern energy services especially during those periods of total blackouts or load shedding arising from system collapse of the national grid as elucidated from the focus group discussants and interviews granted by the officials of the electricity provider.

The socio-economic implication of the poor reliability of the grid cut across socio-economic classes and status as many households have become impoverished, struggling with the numerous impacts of poverty and socio-economic problems, in addition to spending larger part of their disposable income providing alternative off-grid solutions. This was evident from the results of field survey analysis where 25 – 60 per cent of households’ income was expended on self-

generation of electricity and maintenance of generators. This was further substantiated by the focus group discussions and key informants interviewed (see section 5.4.2). Thus, the expenditure of many households on off-grid solutions represents an opportunity cost to the detriment of many of the basic needs of life because household's income is not being spent on other forms of consumption that could have improved the socio-economic growth of the household which will also increase the demand for consumer goods and luxury food items. This study, therefore, supports Birol's (2007) argument that access to electricity is not only a result of economic growth, but that electricity access also contributes actively to economic growth.

Empirical studies have shown that electricity consumption per capita is a good indicator of socio-economic development of households, resulting in a bi-directional causality between energy consumption and economic growth. Households' electricity consumption is a derivative of electricity supplied and whatsoever is required for consumption by households must have been demanded and supplied. One of the indices for measuring the socio-economic well-being at the household level is the quantity of electricity consumption. The productivity of households in advanced countries has been linked to the level of energy consumption, while the economies of households' grow with an increase in energy inputs. The low per capita electricity consumption of 142 kWh is an indication that all the households in the study area live far below the 4000 kWh levels required for achieving a decent standard of human existence as recommended by the UNDP (2010). The average per capita electricity consumption of households in the study area is 142 kWh. This is in sharp comparison to Libya's 4270 kWh, Egypt's 1337 kWh, South Africa's 4560kWh, India's 616 kWh, Brazil's 1934 kWh, China's 1379 kWh, the UK's 4648 kWh and the 10,656 kWh per year consumed by an average American family. This is a pointer to the relatively and absolute low level of electricity consumption and the resultant low productivity of the households in the study area.

In reality, the 142 kWh level of consumption for grid-based electricity supply is underestimating the actual level of consumption due to the prevalence of self-generation. However, the lack of secure and affordable provision of electricity has a negative impact on economic growth because of the considerable amount of household income spent on costly backup of self-generation. At such instances of unavailability of grid electricity, which is very often, the desire for energy services using costly backups competes with other households needs. Therefore, if energy consumption is positively related to economic growth, the benefits of increased electricity

consumption includes generating more income, boosting economic activities at the household level, which will boost economic growth and increase development and ultimately reduce poverty. This study supports the finding of Nussbaumer et al. (2011), that energy consumption is correlated to development, in addition to the quality of the energy services delivered and/or their reliability.

The results of the field research indicate that urban households utilise a combination of energy sources to satisfy their energy needs because electricity, which is at the top of the energy ladder, is often unavailable and, when available, it is not reliable. This often forced the moving up or climbing down the energy ladder from electricity to less-clean and safer energy using the next available and affordable energy source in the energy ladder. However, the upward/downward movement across the energy ladder is not automatically linked to a specific energy source; rather it involved the household having a mix of energy sources to complement one another. The study therefore supports Masera et al. (2010) and their model of multiple energy use patterns referred to as “energy or fuel stacking,” which states that there are various interacting social, economic and cultural factors that explain or rather, determine household energy use patterns and this involves the combination of energy being used for different purposes

6.3 The Implications of the Nature of Electricity Delivery for Urban Energy Poverty

6.3.1 Research Objective Two: to evaluate the implications of electricity delivery characteristics and compare grid-supplied to self-generated electricity

Households have a standard of living and a lifestyle that demands a certain level of access to energy services. At present, the grid-based system cannot provide that level of service, creating an “energy services gap” that is met by self-generation. The use of generators by 71 per cent of the households in the area is a symbol of the failure of the development of a public energy delivery system. The failure of the public energy service delivery system has turned grid-based electricity provision to a “standby”, while generating sets have now become a necessity, the main source of electricity provision and a must-have household item. The results of the field research indicate households are paying between ₦64 (£0.25) to ₦80 (£0.31) per kilowatt-hour with gasoline-powered generators compared to the ₦12.80 (£0.05) paid for grid-electricity. The results further show that 20–60 per cent of households’ disposable income is expended on self-generation of electricity as compared to the less than 10 per cent expended on grid-electricity.

This implies that households spend a large proportion of their disposable income in providing alternative sources of electricity compared to household expenditure on grid-electricity (see Figure 4.3). This expenditure is at the expense of the many other households' competing needs and represents a substantial opportunity cost that could be spent on other forms of consumption. As long as households continue to generate their own electricity using alternative sources, energy poverty will continue to prevail and thus impoverishing the conditions and living standard of the urban poor households specifically those households without generating sets. Energy poverty is more prevalent among the urban poor households particularly the lower and low-income households without generators. On the other hand, those with generators are able to achieve some level of modern energy services using petrol/diesel powered generators thereby reducing the impact and prevalence of energy poverty arising from the poor reliability of the grid system. Off grid solutions using petrol/diesel generation costs ₦87 to ₦130 per kilowatt-hour, compared with the average grid tariff of ₦12.80. The marginalised and impoverished households will continue to struggle with basic living costs when it comes to balancing their income with energy sources and other needs. The results of the study supports the findings of MAN (2013) and World Bank (2013), that households' expenditure on self-generated electricity is 5-10 times as much as that on grid-electricity.

A number of health hazards and associated risks on the environment that could lead to death have been linked to inhaling carbon monoxide emitted from the gasoline-powered generators and subsequent effluent discharges into the nearby water bodies. Some households have lost family members due to fire outbreak from generator explosion and inhaling of the particulate matter (soot), fumes and carbon monoxide from generating sets. The persistent noise arising from the incessant use of generators has deprived many families, residents and neighbours the comfort of sound sleep and has placed some households in a disadvantaged position of rescue action and assistance from their neighbours during emergency and armed robbery attack. Some people can no longer sleep at night without using sleeping pills. Empirical studies have linked hypertension and various adverse psychological behaviours to long-term noise exposure. Therefore, for households to have a secure healthy standard of living, access to adequate and reliable electricity services is important. This study support Modi et al. (2005) and UN-Energy (2005) in their affirmation that the accessibility, affordability and reliability of the modern energy services are very essential to human development and a critical foundation for sustainable development. It

also supports Saghir's (2005) argument that without expanding the use of energy, there can be no evidence of development and poverty reduction.

6.3.2 Research Objective Three: to analyse the relationship between households' income and expenditure on electricity consumption with social-survey-derived variables

Empirical evidence indicates that the total energy requirements of households are found to differ despite the fact that some households are in the same socio-economic situation. Many factors contribute to the energy needs and consumption across the different groups of people and households in the study area. Among these factors is the socio-economic status of the households, such as educational qualification, occupation, gender, age, differences in the income, household size and behaviour of the consumers. The results of the analysis of the relationship between electricity consumption, household expenditure on grid-electricity consumption and household income returned a low R square $r^2 = 0.111$ when compare to the high R square $r^2 = 0.966$ of self-generation of electricity with the use of gasoline-powered generating sets. The results of the grid-electricity consumption analysis are unexpected due to factors earlier identified as unavailability and irregularity of electricity provision characterised with erratic nature of electricity supply and the huge metering gap that hinders measuring consumption accurately, leading to arbitrary estimated billing. The lack of transparency in the electricity billing system together with improper billing management consistently leads to arbitrary billing and extortionate charges of electricity by the electricity service provider in the quest to meet monthly revenue targets. As noted above, the use of estimated billing has seriously frustrated many households who have to pay for electricity not consumed. This frustration cuts across the different socio-economic strata of the rich and the poor; the educated, the semi-literate and the illiterate; and the low, the medium and the high-income households. Most of the households received bills that could not be accounted for or bills for a billing cycle where power supply is inadequate or never provided. The fear of disconnection from the national grid compelled some of these households to pay for services not rendered and electricity not enjoyed.

Among the sampled respondents, there is a relationship between household expenditure on grid-electricity and household average monthly income, type of buildings (particularly those living in shared Brazilian accommodations and flat), tenants, household heads with educational qualifications of Bachelor's degree and PGD, and household heads working with private

organisations. Gender, house ownership, and occupation are negatively and poorly correlated with household expenditure on grid-electricity consumption in the study area. Age, marital status, household size, household type, educational status, types of building and income are factors that influenced household monthly expenditure on grid-electricity consumption in the study area. Even though the relationship is not strongly correlated as expected, it existed. The income of a household determines the kind of energy source they employ to satisfy their needs and is crucial to a household's chance of moving up the energy ladder. The choice of which energy source to move down to may be based on the consumer's behaviour, lifestyles and personal circumstances of the household involved. As energy prices increase, energy poverty can influence population groups higher up the socio-economic ladder. Regrettably, the low-income ("poor") households are mostly affected by increased electricity tariff prices, which constitute a social challenge that exacerbates poverty. The foregoing discussion indicates that the quantity and level of electricity consumed increase with an increase in income, size of households and age and as the number of married women increases.

Furthermore, the results of the cross tabulations and multiple regression analysis, as highlighted in Chapter five (see Tables 5.9 - 5.12), indicate that age has a positive correlation on household expenditure on grid-electricity and a negative correlation on self-generation. Therefore, age may also exert a strong influence on electricity consumption, but it is very difficult to ascertain if this study supports the statements by Clancy and Roehr (2003), Lenzen et al. (2006) and Roberts (2008), that energy consumption and usage vary across age groups. The study only captured the age of the household heads; the ages of other household members/occupants are not captured. Educational qualifications have a positive correlation on both household expenditure on grid and self-generated electricity. This implies that households with higher levels of education are expected to have a higher consumption of electricity. A household's level of education is a contributing factor to ownership of certain electrical appliances, such as a washing machine, microwave, toaster, vacuum cleaner, electric cooker, and LPG, which are found only in the medium to high-income households. This further supports Heltberg's (2004) claim that the level of education attainment affects energy consumption. Household size has a positive correlation on both household expenditure on grid and self-generated electricity and, therefore, corroborates the assertion of Mekonnen and Kolhin (2008) that an increase in household size increases household electricity consumption. An increase in the size of households will lead to an increase in the energy demand and proportion of households requiring access to electricity and basic modern

energy services. In addition, households' disposable income has a positive correlation on both household expenditure on grid and self-generation of electricity and, as empirical studies show, as income increases, so does energy consumption. This study agrees with Hosier and Dowd (1987), Hosier (2004) and Louw et al. (2008) that an increase in income will lead to an increase in electricity consumption.

The increasing demand for electricity supply by many households without corresponding expansion and increase in power generation output and distribution capacity led to the present situation where the demand for electricity is more than the available supply. There is a huge deficit created due to rapid population growth and the inability to meet the ever-increasing households' energy demand. As long as the supply of electricity is not adequate and reliable, the desire to use lower energy sources on the energy ladder to provide energy services will increase and the desire to use generators will also increase, thereby increasing household expenditure on alternative sources of electricity. Similarly, as the prices of petroleum products increase, more of households' disposable income is spent on petroleum products (petrol/diesel) to power their generators. However, this research finding posits these three variables of availability, affordability and reliability as factors that also determine increase in electricity consumption regardless of income. This claim supports the view of IEA (2010) that: "reliability, and not just access and "energy security statement of IEA (2007:160)... adequate, affordable and reliable supplies of energy" is very important to sustainable economic growth". This study is therefore further in support of the statement by Alam (2006) that energy not only serves as a factor of production, but that it also acts as a booster.

6.3.3 Research Objective Four: to investigate and analyse the barriers associated with access to electricity and the problems of non-payments of electricity consumed

The unreliability of electricity supply, the non-provision of basic infrastructure such as distribution transformers, electricity distribution/service poles, the non-metering of customers and delay in the connection of customers are some of the problems encountered by the households in the study area. A common occurrence is a situation whereby community/neighbourhoods imposes a levy on residents for the purchase distribution transformers, meters, electric poles, and conductor cables; and services that ordinarily should have been provided by the electricity provider. The provision of basic electricity infrastructure by the electricity provider towards the delivery of affordable, adequate and reliable electricity supply is the key to overcome the barriers associated

with electricity access. The regular and adequate supply of electricity will increase the readiness and willingness of households to pay for electricity consumed. This is supported by more than 70 per cent of the households that shows the willingness to pay more for a better and improved service. The study supports the submission of Barnes et al. (2005) that income and affordability alone are not necessarily the barrier but service availability and reliability of electricity provision. The study therefore supports the IEA (2010) Energy Development Index which suggests that per capita electricity consumption in the residential sector serves as an indicator of the reliability of, and consumer's ability to pay for, electricity services.

The major issue with metering is reconciling household expenditure with grid-electricity consumption. The findings of this study support the statement by NERC (2013) that metering accounts for 80 per cent of consumer complaints. The provision of pre-payment electricity meters will close the huge metering gap and eliminate the contentious dispute that frequently arises from estimating billing. The provision of pre-payment meters will likewise help customers to manage their energy usage and consumption will be on a pay-as-you-consume basis. The privatised electricity companies are guaranteed a good return on their investment provided there is an appreciable and noticeable improvement on the quality of services delivered. The inadequate metering infrastructure, the non-existence of a robust and comprehensive customer database whereby electricity received from the grid and electricity supplied to households can be measured accurately and reconciled with payments received based on energy consumption encourages energy theft, leading to commercial losses of revenue. The inventory of electricity consumers on a locational basis linked to the electricity supply chain and the creation of a customer identification number (CIN), a process known as consumer indexing, is inevitable for the electricity provider. This will facilitate the reduction of losses of revenue through identification of illegal consumers of electricity and areas and neighbourhood where the electricity provider is experiencing energy theft as a result of non-metered consumption, pilferage/illegal connection, inaccurate/inadequate billing and non-payment of electricity consumed.

6.4 Summary of Major Findings

These are the major findings of the research:

- The study established that, in a typical urban setting, based on the findings of the household survey, focus group discussions and interviews granted, accessibility and affordability of

electricity is not the problem but the adequacy, quality and reliability of the grid-electricity provision.

- The study further acknowledged that households have a standard of living and a lifestyle that demands a certain level of access to energy services. However, the energy services available to households in the study area are below socially and materially necessitated levels. Therefore, at present, the grid-based system cannot provide that level of service; hence, there is an “energy services gap” that is met by self-generation. Those that cannot afford self-generation are disadvantaged. Therefore, the failure of the grid promotes socio-economic deprivation and inequality.
- The huge electricity infrastructure and energy gap burden attributable to poor reliability of the grid leads to a financial burden on households’ disposable income from the off grid-solutions of self-generation of electricity.
- The result of the spatial data analysis on households’ electricity supply and consumption indicate no discernable significant spatial pattern across the residential densities in the study area.
- The results of the cross tabulations show some level of moderate positive association between households’ socio-economic characteristics (gender, age, household size, educational qualifications, number of generators, ratings of generators and income) and expenditure on grid and self-generated electricity. The results revealed a significant relationship ($p < 0.05$); however, there is no discernable pattern of these associations.
- The results of the regression analysis on grid-based electricity consumption returned a very low $r^2 = 0.111$ (11.1per cent) and adjusted $r^2 = 0.104$. The overall relationship is significant and the results significantly showed that age, marital status, household size, household type, educational status, types of building and monthly income are factors that influenced household monthly expenditure on grid-based electricity consumption in the study area. The low r^2 is attributable to the low average consumption of 142kWh of grid-electricity by households due to the inadequate provision of electricity and the non-provision of meters to estimate accurately households’ consumption.
- The result of the regression analysis of the ‘household expenditure on self-generated electricity’ returned a very high goodness of fit of the regression model $r^2 = 0.966$ (96.6per cent) and adjusted $r^2 = 0.965$. This implies that there is a significant relationship between household expenditure on self-generation of electricity and socio-economic characteristics. There is a strong correlation ($r = 0.770$) between those who had more than one generator and

the rating of the generator. This suggests that the rating of generating sets is a major variable that affect household expenditure on self-generation.

- The research findings indicate 20-60 per cent of households' disposable income is expended on self-generation of electricity in the quest to satisfy households' modern energy services desire compared to less than 10 per cent expended on grid-based electricity supply.
- The bane of energy poverty in the study area is the lack of secure, affordable and reliable provision of electricity and the heavy reliance on costly backup off grid-solutions. This undermines households socio-economic development, as a large portion of the household income is expended on self-generation of electricity. This represents an opportunity cost because disposable income is not being spent on other forms of consumption. The high-energy expenditure exerts a negative impact on general household welfare because households are being deprived of other basic goods and services necessary to sustain life.
- The study established that urban households utilises a combination of energy sources to satisfy their energy services desires because electricity that is at the top of the energy ladder is not always available and, when available, the quality is not reliable.
- The unreliability of electricity provision has forced the closure of several small scale businesses that depend solely on electricity for survival and some of the artisans are forced to look for alternative jobs in order to earn a living for survival.
- The emissions of carbon monoxide, poisonous gases and particulates from the unsafe use of gasoline-powered self-generation of electricity have a far-reaching effect on human health and the environment.
- The uncontrolled, unstructured and haphazard nature of the utility network spatial structure is an indication of poor city planning and the lack of proactive approach and pre-emptive strategy on the part of the utility provider to meet up with the rising energy demand from the ever growing population and city expansion.
- Practically all the households in the study area are willing to pay cost-reflective tariffs for electricity consumption and are ready to pay more for an improved electricity service delivery provided adequate and reliable supply of electricity is guaranteed and made available.

6.5 Contributions of the Study

This research makes a significant contribution to the existing knowledge in energy geography, development studies and human geography. It takes a distinctive approach to the selection of respondents/households sampled for the door-to-door household survey. The study is novel in its

approach and provides a pragmatic methodology based on the application of a Geographic Information System (GIS) as an interface between development studies and energy geography. The study used geographical techniques to provide insights into energy poverty at the household level. The resultant energy poverty index map allowed the visualisation of the geography of the sampled populations and ranked households based on the percentage of households' income expended on electricity (grid and self-generation). The importance of the energy index map is not only to prove that energy poverty exists, but also to show the magnitude of energy poverty and identifying where it exists. In doing so, this research has added another dimension to the literature in development studies, human and energy geography.

This research has added to the “energy geography” literature, by exposing the failure of the public energy service delivery system in Nigeria. This research has also highlighted the environmental impacts of self-generation of electricity using gasoline-powered generating sets with its attendant adverse effect on human health and the environment. The emissions from self-generation of electricity with the use of gasoline-powered (petrol and diesel) generators contribute to a range of human health issues. The indiscriminate discharge of effluents from the servicing and maintenance of generators constitute an environmental concern to the nearby water bodies, plants and animals with far reaching effects. The carbon monoxide (CO), poisonous gases and particulates released into the environment are a major cause of lungs, blood and central nervous system (CNS) related diseases. The findings of the research provide theoretical and practical sources upon which to expand the national strategies to strengthen energy policies, rehabilitate and reinforce existing electricity infrastructure, leveraging technologies towards building a resilient national grid aimed at improving electricity service delivery in Nigeria.

6.5.1 Limitations of the Research

The unreliability and unavailability of official data such as census data (geo-demographic) on households' socio-economic characteristics in a usable and suitable format is a major constraint and setback to this study. The research revealed that some basic routine datasets that should be part of the daily cycle of the electricity service provider are non-existent. The World Bank (2013) asserts that, without reliable data and quality statistics, there can be no meaningful design, development or evaluation of national strategies to identify socio-economic challenges in Nigeria. The lack of reliable data and verifiable scientific research findings on energy poverty in Africa and indeed, in Nigeria, had continued to be a major challenge against effective policies and actions to

combat urban energy poverty. In addition, there is no evidence of any baseline studies with regard to electricity demand, supply and consumption at the household level neither a load study that enables utilities to study the ways their customers use electricity, either in total or by individual end-uses. The lack of a customer spatial database and digital map of the utility geographical network showing electrical network assets/elements location and distribution mains from where households and consumers are being supplied electricity also constitute a major obstacle to electricity network planning and management and a limitation to this study.

The unavailability of the household composition data highlighted above further constrained the research methodology, because getting consistent information is very difficult, as pointed out in Section 3.9. This necessitates the conduct of a door-to-door household survey in order to gather information in an interactive discussion from the randomly selected households identified from the map of the study area. The information gathered on each household sampled is linked to the actual residential location of each household on the map with the use of a unique identifier for ease of statistical and spatial analysis. The availability of all the aforementioned census and grid data could have accurately help estimate energy received from the grid to energy supplied and energy consumed in each of the households. The linkage of the digital geographical distribution network map of the study area to the customer spatial database would have created a unique customer identification number (CIN) detailing how each consumer is connected to the utility network. This could have helped identify areas where the utility is experiencing commercial losses of revenue in terms of energy theft arising from pilferage through illegal connection, non-metered consumption, inadequate billing and non-payment of electricity consumed. It could have further assisted to analyse household energy consumption pattern by linking it to the geo-demographic census data of the study area to aid policy formulation and the expansion required in the delivery of an efficient electricity services.

Another limitation of this study is the inability to gather detailed information about other household occupants, particularly age and other socio-economic variables, due to security reasons and cultural beliefs that forbid the head count of the children in some households. The thesis could have also benefited more from the discussion of participants and stakeholders during the electricity consumer public consultative forum under the aegis of Power Consumer Assembly (PCA) organised by NERC. The postponement of the public consultative forum the second time to a later date outside the duration of the field trip prevented the researcher from participation. A

further limitation of this research is the absence of private investors' participation during the interview stage of the field survey exercise. The handing over to the private owners had not taken place at the time of the field survey exercise. Considering the role of the private investors, it would have been desirable to hear how they intend to overcome the existing infrastructure and energy gap, improve electricity service delivery and increase the willingness of households to pay for electricity consumed.

6.6 Implications of the Findings for Policy

First and foremost, the three tiers of governments (federal, state and local) should promote and expand the use of Liquefied Petroleum Gas (LPG) at households for a cleaner environment. Households should be encouraged to embrace the use of LPG, as it provides cleaner and safer energy that is cost effective, healthy and environment-friendly. The three tiers of government should deepen the consumption of LPG in order to increase the number of people living healthier lifestyles in a cleaner environment. The provision of stimuli and subsidies is necessary to encourage the use of LPG.

The findings of this study acknowledge the huge infrastructure, energy and metering gap as the major challenges that bedevil the electricity sector in Nigeria. The infrastructure deficit is the consequence of the energy gap that gave rise to the poor reliability of the grid network. The energy gap witnessed in the study area is a reflection of the broader situation across the urban centres and cities of Nigeria. The huge gap is attributable to corruption, mismanagement, poor funding and low operational performance, and poor transmission and distribution infrastructure. Other contributing factors are the long years of gross neglect of the electricity sector, poor billing infrastructure, poor revenue collection, grossly inadequate metering, poor maintenance, and low level of technological upgrade. The cumulative effect is the decay of the utility grid network and the inability of the power generation plants to function at full capacity, culminating in electricity shortfalls. Additionally, the inability of the Nigerian Gas Company (NGC), a subsidiary of the Nigerian National Petroleum Corporation (NNPC), to ensure a steady supply of gas to the thermal generating plants is also a major setback for the electricity supply chain of the country. The overhauling, maintenance, upgrading and expansion of the grid network infrastructure and adequate supply of natural gas to the power-generation plants are essential to ensuring the adequate provision of reliable electricity to the households.

The failure of the state-owned electricity supply industry and its attendant negative effects on the economy made the government consider power sector reforms and privatisation. The power sector reform recognised that improving electricity supply chain and performance is critical to address development challenges. The reform and privatisation of the power sector is seen as a solution to the inadequate provision of electricity with the confidence that the privatised market will reposition the sector and deliver a better solution. In addition, it will provide the pathway of addressing the increasing challenges militating against improved electricity supply efficiency, and reducing losses and electricity provision cost in the country. However, the deregulation of the monopolistic hold of the state-owned vertically integrated utilities is expected to be to the advantage of the economy and the welfare of the citizens. The yearning of the population is to witness a tremendous improvement in the electricity supply chain with electricity service delivery getting better on a daily basis. The general belief is that privatising the power sector will signal a new dawn and bring a new lease of life even if it means paying more. The high level of corruption within the power sector makes any structural change very hard to implement and some of the overall intended outcome of privatisation is to enhance greater transparency and the reduction of corruption. However, the privatisation of the power sector in Nigeria still creates private monopolies because of the way the privatisation process is handled and sold to phoney firms put together by corrupt public figures, their allies and dodgy businessmen. The privatised electricity companies does not give consumers the choice of migration to another electricity service provider because of the way the privatised distribution companies are trade off into zones instead of into smaller fragments of districts/business units. This type of privatisation is creating a private monopoly to the detriment of the consumer interests and thus needs effective and efficient regulation to prevent abuse of monopoly power.

There have been no significant improvements in the grid network on account of the short-term pressures as private investors of the privatised electricity companies seek to quickly maximise and start to increase profits within a very short-term thereby avoiding investing in long-term projects. There is a lack of investment in strengthening the weak and obsolete infrastructure to enhance their efficiency and productivity towards efficient service delivery. The generation utilisation capacity need to be improved in order to increase the available installed capacity with the addition of more megawatts to the national grid. What is distributed is a derivative of what is generated. The transmission and distribution network needs to be rehabilitated to be robust and flexible enough to accommodate the nation's demand for electricity. The owners of the privatised

electricity companies need capital to fund required investments. The privatised companies are only trying to make use of existing plants rather than invest in new ones. One of the antidotes for an improved privatised power sector is for the private investors to make massive investment upfront to stabilise, improve the electricity service provision by focussing more on efficient service delivery through infrastructure review and improvement, and close the huge infrastructure, energy and metering gap.

Furthermore, the privatised electricity distribution companies need to understand their customer database through the automation of the business and operational processes. The mapping of the entire grid network and consumer spatial database development is inevitable. The consumer indexing should cover data gathering at all level of government administrative hierarchy or units from ward level to local government and state levels. This will facilitate locational analysis of energy demand-supply connection upon which government policy and measures can be based and on the other hand plug the leaking holes of commercial losses of revenue. The privatised companies should be conscious of the fact that consumers obligation is to pay their electricity bills while the privatised distribution companies should provide efficient service delivery, including provision of meters. They must improve the metering procedure through adequate provision of pre-payment meters to aid the prompt revenue collection and payment of electricity consumption by households. Without effectively monitoring consumption and payment of bills, there cannot be enough income for the privatised companies; and electricity supply that does not reach the consumers cannot translate to money. Metering all households with timeline and guidelines will solve the non-payment and arbitrary estimated billing problems that have been long-standing and contentious between households and the electricity provider. The privatised companies must further invest in cutting-edge and innovative technologies that incorporate smart grid system, supervisory control and data acquisition (SCADA), GIS and distribution automation (DA). This is to ensure sustainable, efficient and safe delivery of electricity and maximise grid efficiency and reliability towards building a resilient grid network.

The National Electricity Regulatory Commission (NERC), the industry's watchdog saddled with responsibility of coordinating and regulating the electricity supply industry, should ensure that the private investors/owners take a proactive and pre-emptive strategy towards building an efficient and resilient grid system. This is to forestall any future occurrence of frequent blackouts, reduce load shedding and prevent system collapse. The NERC must impose consumer welfare and anti-

competition contravention without prejudice. The antitrust law is, therefore, necessary to protect consumers from exploitation by privatised electricity companies and competition from voracious business practices with the aim of ensuring that unbiased competition subsists in an open market economy. The law must be in place to ensure consumers' protection by way of an increase of welfare and fairness to consumers. The NERC should promulgate a law that establishes a legislative and strong regulatory framework to legitimise consumers grid-electricity connections which must be strictly adhered to before buildings are connected to the national grid to control the haphazard and uncontrolled nature of the grid. The uncontrolled, haphazard and indiscriminate connection to the grid by households should be checked by re-introducing the mains inspection connection practices whereby laid-down procedures are followed before connecting households to the grid.

The enforcement of the new electricity tariff regime and the fixed charge through the Multi-Year Tariff Order (MYTO) by NERC to encourage privatised companies to recoup their investments should be a gradual process. It is desirable that the privatised companies make profit and recoup their investments. The procedure should, however, be subjected to the simple market principle of payment according to services rendered. The NERC, with its regulatory function, is expected to endorse a law with strong powers of execution that is very critical to protect consumers from exploitation by the privatised electricity companies through increase in the electricity tariff without tremendous improvement in the service delivery of electricity supply. There must be a thorough consultation and transparent process of stakeholders' involvement of the civil society organisations, consumer groups and electricity provider before any tariff rate review becomes conclusive and official. The NERC should equally pay more attention to and monitor the improvement of efficiency and safety of the networks, especially the distribution segment that represent the face of the utility to the public.

Another major challenge facing the electricity supply industry in Nigeria is the unavailability of an enabling law to empower the Nigerian Electricity Regulatory Commission (NERC) to regulate gas supply, unlike what occurs in developed economies of the world where gas is heavily regulated. The removal of government subsidy in the price of gas as a result of privatisation has further affected a number of issues relating to the power sector performance and improvement. For example, gas shortages being experienced in firing the thermal stations is as a result of the increase in the price of gas which has a multiplier effect in the hike in electricity tariff to the

detriment of citizens particularly the poor households with low-income. The industry stakeholders should ensure the prompt passage of the Petroleum Industry Bill (PIB) by the National Assembly to enhance the commerciality of gas to power and bring in more megawatts of electricity generation. An improved supply of uninterrupted electricity will boost the confidence of the populace and expedite the resuscitation of small and medium-scale enterprises (SMEs) and businesses that have closed down and the coming back of many of the factories and industries that have relocated out of Nigeria as a result of inadequate supply of electricity.

The three tiers of government should diversify and ensure a secured energy mix by exploring other renewable sources of energy that are environment friendly to meet the Vision 20:2020 target of 40,000MW (NPC, 2010). The Nigerian government should look beyond fossil-fuels (thermal and hydro) sources of electricity generation by exploiting the arrays of renewable and sustainable energy potentials that abound and shifts to a more low-carbon energy mix and reduce the greenhouse gas emission and the cumulating effect of global warming on climate change. The country is located within the tropics of Cancer and Capricorn, where there is abundance of sunlight and the availability of the energy whose reservoir is the sun is infinite which is very favourable for the implementation of photovoltaic (solar) technologies. The Federal Government should intensify the aspiration of reducing energy poverty because they dictate the key policies that shape the economy of the country. The three tiers of government must, therefore, tackle energy poverty in aggressive and verifiable ways.

The ownership of the electricity generation and distribution companies has been privatised and rights of ownership exchanged hands. The privatisation is anticipated to translate into more megawatts of electricity, providing a pathway to sustainable electricity supply market and ensure a regular and adequate supply of electricity needed to stimulate and drive the growth of the Nigerian economy. The privatisation of the electricity sector is expected to boost the Nigerian economy through massive job creation opportunities, industrialisation and development of small and medium scale enterprises (SMEs). However, the privatisation has not produced the desired result of improvement in the electricity service delivery despite the fact that the sector has been in private hands since November 1, 2013. The projection before the sector is privatised is that by the end of 2014, Nigeria would have been generating over 10,000MW but official figures from the Federal Ministry of Power as of April 12, 2015 showed that the country's peak generation, is 3,263.6MW, while the energy sent out is 2,988.72MW. The lack of significant improvement since

the handing over is a cause for concern and raises questions as to the high expectations and significance of the energy sector reform that leads to the process of privatisation and the net benefits to the economy. The reforms and privatisation promised radical changes in the sector but not much progress is on display.

The post-privatisation of the power sector must be vigorously pursued with effective regulations to raise the productivity of Nigerians and bring down the poverty level in Nigeria. The privatised companies should, therefore, adopt a multi-sectoral holistic and integrated approach to electricity generation for growth. This could be done by increasing electricity-generation capacity through substantial investment in both renewable and non-renewable sources of energy. The private investors should be closely monitored to ensure that they fulfil the expectations of Nigerians for significant improvements in the quality of electricity supply. The improved quality of supply will increase the desire and willingness of households to pay for electricity consumed. Empirical studies have shown that what makes privatisation work is regulation and what makes reform work is regulation. Privatisation is only useful and good when responsible authority regulates it.

6.7 Recommendations

In view of the foregoing, the following recommendations are imperative:

- The massive expansion, rehabilitation, turn-around maintenance (TAM) and overhauling of the entire national grid is urgently required. The development of mini-grids and micro-level systems at the household/community level and new power stations on a regional level basis are required to move the power sector forward.
- The use of renewable energy technologies, such as solar panels, wind power or small-scale hydroelectricity are urgently required to close the huge energy and infrastructure gap.
- Corruption must be tackled headlong with zero tolerance for corruption. The reign of impunity and unbridled looting must be checked.
- The right metric for each priority must be set and metrics should be designed to measure outcomes not inputs. For instance, the reform and privatisation of the power sector should be measured by how many Nigerians have gained access to reliable and adequate electricity supply rather than how many Nigerian are connected to the grid.
- The prompt passage of the Petroleum Industry Bill (PIB) by the national assembly and implementation of the gas master plan will further enhance and accelerate the adequate delivery of gas to power the thermal generation plants.

- The three tiers of governments should promote and encourage the use of LPG for cooking at households for a cleaner environment. The provision of stimuli and subsidies is urgently desirable to encourage the use of LPG.
- The adequate provision of electricity to residential homes and industries is the panacea to a continued accelerated intervention to achieve the Millennium Development Goals (MDGs).
- The provision of electricity meters in all households is urgently mandatory to close the huge metering gap and eliminate the disputes arising from estimating billing phenomenon.
- Nigeria should start to look beyond the fossil-fuel based solution and pursue more sustainable energy solutions that bring with them the dual benefits of reducing reliance on fossil fuels and reducing carbon emissions.
- The country needs to enact an emission law that would provoke adaptation policies and legislations together with an emission-reduction strategy that will significantly reducing the usage of generators for a sustainable carbon dioxide emission reduction, leading to a cleaner and greener environment towards a sustainable vehicle required to develop a low-carbon economy.
- There is the need for concerted efforts through robust interaction, policy formulation, collaboration and partnership among all the stakeholders and ensure a holistic and comprehensive debate towards policy formulations as well as enforcement of policy implementation backed with strong political will.
- There is a dearth of institutions offering energy-related studies, Government should, therefore, seek to engage in capacity building and promote energy studies in the country's institutions of higher learning.
- The digital mapping of the grid network, metering of the grid, and consumer indexing would provide detailed grid data of energy received, supplied and consumed and thereby help plug the holes of commercial losses of revenue from energy theft, and illegal connections.
- The deployment of technologies in strengthening the grid network towards building a resilient smart grid system should be sought by the new owners of the privatised electricity generation stations (Gencos) and distribution companies (Discos) rather than the conventional manual methods.

6.8 Areas of Further Research

A significant shortcoming of this study is that information on all other members/occupants of the households sampled, households' expenditure on other forms of energy and differentiation of

appliances ownership are not captured. Further studies should, therefore, consider collecting information on other household members/occupants and estimate households' energy consumption pattern based on an exhaustive household demographic composition, households' disposable income, and expenditure on all other forms of energy in order to identify and determine energy types that consume more of households disposable income. Households should also be randomly sampled across major towns and cities in Nigeria to provide additional complementary insights. The results of such surveys would assist in designing and implementing geographically focused interventions to influence institutional/governmental policies. Capturing all households' expenditure on all other areas of energy usage and consumption and ranking them in order of preference and priority could also be attempted, for instance, type of households' energy use for cooking, like kerosene or LPG, transportation using petrol or diesel vehicles or using public transport. Consideration should be given to other factors, such as the power/voltage rating of appliances available in each household. The following questions could also help: What is the duration of use of the electrical appliances on a daily basis and appliance that consumes more of electricity? How often is the usage? What is the energy ratings and the energy efficiency of appliances? Who among household occupants/members uses what appliance most and for what purposes? These will inform household energy usage and consumption pattern and provide the basis for comparative analysis of percentage of households' expenditure on energy consumption.

There are numerous data not currently available in a suitable and usable format. The privatised systems are expected to improve the metering system and provide a lot more of grid data and information on consumption. This could be the starting point to provide a quantitative measure of comparing energy poverty level among households and communities, by replicating this study on a national scale to identify the magnitude of energy poverty across different strata of households, particularly in an urban setting. The availability of a digital map of the utility distribution/geographical network, detailed grid data linked to geo-demographic census and consumer-indexed data would provide a good starting point in understanding the magnitude of energy poverty experienced by households on a locational basis and ascertain where it exists.

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Appendix One: Participant Information Sheet

I am a postgraduate student of the University of Leicester, Department of Geography. I am carrying out a research on energy poverty in Ibadan, South West Nigeria with particular emphasis on electricity. I wish to collect/ gather some information from you as regards the research in order to inform policy and decision making in Nigeria. The research is self-sponsored and the confidentiality of your opinions is highly guaranteed. Thanks for your anticipated cooperation.

Aim of the Study

The study examines and analyses the causes of energy poverty in Nigeria through a case study of Ibadan, South West, Nigeria.

Objectives of the Study

The objectives of the research are to:

- Assess and analyse the delivery of electricity as a way to understanding the spatial issues of demand, supply and consumption in the study area;
- Integrate social-survey-derived variables, such as household income and electricity supplied and consumed to assess and map issues such as unaccounted energy, access and poverty;
- Compare grid-generated to self-generated electricity, and evaluate their relationship to land-use diversity;
- Investigate and analyse the problems of non-payments and barriers associated with access to electricity.

Purpose of the Research

This study describes the lack of access to electricity and the consequences of energy poverty in Ibadan, Oyo state, Nigeria. The absence of spatial evidence to support decisions and policies is common to resource management and sustainability issues in most developing countries.

The significance of this study is:

- To inform work/policy towards a more efficient energy system;
- To inform policy and institutional regulatory framework towards reducing energy poverty and increasing payments.

Appendix Two: Informed Consent Sheet

- Please tick**
1. I confirm that I have read and understand the information sheet for the study described in the participant information sheet, and that I have had the opportunity to ask questions.
 2. I understand that my participation is voluntary and that I am free to withdraw from the study at any time, and I do not have to give a reason for this.
 3. I agree to take part in the study described in the participant information sheet.

- Include/delete as appropriate*
- | | Yes | No |
|--|--------------------------|--------------------------|
| 4. I agree to the interview / focus group / consultation being audio recorded | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. I agree to the interview / focus group / consultation being video recorded | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. I agree to the use of anonymised quotes in written work or reports based upon this project. | <input type="checkbox"/> | <input type="checkbox"/> |

Name of Participant	Date	Signature
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Name of Researcher	Date	Signature
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Appendix Three: Household Survey Questionnaire

This questionnaire is only for research, to investigate and analyse the causes of energy poverty in Nigeria using Ibadan as case study.

A: HOUSEHOLD CHARACTERISTICS

1. Electrical Service Address of Respondent/Building ID
2. Gender: Male Female
3. Age: 20 – 30 31 – 40 41 – 50 51 – 60 61 -70
71 - 80
4. Marital Status: Single Married Divorcee Separated
Widowed
5. Household size: 1 – 4 5 – 7 8 – 10 11 – 12
6. Type of Household: Nuclear Extended Single Shared
7. Type of House: Communal (Face to face) Bungalow Flat
Duplex
8. Ownership Status: Owner Tenant
9. Educational Qualification: None Pry Six Secondary
NCE OND HND BSc PGD
M.Sc PhD
10. Occupation: Civil Servant Private Business Owners
Artisans
11. Average Monthly Income: ₦ 10,000 – ₦50,000 ₦ 50,001 – ₦ 100,000
₦101,000 – ₦ 250,000 ₦ 251,000 - ₦ 500,000

B: PROBLEMS AND PERCEPTIONS OF SUPPLY AND ACCESS TO ELECTRICITY

12. Are you connected to the grid? Yes No

13. Are there any barriers or limitation to you connecting to the electricity grid? If any, please state

- (a) Money
- (b) Unavailability of electricity supply
- (c) Others (Explain)

14 Do you have to pay before being connected to the electricity grid in your neighbourhood?

15 (a) To who?

(b) And how much must you pay before getting connection?

~~₦~~2,000 – 10,000

~~₦~~10,001 – 25,000

16 How are you connected to PHCN Supply?

(a) PHCN Pole

(b) Neighbour's building

17. (a) Do you have an Account with PHCN? Yes No

(b) Do you receive electricity bills? Yes No

(c) Request to see bill for sighting purpose?

(d) Electricity Bill Account no:

(e) Do you pay your electricity bill regularly? Yes No

Decline to answer

(f) What are your reasons for non-payment?

18. (a) Are you satisfied with the services provided? Yes No

(b) If Yes, why?

(c) If No why?

No Bill	Inaccurate/Crazy Bill	No Regular Supply	Phase off	Low Voltage
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19. Do you depend on electricity for your daily income?

a) Totally dependent

- b) Partially dependent
- c) Totally independent

20. How many hours in a day do you normally have regular supply of electricity?

21. Is the time of supply predictable? Yes No

22. What time of the day is the supply of electricity regular? Morning Noon
Night Others

23. How many times in a week do you have supply of electricity?

24. How many times in a week/month do you experience outage due to faults on the electricity network?

25. Would you pay more for an improved supply of electricity?

- a) Yes
- b) No

26. If Yes, how much more

- a) Little more
- b) Much more
- c) A lot more

27. How much do you spend monthly on grid-supplied electricity? 0
500 – 1000 1001 – 2000 2001 -3000
3001 – 5000 5001 - 10000

28. How do you pay cash or cheque? Cash Cheque

29. Which way would you prefer to pay? Cash Cheque Others

30. Where do you pay? Banks or PHCN cash collection centre:
 Banks PHCN CCC
31. Is your Electricity bill payment a true reflection of your Electricity consumption?
 Yes No
32. What is the Distance to cash collection/payment centres:
 1–2km 2–3km 3 – 4km
33. Do you own a generator? Yes No
34. Do you own or use solar for electricity? Yes No
35. How many generators do you have?
36. Are your generators diesel or petrol powered? Diesel Petrol
37. How many litres of petrol or diesel do you buy on a daily basis?
 1 – 4 5 – 10 11 – 15 16 – 20 20 & above
38. What is the rating (Kva) of your generator?
 (a) 650 – 1200Kva (b) 1200 – 2500Kva
 (c) 2500 – 5000Kva (d) Above 5000Kva
39. Roughly how much do you spend on the average fuelling your generator daily
 (self-generated)?
 (a) ₦0 – 1000 (b) ₦ 1001 – 2000 (c) ₦ 2001 – 400
 (d) ₦ 4001 – 6000 (e) ₦ Above 6000
40. Like how many hours do you switch-on your generator on a daily basis?
41. How much do you spend on servicing and maintenance of generating set monthly?
42. Please feel free to make any other comments

.....
.....
.....
.....
.....
.....
.....

Thank you

Appendix Four: Questionnaire Coding Frame

A. HOUSEHOLD AND SOCIO-ECONOMIC CHARACTERISTICS:

1. Building ID

2. House Address of Respondent.

3. Gender.

Male	1
Female	2

4. Age.

20 - 30	1
31 - 40	2
41 - 50	3
51 - 60	4
61 - 70	5
71 - 80	6

5. Marital Status.

Single	1
Married	2
Divorcee	3
Separated	4
Widowed	5

6. Household Size.

1 - 4	1
5 - 7	2
8 - 10	3
11 - 12	4

7. Type of Household.

Nuclear	1
Extended	2
Single	3
Shared	4

8. Type of House.

Face to Face	1
Bungalow	2
Flat	3
Duplex	4

9. Ownership Status.

Owner	1
Tenant	2

10. Educational Qualification.

None	1
Pry Six	2
Secondary	3
NCE	4
OND	5
HND	6
B.Sc	7
PGD	8
M.Sc	9
PhD	10

11. Occupation.

Civil Servant	1
Private	2
Business Owners	3
Artisan	4

12. Average Monthly Income:

10'000 - 50'000	1
51'000 - 100'000	2
101'000 - 250'000	3
251'000 - 500'000	4

B.PROBLEMS AND PERCEPTIONS OF SUPPLY AND ACCESS TO ELECTRICITY:

13. Connection to the Grid:

Yes	1
-----	---

No	2
14. Barrier or limitation two the grid:	
Yes	1
No	2
15. If YES, why? :	
Money	1
Unavailability of Supply	2
Others	3
16. Do you have to pay before being connected to the electricity grid?	
Yes	1
No	2
17. To who?	
PHCN	1
PHCN & Landlord Association	2
Landlord	3
18. How much do you pay before getting connection?	
2'000 - 10'000	1
10'001 - 25'000	2
19. How are you connected to PHCN Supply?	
PHCN Pole	1
Neighbours building	2
20. Do you have an Account with PHCN?	
Yes	1
No	2
21. Do you receive electricity bills?	
Yes	1
No	2
22. Request to see bill.	
Sighted	1
Non Sighted	2
23. Electricity Bill Account Number.....	
24. Do you pay your electricity bill regularly?	
Yes	1

No	2
Decline to answer	3

25. Reasons for your non- payment of electricity supply.

On disconnection	1
Uncompleted building	2
Demolished	3
School	4
None	5
Market	6

26. Are you satisfied with service provided?

Yes	1
No	2

27. If YES, why?

28. If NO, Why?

No Bill	1
Inaccurate Bill	2
No regular Supply	3
Phase Off	4
Low Voltage	5

29. Do you depend on electricity for your daily income?

Yes	1
No	2

30. If YES, to what extent is your dependence?

Totally dependent	1
Partially dependent	2
Totally independent	3

31. Number of hours you normally have supply of electricity on daily basis.

32. Is the time of supply predictable?

Yes	1
No	2

33. What time of the day is the supply regular?

Morning	1
Noon	2

Night	3
Anytime	4

34. How many times in a week do you normally have supply of electricity?

35. How many times in a week/month do you normally experience outage due to fault on the network?

36. Would you pay more for improve supply of electricity?

Yes	1
No	2

37. If YES, how much more.

Little more	1
Much more	2
A lot more	3

38. How much do you spend monthly on grid supply of electricity?

0	1
500 - 1'000	2
1'001 - 2'000	3
2'001 - 3'000	4
3'001 - 5'000	5
5'001 - 10'000	6

39. How do you pay?

Cash	1
Cheque	2

40. Which way would you prefer to pay?

Cash	1
Cheque	2
On- line	3

41. Is your electricity bill payment a true reflection of your Electricity consumption?

42. Distance to cash collection/payment centre.

1 - 2km	1
2 - 3km	2
3 - 4km	3


43. Do you own a generator?

Yes	1
-----	---

- | | |
|----|---|
| No | 2 |
|----|---|
44. Do you own or use solar for electricity?
- | | |
|-----|---|
| Yes | 1 |
| No | 2 |
45. How many generators do you have?
46. Are your generators diesel or petrol powered?
- | | |
|--------|---|
| Diesel | 1 |
| Petrol | 2 |
47. How many litres of petrol or diesel do you buy on a daily basis?
- | | |
|------------|---|
| 1 - 4 | 1 |
| 5 - 10 | 2 |
| 11 - 15 | 3 |
| 16 - 20 | 4 |
| 20 & Above | 5 |
48. Rating of your generator in Kva.
- | | |
|------------------|---|
| 650 - 1'000Kva | 1 |
| 1'200 - 2'500Kva | 2 |
| 2'500 - 5'000Kva | 3 |
| Above 5'000Kva | 4 |
49. Amount spent on the average fuelling of generator on a daily basis?
- | | |
|---------------|---|
| 0 - 1'000 | 1 |
| 1'001 - 2'000 | 2 |
| 2'001 - 4'000 | 3 |
| 4'001 - 6'000 | 4 |
| Above 6000 | 5 |
50. Number of hour that your generator is switch-on on a daily basis.....
51. Amount spent on servicing/maintenance of your generating set on monthly basis.....
52. Comments.
- | | |
|--|---|
| No regular Supply/low Voltage | 1 |
| No regular Supply/Inaccurate Bill | 2 |
| No regular Supply/Phase Off | 3 |
| No regular Supply/Overloaded Transformer | 4 |

No regular Supply	5
No regular Supply/No Bill	6

Appendix Five: NEPA Form 74



Power Holding Company of Nigeria Plc.
DUGBE BUSINESS UNIT
APPLICANT NO.

Photograph of
the applicant

APPLICATION FOR ELECTRICITY SUPPLY AND AGREEMENT FORM
(TO BE COMPLETED IN DUPLICATE BY THE APPLICANT AFTER STUDYING THE CONDITIONS AND REGULATIONS OF SUPPLY SPECIFIED OVERLEAF)

PART 1

1.1 APPLICANT'S SURNAME (MR/MRS/MISS).....
OTHER NAMES IN FULL.....

1.2 ADDRESS AT WHICH SUPPLY IS REQUIRED.....

1.3 TYPES OF PREMISES.....

1.4 USE OF THE PREMISES.....

1.5 PREVIOUS
(a) RESIDENTIAL ADDRESS.....
(b) ACCOUNT NUMBER..... METER NO.....

1.6 NAME AND ADDRESS OF EMPLOYER/BUSINESS.....

1.7 CONTACT TEL. No. (if any).....

PART 2: DECLARATION (TO BE COMPLETED BY C.E.C.L.B. LICENSED ELECTRICAL CONTRACTOR)

2.1 Supply required for the following

	No.	Wattage		
A. Lighting Points			Motor: Single Phase Three Phase Other Equipment	Total H. P
B. Ceiling Fans				
C. Socket Outlets	5 Amps			
	13 Amps			
	15 Amps			
D. Cooker				
E. Water - Heater				
F. Airconditioner				
G. Others				

Total installed load.....Watts

2.2 ESTIMATED MAXIMUM LOAD APPLIED FOR.....Amperes per phase

2.3 REQUESTED VOLTAGE/TYPE OF SUPPLY.....

2.4 Name of C.E.L.B Licensed Electrical Contractor.....
Address.....
Licensed No..... Category.....
Signature..... Date.....

If over 100KVA, please complete Large Customer Record Card Form PHCN 74A in addition to this form

2.5 TO BE COMPLETED BY ONLY THOSE REQUESTING FOR CHANGE OF CUSTOMER
METER NUMBER..... ACCOUNT NUMBER.....

2.6 I/WE HEREBY REQUEST THE POWER HOLDING COMPANY PLC. TO SUPPLY ME/US WITH ELECTRICITY AT THE ADDRESS STATED AT 1.2 ABOVE FOR THE PURPOSE STATED IN 1.4 ABOVE AND AGREE TO PAY ALL CHARGES MADE BY PHCN IN ACCORDANCE WITH THE PREVAILING PHCN TARIFF. I/WE ALSO AGREE TO OBSERVE AND BE BOUND BY THE PREVAILING CONDITIONS AND REGULATIONS OF SUPPLY AS SPECIFIED BY PHCN

2.7 I/We confirm the information given in Part 1 above is true in all its entirety and agree that if any part of it is found to be untrue the electricity supply may be discontinued.

APPLICANT'S SIGNATURE _____ Date _____

PART 3 TO BE COMPLETED BY OWNER OF PREMISES

- 3.1 NAME.....
- 3.2 ADDRESS.....
- 3.3 METER NUMBER.....ACCOUNT NUMBER.....
- 3.4 NAME AND PRESENT ADDRESS OF PREVIOUS CUSTOMER AT THE ADDRESS WHERE SUPPLY IS REQUIRED.....
- 3.5 I confirm that the Applicant is my tenant and guarantee his/her request for electricity supply and also accept to notify PHCN writing when he/she gives notice (in writing or otherwise) of termination of his/her tenance agreement, failing which any outstanding debt or dues on his/her account may be debted to my own account.

Signature..... Date.....

PART 4 FOR OFFICE USE ONLY

(A) TO BE COMPLETED BY COMMERCIAL OFFICER

TYPE OF APPLICATION	TICK	PAYMENTS	AMOUNT N
NEW SERVICE		EXCESS SERVICE CHARGE/ CAPITAL CONTRIBUTION RECEIPT NO.	
ADDITIONAL LOAD/REDUCTION		DATE	
CHANGE OF CUSTOMER		SECURITY DEPOSIT PAID RECEIPT NO.	
ADDITIONAL METER		DATE	
CHANGE OF TARIFF		CONNECTION FEE AND PAID RECEIPT NO.	
CONVERSION FROM		DATE	
SINGLE PHASE TO THREE PHASE		TOTAL AMOUNT PAID	

THE ORIGINAL OF THIS APPLICATION HAS BEEN RECEIVED BY ME

NAME..... DESIGNATION.....
SIGNATURE..... DATE.....

(B) TO BE COMPLETED METER SUPERVISOR

METER NO.....ACCOUNT NO.....
METER READING ON THE LAST BILL.....
FINAL METER READING ON..... IS.....
(Date)

CHARGEABLE UNITS ARE.....

SIGNATURE..... DATE.....
NAME..... DESIGNATION.....

(C) TO BE COMPLETED BY CREDIT CONTROL SECTION

THE LATEST BILL ON THE ACCOUNT IS THAT OF.....AND THE AMOUNT

THEN OUTSTANDING IS N.....FINAL BILL AS PER PART (B) ABOVE IS N.....

THE TOTAL NOW DUE OF N.....

* (i) WAS SELECTED ON.....VIDE PHCN MACHINE RECEIPT NO.....
OF.....(DATE)

(ii) N.....HAS NOT BEEN SETTLED BUT TRANSFERRED TO ACCOUNT OF.....

OF.....ACCOUNT NO.....METER NO.....

Address

THE APPLICATION IS HEREBY CLEARED FOR FURTHER PROCESSING

SIGNATURE..... DATE.....
NAME..... DESIGNATION.....

CONDITIONS AND REGULATIONS OF SUPPLY

Electricity will be supplied in accordance with the Ibadan Electricity Distribution Company Plc. Decree 1972 (Decree No. 24 of the Federal Government of Nigeria) and the Electrical Supply Regulation of the Laws of the Federation of Nigeria and Lagos Revised Edition 1958.

The Ibadan Electricity Distribution Company Plc. (hereinafter called "The IBEDC") will supply Electricity subject to the following terms in conditions.

1. SYSTEM OF SUPPLY

The IBEDC system is Alternating current at a frequency of 50 Hertz. The medium voltage supply will be either 230 Volts single phase or 400 Volts three phase.

2. INSTALLATION

Wiring Installation shall be executed to the approval of the IBEDC which will inspect and/or test the installation once free of charge. For all subsequent tests, a fee per test is payable in advance.

3. SERVICE LINE

The nature and location of service lines and other supply facilities shall be determined by the IBEDC. The IBEDC shall be at liberty at any time to take branch services off the service lines whether on the customers's premises or not, for the purposes of supplying electricity to any other premises. The customers shall obtain and maintain all facilities required by the IBEDC for the installation of the service line including the necessary way leaves over his own and/or adjacent property which the IBEDC may require.

4. ACCESS TO PREMISES

The Customer shall give the IBEDC all reasonable and necessary access to the customer's premises for the purpose of connecting, disconnecting, inspecting, testing, altering, replacing, maintaining or removing any service line, meter and/or other apparatus or any part thereto and for reading the meter. The IBEDC official will produce the IBEDC official identity card, upon demand. The Customers shall pay a fee for each special meter reading made on request.

5. ADDITIONAL APPARATUS

After the installation referred to in the schedule on the front hereof has been tested and passed by the IBEDC, the customer shall have any additional apparatus connected to his installation without submitting an application form IBEDC 74 to the IBEDC giving at least seven days notice of his intention to do so, and he shall not use such additional apparatus until installation has been re-tested and passed by the IBEDC. Neglect of this precaution may cause interruption of supply and damage to IBEDC Equipment. A penalty may be imposed for default.

6. TESTING AND ACCURACY OF METERS

Should the customer or the IBEDC give notice disputing the accuracy of a meter; such meter shall be tested by the IBEDC. If the Customers considers his meter as inaccurate, his notice to that effect shall be accomplished by a deposit to cover the cost or the test. In the event of the meter having an error exceeding the limits of error as may be allowed by the regulations in force, the amount payable for electricity charges for the period for which the customer is charged on the last invoice rendered prior to the notice of dispute shall be determined by correcting the registration in question by reference to the degree of inaccuracy shown by the test and the deposit shall be returned to the Customer. If the meter shall have ceased to register the Customer shall pay to the IBEDC such amount as may be estimated by the IBEDC to be payable for that period.

7. DISCONTINUANCE OF SUPPLY

Not less than seven clear days notice in writing shall be given to the IBEDC by the Customer before vacating the premises. In default of such notice Customer shall be liable to the IBEDC for all accounts arising until such notice is received or until the IBEDC accepts an application for supply to the same installation from another Customers. The IBEDC reserves the right to discontinue supply of electricity when other Customers are being connected or when the IBEDC's mains or apparatus are being tested, repaired, on in cases of unavoidable interruptions due to fire, flood, tempest, accidents and break-down of machinery etc.

8. PAYMENT FOR ELECTRICITY

From the date supply is made available, the Customer shall pay monthly for all electricity supplied in accordance with a tariff in force. Official Receipts are issued by the IBEDC for all payments made to it. Customers are advised on each occasion to check that the amount machine-printed on

Appendix Six: New Service - Customer File Movement

19/9/13/7722-01

POWER HOLDING COMPANY OF NIGERIA PLC.
AKANRAN BUSINESS UNIT
(New Service)
CUSTOMER FILE MOVEMENT

Service Unit: Akanran District Facility: RS Contractor's Name: Jeje Onigbala

Customer's Name: Pastor Akw Oshun CH# 14 Ife Obi Irem City Airport 2


(registered by: O. K. Fabiyi (Mrs))

Date Registered: 06/03/2012

Application No: IBJ/AKRBU/2012/1/3/014

1. Customer's Name (registered by: <u>O. K. Fabiyi (Mrs)</u>)	7. Manager New Service Signature: <u>[Signature]</u> Date: <u>16/05/12</u>
2. Mains Inspector: Name: <u>[Signature]</u> Signature: <u>[Signature]</u> Date: <u>[Signature]</u>	8. Credit Control (Manager Revenue) Receipt of bill or bank draft Signature: <u>[Signature]</u> Date: <u>26-03-12</u>
3. CSS: (Name): <u>ABEGANDE M.K</u> Confirmation of Nearest A/C: Signature: <u>[Signature]</u> Date: <u>07/03/2012</u>	9. Customer Service Officer (CSO) Approves bill for payment Signature: _____ Date: _____
4. Service unit (Manager) Approval of Mains Inspector's Report: Signature: <u>[Signature]</u> Date: <u>12-03-2012</u>	10. Manager New Service Servicing and Meter Installation Date Meter Fixed: _____ Type of Meter: _____ Meter No: _____ Reading: _____ Fixers Name: _____ Fixers Signature: _____
5. Manager New Service: Issue permit to wire Signature: <u>[Signature]</u> Date: <u>[Signature]</u>	11. "Business Manager" (BM) Approval of CRMD Signature: _____ Date: _____
6. Installation Inspection Installation test report Signature: <u>[Signature]</u> Date: <u>[Signature]</u>	

Appendix Seven: Mains Inspector Report Form



NATIONAL ELECTRIC POWER AUTHORITY

MAINS INSPECTION REPORT

(To be completed in Triplicate)

From: UNDERTAKING COMMERCIAL SUPTD To: DDM/ UNDERTAKING DISTRIBUTION SUPTD

Application Number TR/AKR31/2012/1/3/014 Date 06/03/2012

Prf: Akwaran District

(A) REQUEST FOR MAINS INSPECTION (FOR LOW VOLTAGE ONLY)

PLEASE FIND ATTACHED THE COPY OF THE APPLICATION FORM FROM PRESPECTIVE CONSUMER WITH DETAILS AS STATED BELOW:

1. NAME OF CONSUMER Pastor Akintshun Abraham
2. ADDRESS AT WHICH SUPPLY IS REQUIRED C14, Ife Ow, Igem City
3. APPLICATION SERIAL No 2012/014 DATE 06/03/12

FOR THE CONNECTION OF A SINGLE / THREE PHASE LOW VOLTAGE LOAD OF _____ *SINGLE AMPS/PER PHASE

YOU ARE HEREBY REQUESTED TO ARRANGE THE MAINS INSPECTION AND FORWARD YOUR REPORT TO ME TO ENABLE US PROCESS THE APPLICATION FURTHER.

NAME _____ DATE _____

SIGNATURE _____

(B) MAINS INSPECTION REPORT (FOR LOW VOLTAGE ONLY)

1. MAINS AVAILABLE YES
2. NAME AND NUMBER OF THE TRANSFORMER SUBSTATION IGEM 7500KV 2S
3. PERCENTAGE LOADING OF THE TRANSFORMER 68%
4. SIZE OF MAINS 1000mm² Aluminium Conductor
5. PRESENT LOAD ON MAINS R= 460 T= 474 B= 480
6. NUMBER OF SPANS FROM THE TRANSFORMER SUBSTATION 1 span
7. CONNECTION POLE NUMBER No connection by New pole
8. SKETCH OF CONNECTION DETAILS ON THE REVERSE SIDE P.T.O

I CERTIFY THAT THE APPLICANT SHOULD/SHOULD NOT BE CONNECTED TO THE EXISTING NETWORK FOR THE FOLLOWING REASONS:

Its Okay for Connection

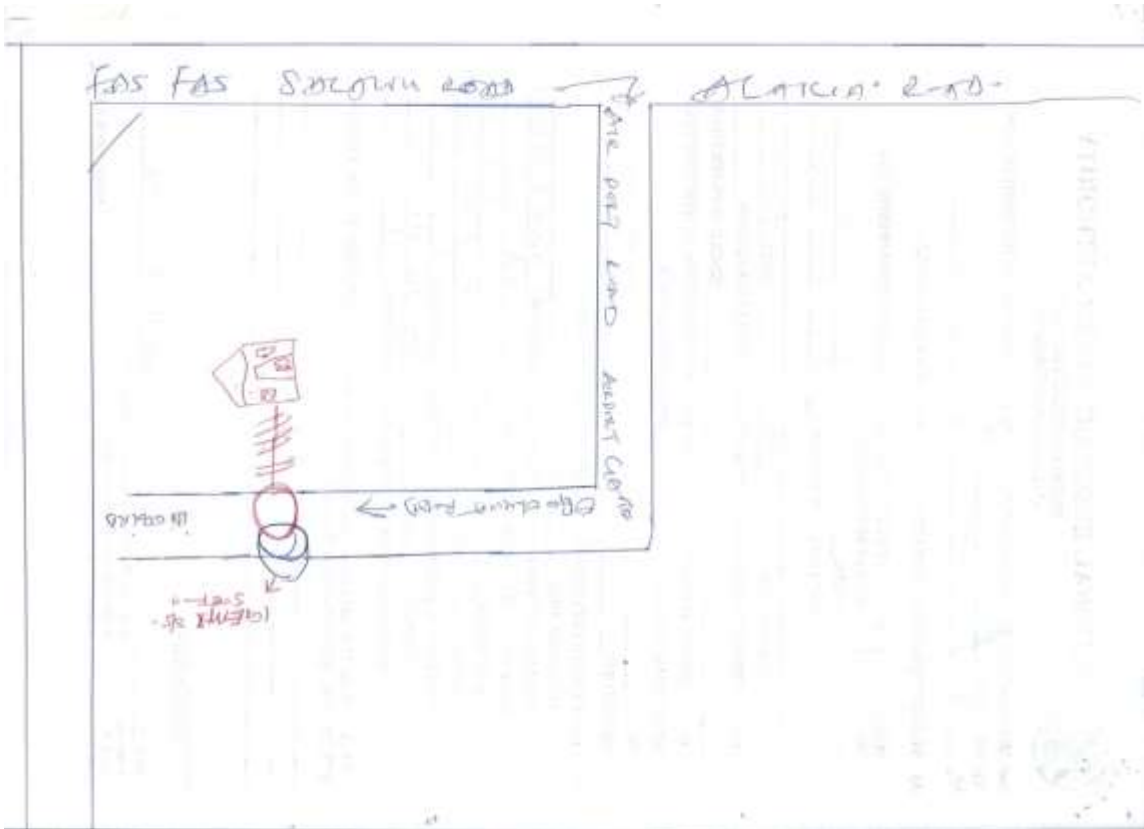
 MAIN SUPTD/HTO

NAME AKP... J.D DATE 12-03-2012

ORIGINAL	"	RETURN TO COMMERCIAL MANAGEMENT
YELLOW	"	RETAINED BY DISTRIBUTION
PINK	"	RETAINED BY COMMERCIAL SF

FORM NEPA 748

Appendix Eight: Hand Drawn Schematic Diagram of Applicant's Residential location



Appendix Nine: Permit to Wire - Form

Form 100

- PERMIT TO WIRE

To: Pastor Kwechun Abraham
C/A Hebe Igem City
Airport area

From: Atkinson
Undertaking
To

Date: 06/03/12

I have to acknowledge receipt of your application to wire up the following premises for electrical supply and permission is granted accordingly.

It is to be understood that the issue of this permit does not guarantee the continuation of electricity supply to the customer unless all conditions of supply have been complied with.

Payments to be made

Item	Description	Amount	
		N	K
1	Connection Fee <u>20</u>	<u>55,000</u>	
2	Focus Service Charge		
3	Capital Contribution		
4			
Total		<u>55,000</u>	

M.A.P. Agreement is included (YES/NO) _____

Engineer/Manager _____

Appendix Ten: Installation Inspectors Report and Completion Certificate

Form N.E.P.A. 102

INSTALLATION INSPECTOR'S REPORT AND COMPLETION CERTIFICATE

I certify that the electrical installation
Pastor Akimoshin Abraham
C4, 170 Olu, Igem City Area, Airport Rd. Lagos

has been inspected and tested by me and the results are as indicated below:

1. Polarity throughout the installation is correct/wrong.....
2. Insulation resistance between conductors is.....Megohms.
3. Insulation resistance between conductors and earth is.....Megohms.
4. Earth loop impedance is.....ohms
5. There is overloading of sub-circuits..... YES/NO? NO
6. There is sign of overloading of conductors. YES/NO? NO
7. Method of installation earthing.....
8. I certify that the following defects were found in the installations as follows:
.....
.....

[Signature]
Signed: (Installation Inspector)

9. I recommend that this installation is not ~~is not~~ satisfy the requirements of the Electricity Regulations of Nigeria.

Date: 7/3/2012

Note:
Where the test fails to satisfy the standards required, another test must be carried out within 7 days after payment of a test fee of N1.00.

210

Area: <u>It</u>	Total Installed Load: <u>20x26/10x200/5x1000amps</u>
Customer: <u>Pastor Akintolu</u> <u>Abraham</u>	No. of Phases Req'd: <u>3φ</u>
Application: <u>TBA/KRB/12512</u> Form No: <u>11/3/04</u>	Sizes & Type of Mains: <u>100mm aluminium Cable for</u>
Date Received: <u>06/03/12</u>	Sizes & Type of Service: <u>16mm PVC Cable</u>
Mains Available: <u>Yes</u>	Sizes & Type of Cut-out: <u>30A</u>
Excess Service Fee* Date Paid: Receipt No.	Size of Service Fuse
Permit Issued*	Ins. Res. Between Conductors
Completion Form Recd.*	Ins. Res. Between Conductors & Earth
Passed for Servicing	Earth Resistance
Service Erected*	Date*
Installation Tested: <u>7/3/12</u>	Size & Type of Meter
Meter Fixed*	No. of Meter
Remarks: <u>1no. of M.T.C</u> <u>1no. of M.C.B.</u>	Date
	Size, Type of M.D. Indicator
	No. of M.D. Indicator
	Date
	Floor Area
	Assessed M.D.
	Hire Apparatus Details

*All entries must be signed and dated

Appendix Eleven: NEPA Form 111 - Completion Notice Form

Form N.E.P.A. 111

COMPLETION NOTICE FORM

Undertaking
 I/We wish to give notice, that the installation in the premises of St Akindshin Abraham
 situated at C-14 Ibe Olu IGEM CITY AREA AIR PORT
 has been completed in accordance with Electricity Regulations of Nigeria and I/We request that
 the installation be inspected and tested

If the entire installation is satisfactory, necessary service connection and metering is requested
 at your earliest convenience.

Particulars of the installation are as follows:-

Lights		Plugs		Motors		Apparatus Or Apparatus	
No.	Watts	No.	Amps	H.P.	H.P.	Description	Watts
20	26	10	13	15			
2	80		6	30			

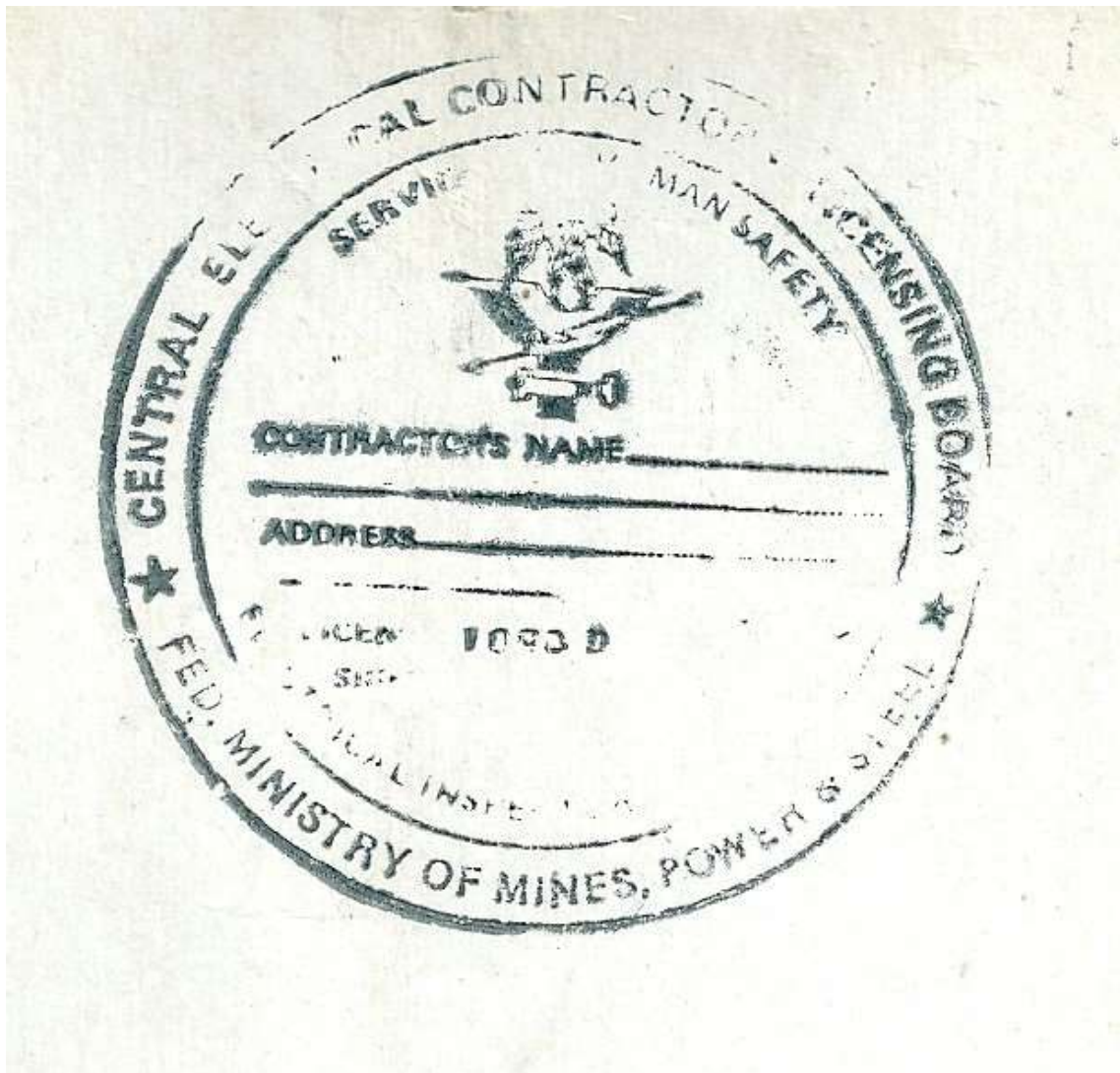
Total Load 9470 Watts
 Peak Rating 60 Amp
 No. of Phases 3
 Earth Continuity Conductor (size) 4 wire 6mm
 System of Wiring surface/bench/underground cable
 Type of cable used PVC
 Permit to Wire issued to me is returned

Conduct with wire

1090 D
 Licence No. _____ Date _____

215

Appendix Twelve: Federal Ministry of Mines, Power and Steel (Central Electrical Contractors Licensing Board) Seal




Appendix Thirteen: Licensed Electrical Contractors Association of Nigeria (LECAN) Seal



Appendix Fourteen: Request for Transformer by Ifesowapo Community of Bodija Inukoko Area

OTUSU ADOSI IBADAN

TELEPHONE: IBADAN 810309, 810316



OYO STATE RURAL ELECTRIFICATION BOARD
P. O. BOX 27150, AGC 21
IBADAN, OYO STATE OF NIGERIA

All communications should be addressed to the Chairman of the Board quoting
REF/56/1/57

Date Recd. No. 21 October, 2001

The Chairman,
Ifesowapo Landlord Association,
c/o Oluadunni Memorial School,
Bodija, Oosunkaye,
P.O. Box 7262,
Ibadan.

Dear Sir,


RE-REQUEST FOR TRANSFORMER AND ELECTRIFICATION ASSISTANCE

I am directed to refer to your letter of 9th September, 2001 on the above subject matter and to inform you that the Board can assist your community with the underlisted materials;

i) 200KVA 11/0.415KV Transformer	1 No.
ii) 800AMP 4 Ways Feeder Pillar	1 No.
iii) 100mm ² ACSR Conductor	0.825km
iv) Steel X-Arm 11KV	2 No.
v) Wooden X-Arm 11KV	2 No.
vi) Earth rod	7 No.
vii) 4 x 120mm ² PVC/SWA/PVC	5m

2. However, the materials can not be released until you show evidence of payment of participation fees of two hundred and ninety thousand, two hundred and seven naira, sixty kobo (N290,207.60) to the Board.

3. Thanks for your cooperation.


Engr. T. A. Oni
Project Manager
for Chairman.

