

PETROLEUM PRODUCTS UTILIZATION IN THE FEDERAL CAPITAL TERRITORY (FCT) ABUJA, NIGERIA: CURRENT TRENDS AND PROJECTED DEMAND.

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Abstract: The problem of lack of proper energy planning to meet demand has always affected the provision of adequate, clean and affordable energy in many countries and cities especially in a fast growing state capital like Federal Capital Territory (FCT), Abuja in Nigeria. The objective of this study was to determine the petroleum products utilization pattern in the Federal Capital Territory (FCT) and to make projections of its demand in the FCT from 2009 to 2035. A total of 520 questionnaires (household =150, Services =150, Industry =50 and Transport =170) were administered with 507 valid responses representing a 97.5% response rate. The language, content and design of the questionnaire made it easily understood and placed limited time burdens (10 minutes) on the respondents. Quota sampling method was adopted for the survey so as to capture all types and categories of the various sectors considered in this research. The questionnaires were administered in the selected locations of the six area councils of the Federal Capital Territory. Data collected was used in running the model for analysis of energy demand (MAED) and to establish the energy demand base year data of the Federal Capital Territory. The result of the study shows that at base year 2009, the FCT economy was driven by services sector with about 92% contribution to the total gross domestic products (GDP) of the FCT. It also shows that petroleum products are being consumed in the FCT in three forms as motor-fuels, fossil substitutables and fuel for self-generation of electricity. The result went further to show that passenger transport consumed highest among all the sectors while services sector consumed least. The results were found to be in agreement with Energy Commission of Nigeria (2010) report of energy demand projections for Nigeria and are in line with the National Energy Policy and the Federal Government's Vision 20:2020. It is recommended that an energy policy and plan be put in place and other sustainable energy measures be adopted in the FCT for optimal and efficient utilization of petroleum products in the capital territory.

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1. Introduction:

The role of energy in economic development, social welfare, and environmental sustainability increases everyday with growing population and economic activities. This has led to cities all over the world planning and implementing more sustainable approaches to their energy production and use. By the year 2020, more than half of the developing world population is expected to live in cities (IEA 2007). Cities consume 75% of the world's resources and produce 75% of the world's wastes, while occupying only 2% of the earth's surface (IEA 2007). The aggregate analysis and how the totality of the energy resources are consumed in respect to the efficiency of conversion technologies is what is regarded as the utilization. Nigeria is the largest

oil producer in Africa, the eleventh largest producer of crude oil in the world and a member of the Organization of Petroleum Exporting Countries (OPEC). In 2006, Nigeria's total oil exports reached an estimated 2.15 million bbl/d (CBN, 2010). Nigeria shipped approximately one million bbl/d or 42 percent of its crude exports to the United States in 2006 (Sambo et al, 2009). Consumption of petroleum products grew tremendously from the middle of the 1980s reflecting the rapid growth in the number of automobiles, industries, households, intensified rural-urban migration, economic and political developments (NBS, 2011). The bulk of products consumption has been the premium motor spirit (PMS) or petrol, automotive gas oil (AGO) or diesel, dual purpose kerosene (DPK) and bitumen/asphalt. These, together, account for more than 60 percent of the total consumption of petroleum products (ECN, 2010). Petrol and diesel are the major fuels utilized in the road transportation sector as well as for small to medium sized electricity generation plants for power supply in homes and locations detached from the grid supply, as well as standby power sources in industries. Specifically, diesel is largely used on heavier engines while petrol is used in vehicles, small electricity generating plants, drives for compressors, etc. Household kerosene is mostly used in homes for heating and lighting, in aviation (an upgraded form of it) as aviation fuel and in industries to produce insecticides and other pest control products. Many researchers have works in this area for example; Ohunakin O. S (2010) in his work gave a detailed overview of energy utilization in Nigeria with emphasis on both fossil and renewable energy sources. Irimiya *et al.* (2010) made comparison between the energy utilization in a rural and urban area in which they evaluated the energy utilization in the rural and urban areas and its environmental impact. Also, Dzioubinski *et al.* (1999) looked at increasing disposable income and changes in lifestyles which show that households tend to move from the cheapest and least convenient fuels (biomass) to more convenient and normally more expensive ones (kerosene) and eventually to the most convenient and usually most expensive types of energy (LPG, natural gas, electricity). The study also noted that the Key factors in the growth of household electricity consumption are the number of households with access to electricity supply, penetration rates of electric appliances and the size and efficiency of appliances. Samish Indian Nation Long-Term strategic energy plan prepared by RIDOLFI Inc. and Shuksan energy consulting (2005) for Samish Indian Nation is divided into three parts: Tribal energy vision, current energy status and action plan. The tribal energy vision provides a description of the tribe's energy goals (where it wants to go); the current energy status evaluates existing tribal

energy use (where it is now); and the action plan identifies options for moving toward achieving the tribe's energy goals (how it will get there). Another study that discussed in detail the is the study by Dayo (2008), in his research on the energy consumption pattern in Nigeria, highlighted the historical data on Nigeria's energy system which is the baseline information utilized in this study. His report provides country background information focusing on country trends for energy demand, supplies of energy, clean energy technologies, and energy policies.

Generally, the demand for petroleum products has continually been on the increase. Most of the demand for the products is usually supplied by the domestic refineries. However, owing to the poor conditions of three of the four refineries (Table 1), there have been shortages which had to be augmented with importation from time to time. Nigeria has four domestic refineries owned by the government with capacity to process 445,000 barrels of oil per day, yet imports constitute more than 75% of petroleum products requirements. The state owned refineries have hardly operated above 40% capacity utilization rate for any extended period of time in the past two decades. The gasoline market is much better supplied than kerosene and diesel because of its higher political profile. This factor explains why the government has embarked on large import volumes to remedy domestic shortages of the product. Jaja (2010) in her work analyzed recent trends and spatial patterns of gasoline consumption in Nigeria which show that the volume of gasoline consumption in the country fluctuates with changes in economic growth. The pattern of distribution of gasoline consumption indicates that the largest consumption centers are in the South-West and South-South geopolitical zones of the country, specifically Lagos, Oyo, Ogun, Edo, Rivers and Delta States. Other locations of high gasoline consumption are Kaduna, Kano, Imo states and Federal Capital Territory.

Energy demand projection is usually carried out using the modeling tools which are either developed by the planner or already developed and used by other people or organizations. Usually, energy demand is disaggregated into a number of end- use categories, each corresponding to a given service or to the production of a certain good e.g. industrial sector, transport sector, household and services sectors (Sambo *et al.*, 2006).

The nature and level of the demand for goods and services are a function of several determining factors, including population growth, GDP growth rates and changes of GDP structure, number

of inhabitants per dwelling, number of electrical appliances used in households, peoples' mobility and preferences for transport modes, national or regional priority for the development of certain industries or economic sectors, evolution of the efficiencies of certain types of equipment, market penetration of new technologies or energy forms. The expected future dynamics for these determining factors are exogenously introduced (ECN, 2009). The Federal Capital Territory (FCT) Abuja, Nigeria was chosen for carrying out this research work because of its strategic position, role and relevance to national development, being the federal capital of the country and also adjudged the fastest growing city in Africa. The territory is currently made up of six (6) local councils, namely: Abuja Municipal Area Council, Abaji, Gwagwalada, Kuje, Bwari and Kwali. It has an area of 7,315 km² (2,824.3 sq mi), a population density of 192.1/km² (497.5/sq mi) and an estimated population of 1,579,595 in the 2007. This research, therefore, was undertaken to determine the petroleum products utilization pattern in the Federal Capital Territory and to make projections of petroleum products demand in the FCT from 2009 to 2035

2. Materials and Methods

2.1 Materials

The materials used for this research work include;

- ✓ Questionnaires
- ✓ Equations and Formulae
- ✓ Model for Analysis of Energy Demand (MAED) - software from International Atomic Energy Agency (IAEA).
- ✓ Secondary data from relevant government ministries, agencies and departments (MDAs), other stakeholder organizations in the energy sector and international organizations.

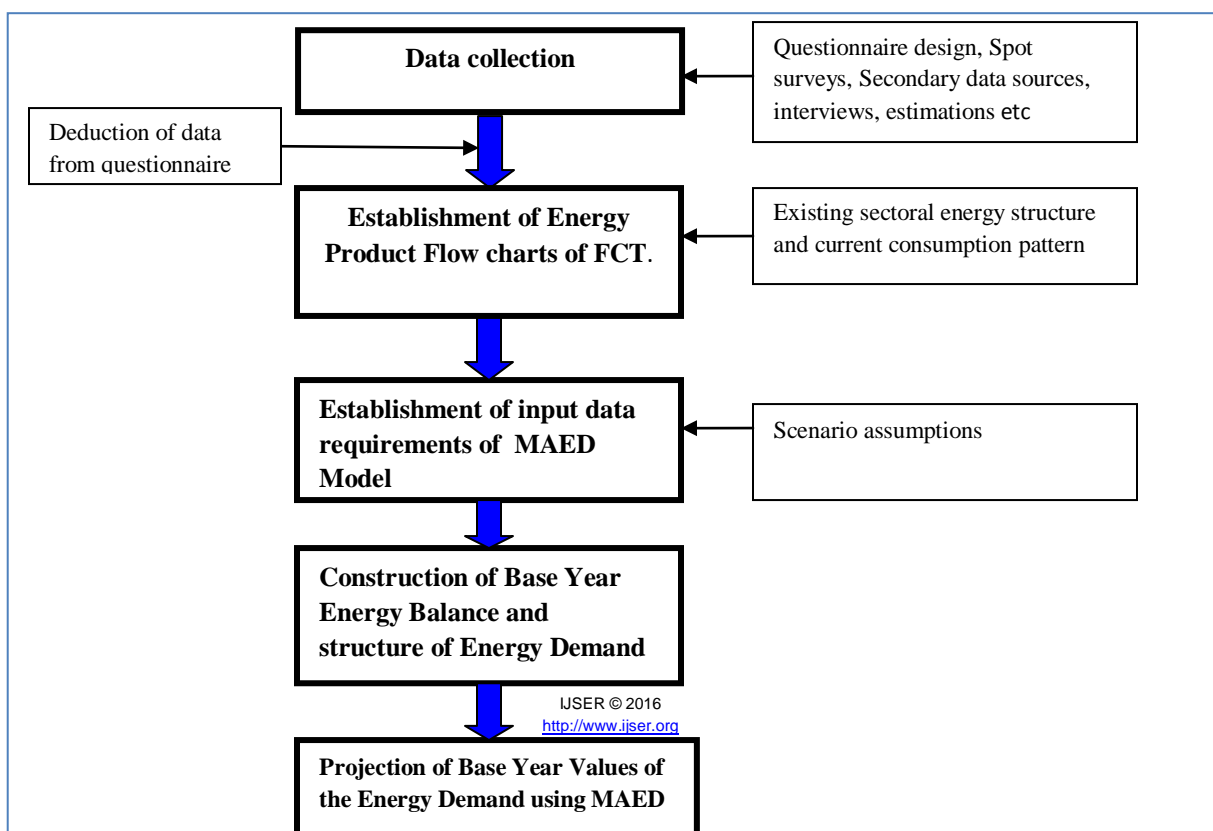
2.1.1 Questionnaires

In the design and administration of questionnaires, the Energy Commission of Nigeria's methodology in their work on energy demand and supply projection for Nigeria 2005, as

presented by Olayande (2008) was adopted. The study made use of the percentage contributions of the various sectors as their respective weights for energy consumption and that was used as the sectors' corresponding percentage number of questionnaires. Quota sampling method was adopted for the survey so as to capture all types and categories of the various sectors considered in this research. The questionnaires were administered in the selected locations of the six area council of the Federal Capital Territory. A total of 520 questionnaires (household =150, Services =150, Industry =50 and Transport =170) were administered with 507 valid responses representing a 97.5% response rate. The language, content and design of the questionnaire made it easily understood and placed limited time burdens (10 minutes) on the respondents.

2.2 Methods

The methodology used for this study was designed according to the energy demand modelling steps of Energy Commission of Nigeria for the national energy demand and supply projection. In designing the questionnaires for the collection of data needed for the running of the model (MAED) and to establish the energy demand base year data of the Federal Capital Territory, the input data requirements were put into consideration. The method used for this work is as expressed in the activity flow diagram shown in Figure 1 below.



2.2.1 Data Collection

The availability of data is the prerequisite for any kind of planning and analysis especially energy planning. Sources of data for this research were grouped into two; Primary and Secondary data sources. The primary data sources were obtained through spot surveys and interviews, while the secondary sources were obtained from relevant agencies of government and other organizations and stakeholders in the energy sector.

2.2.2 Sampling design and size

The sampling frame consists of the four major economic sectors under consideration (transport, services, household and industry), and this comprises of the drivers of energy demand in the sectors which include; demography, socio-economic indicators, efficiency of conversion equipment, age of vehicles, type of vehicles, types of household and the size, etc and these are limited to the Federal Capital Territory, involving only petroleum products consumption. The sample size considered a portion of the Territory in a logical and scientific manner using the formula provided by Yamane (1974) as cited by Evborokhai (2009) which is as follows;

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where;

n = required sample size

N = total population of sample frame of each sector considered

e = significance level chosen (5%)

1 = constant

2.2.3 Overview of Model for Analysis of Energy Demand (MAED)

MAED is a simulation, bottom-up model for evaluating the energy demand implications (in the medium and long term) of a scenario describing a hypothesized evolution of the economic activities and of the lifestyle of the population. MAED model evaluates future energy demand based on medium- to long-term scenarios of socio-economic, technological and demographic developments. The model focuses exclusively on energy demand, and even more specifically on demand for specified energy services.

2.2.4 Generic Equation of MAED for Energy Demand Calculation

$$EDFY = (ED/DP) BY * DPFY * CHFY \dots\dots\dots(1)$$

Where:

EDFY – Energy Demand in Future year

(ED/DP) BY – Specific energy demand per unit of driving parameter in base year

DPFY – Driving Parameter in future year

CHFY – Coefficient of evolution of specific energy demand per unit of driving parameter

3. Results and Discussion:

3.1 Demography

The population of Federal Capital Territory (FCT) grew from 1.406 million in 2006 to 1.9 million in 2009 and a population density of 192 people per square kilometre. It accounts for 1.3% of Nigeria's total population (NPC, 2006). The projected population growth rate increase slightly from 3.16% per annum in 2009 to 3.8% per annum in 2020 as is seen in Figure 2, this was due to fertility, cultural practices, religious beliefs, mortality and migration, bringing the

population to 2.258 million people in 2015 and 2.721 million people in 2020 as shown in Figure 3. Figure 2 shows a decline in population growth rate to 3.88% per annum from 2035. This is likely going to be as a result of government policies in birth control and reduced urbanization due to even development of all the Area Councils in the FCT.

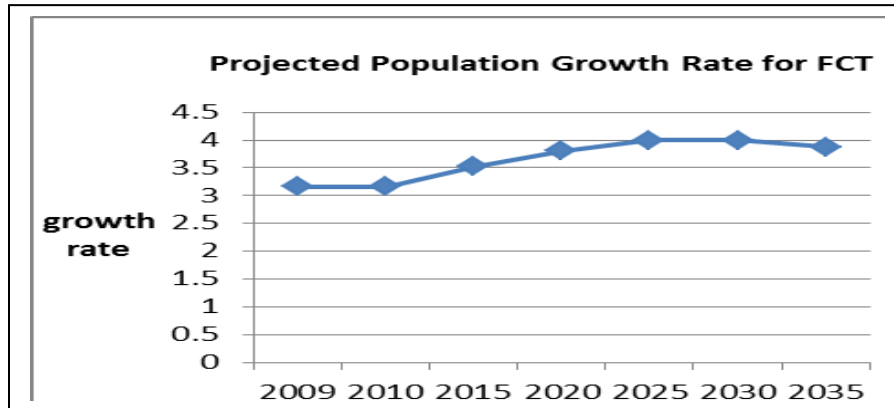


Figure 2: Projected Population Growth Rate of FCT 2009-2035

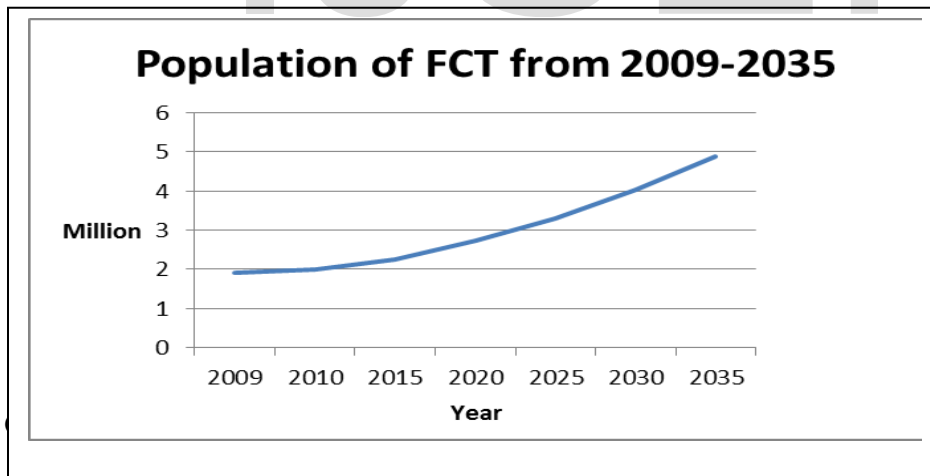


Figure 3: Projected Population of FCT from 2009 - 2035

3.2 Gross Domestic Product

The overall Gross Domestic Product (GDP) of the Country in 2009 was put at about 716,949.68 billion naira, and the FCT contribution to the GDP was 26.6707 billion naira. This is about

3.72% of the total GDP of the country. Figure 4 shows the base year GDP of FCT and the percentage contribution of all the various sectors. It also shows that Services sector contributed about 92% of the total GDP of the FCT, amounting to 24.537 billion naira. This means that FCT economy at the base year was service sector driven, and this is so with most cities in developed countries.

The result of the GDP projection in Figure 4 shows that the GDP is increasing every projected year for all the sectors of the economy. It also shows that Services sector will remain the major contributor of the GDP in the FCT till 2035 which is the last projected year, but with a decline in percentage (54%) contribution to the economy, as other sectors like Manufacturing (15%) and Energy (13%) improved significantly against what they contributed in the reference year (2009). The total GDP for FCT will increase to 145.4231 billion naira (about USD765,384,736.84 at 190/USD) in 2035. This result agrees with Hannesson (2009) in his work where he stated that there is a significant positive relationship between growth in energy use and growth in GDP for all countries taken together and for all subsets of countries, although not necessarily proportional.

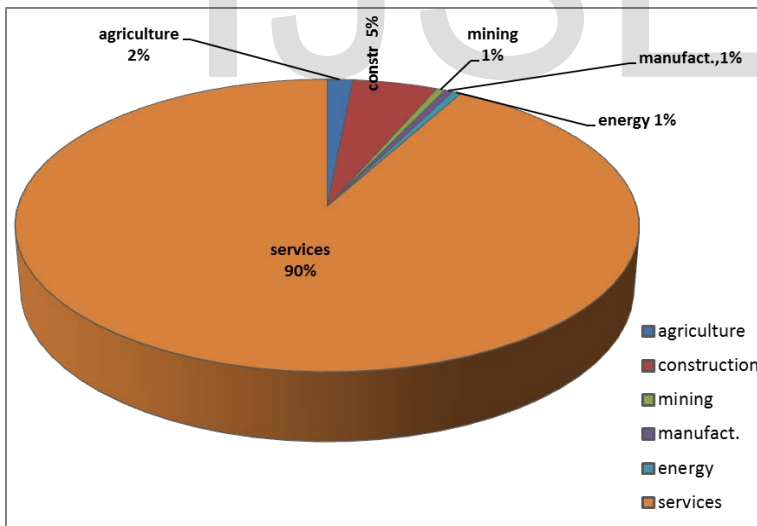


Figure 4: Sectoral Contributions to the GDP of FCT

3.3 Motor-Fuels Per Sector

Motor Fuels are basically fuels used for the powering of motor vehicles for both passenger and freight, public and private, equipment in industries, and this forms part of the petroleum products consumed in the FCT. The major fuels in transportation will continue to be PMS and AGO. Air planes and water transport vehicles are not within the scope of this work, therefore, their consumptions were not considered in this work. The result of this study showed that the base year consumption for motor-fuels that it is only in the industrial and transport sectors that the motor-fuel is consumed. Figure 5 shows that the industrial sector consumed about 0.051Gwa which accounted for about 11% of the total motor fuels consumed in the base year, while the rest was consumed in the transport sector which accounted for about 14% for freight and 75% for passenger Transportation as shown in Figure 6. This increase was more significant in the passenger transport, then in the industrial and freight transport sectors, as seen in Figure 7. This implies that the demand for motor fuel will continue to increase in the FCT over the projection years especially for the passenger transportation having the greater share against the freight transport and industrial sector.

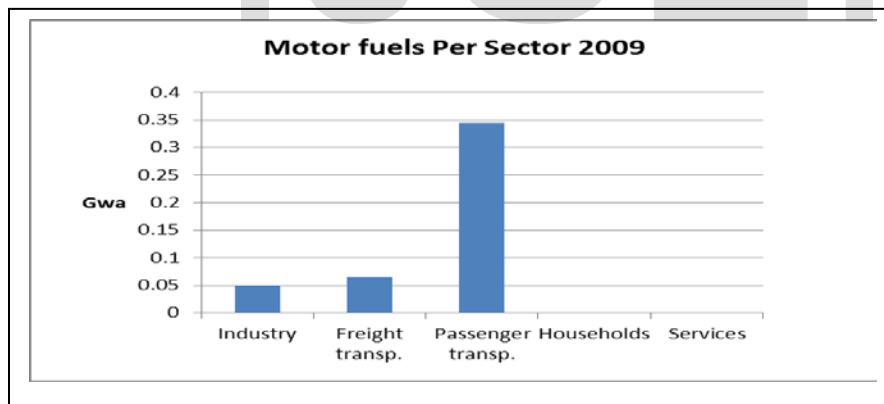


Figure 5: Motor-Fuels Per Sector for Base Year (2009)

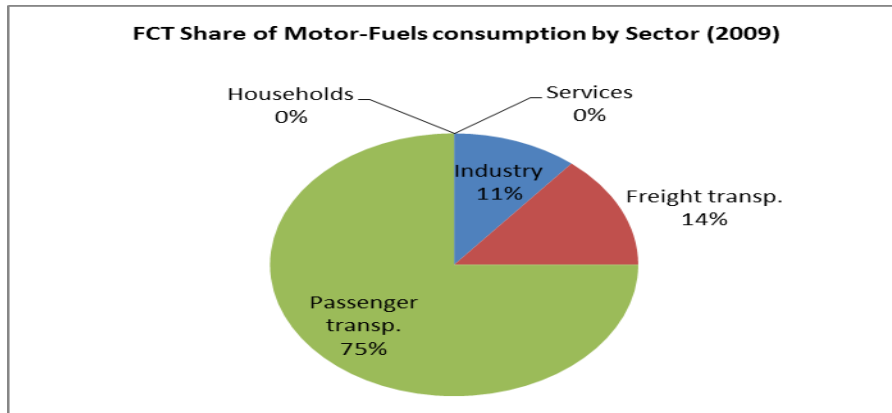


Figure 6: Percentage Share of Motor-Fuels Per Sector for FCT in 2009

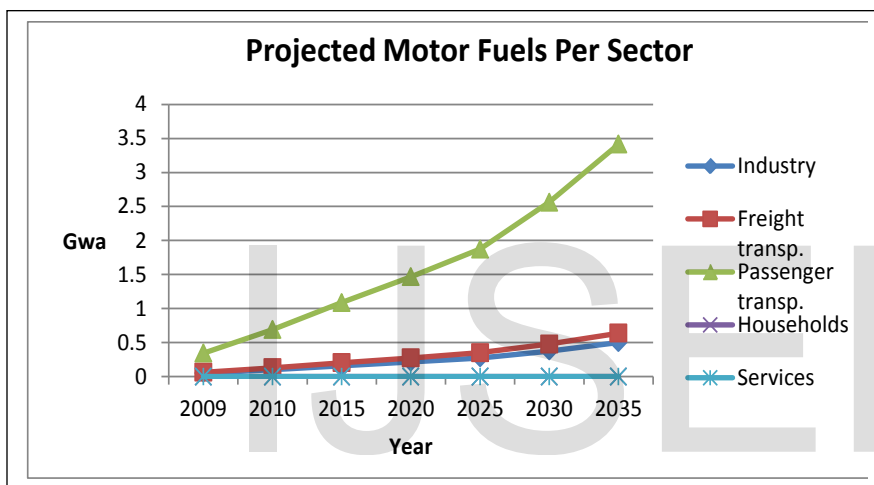


Figure 7: Projected Motor-Fuels Per Sector from 2009 - 2035

3.4 Petroleum Products Consumption in the Services Sector

In Nigeria, there are only three (3) energy forms consumed in the services/commercial sector in the base year and these are; electricity, non-commercial and fossil substitutables. Electricity consumption accounted for about 55% of the total, while non-commercial energy form and fossil substitutable accounted for about 28% and 17% respectively. About 40% of the electricity consumption of the Services sector was generated from small private/personal generating power plants (generators) and these generators are powered by petroleum products (AGO and PMS) depending on the capacity of the generator. Therefore, petroleum products consumption in the

FCT is basically for electricity generation and as fossil substitutables (DPK, LPG, Acetylene etc.). Figure 8 shows that petroleum products consumption in the FCT will increase till 2020 and start declining till the last projection year of 2035. This will be because of the fact that by 2020, there must have been adequate and reliable electricity provision in the FCT from the grid, therefore making the consumption of AGO and PMS for self-generation of electricity to decline.

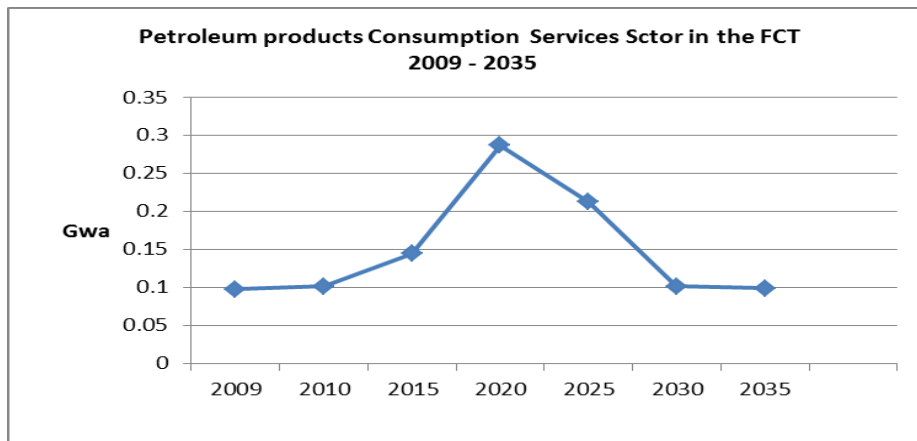


Figure 8: Petroleum Products Consumption in the Service sector in FCT 2009 - 2035

3.5 Petroleum Products Consumption in the Household Sector

The total number of Households in the FCT was estimated to be about 300,000 in the base year comprising of different types of houses and an average of 6.5 persons per household. These two parameters and the end use conversion technologies in the form of household appliances are the determinants of energy demand in the Household sector in the FCT. The result shows that fossil fuel is still used for lighting in the household sector in the FCT. There is also the fossil substitutable energy form which is energy from fossil used specifically for heating purposes in the Household sector. The projected petroleum products demand in the household sector as shown in Figure 9 shows that the demand for petroleum products in the Household sector will keep increasing till 2020, as in the case of services sector, but will start declining too till 2035.

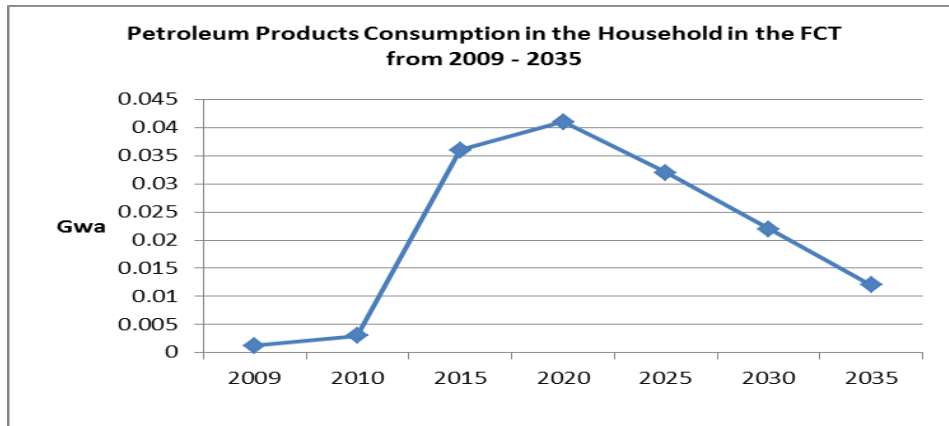


Figure 9: Petroleum Products Demand in the Household sector in FCT 2009 - 2035

This result has similar trend with ECN, (2010) report of energy demand projections for Nigeria, this showed continuous increase over the year from the base year of 2005 and a decline after some years. The increase will be due to the increase in population, increased GGP and changes in life style, while the decline will be due to adequate grid supply of electricity which will result to less consumption of petroleum products for self-generation of electricity. More so, the efficiency of the appliances is also a determining factor for the energy demand in the Household sector, which is likely to change over time due to awareness on the use of more efficient and energy saving appliances.

3.6 Energy Consumption of Passenger Transport

Petroleum products consumption in passenger transport sub-sector in the FCT is mostly on cars and mass-transit buses. This was so because as part of the assumptions in this study, motorcycles, tri-cycles, etc. are all converted to car equivalents and included in car population. Figure 10 shows that in the base year (2009), cars consumed 0.217Gwa which accounted for about 82% of the total energy consumed for passenger transport, while mass-transit had a share of 17% (0.01Gwa). The result also shows that the demand for energy for passenger transport in the FCT will continue to increase as a result of increase in population and economic activities. This result also agrees with ECN, (2010) result of Energy demand and supply projection for Nigeria.

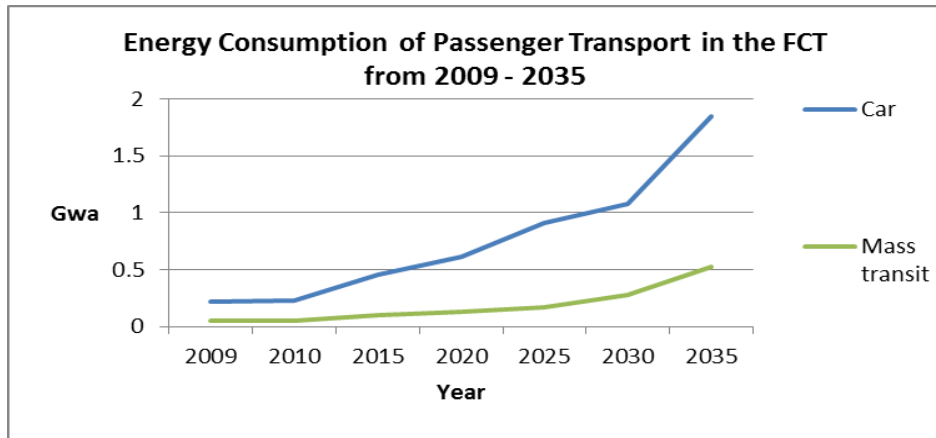


Figure 10: Petroleum Products consumption in Passenger Transport in FCT 2009 - 2035

3.7 Petroleum Products demand of Freight Transportation

The result in Figure 14 also shows that energy consumption was only witnessed in three (3) transport modes which includes; Small-Trucks, Big-Trucks and Pipeline. It also shows that 0.035GWa of the total petroleum products demand in the freight transport was consumed by Big Trucks and this accounts for about 53% of the total energy in the sub-sector. The result of the projected energy demand in the freight transport also in Figure 11 shows that diesel train will be introduced to the FCT by 2015 (Even though this has not been fully achieved, construction is still under way). Figure 14 shows that energy demand for Freight Transportation in FCT will keep on increasing from what it was in the base year (2009) till the last projection year of 2035. This increase will be as a result of increased economic activities in the FCT, which will result also to more ton-kilometer of goods and services in the FCT.

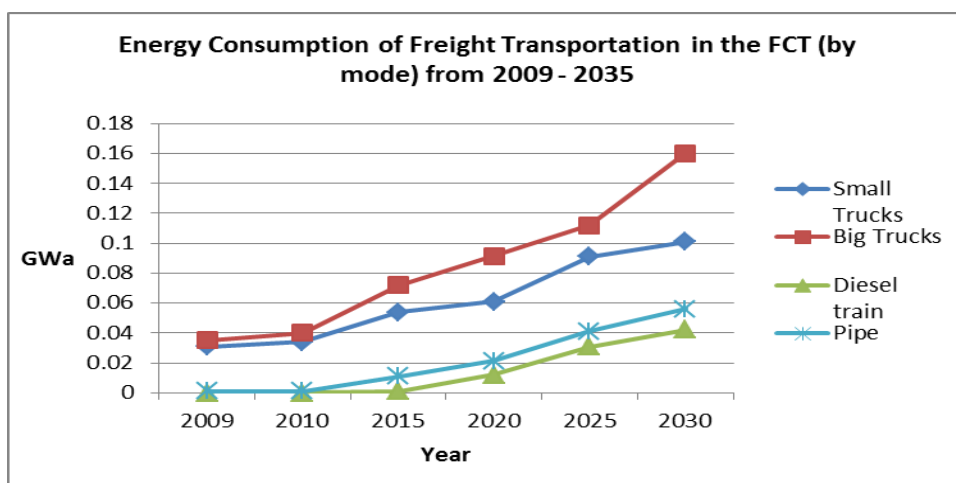


Figure 11: Petroleum Products consumption in Freight Transport in FCT 2009 - 2035

3.8 Petroleum Products Demand in the Industrial Sector

The industrial sector in the FCT contributed about 23% of the total Gross Geographic Product (GGP) in the base year, and this has four sub-sectors including; agriculture, mining, construction and manufacturing. Energy demand in industry is from four different fuels; electricity, motor fuels, non-commercial and fossil substitutables. Petroleum products are used in the industry for self-generation of electricity, as motor-fuels and as fossil substitutables. The result in Figure 12 shows that the total energy (petroleum products) demand in the industry in the FCT will continue increasing from the base year till 2035 because there will be significant increase in economic activities and industrial growth. This also agrees with ECN (2010) report of energy demand and supply projection for Nigeria.

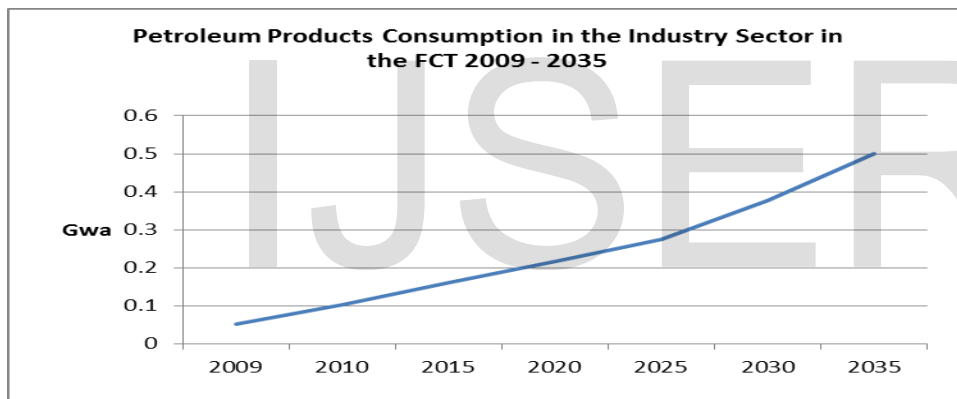


Figure 12: Petroleum Products consumption in the Industrial sector in FCT 2009 – 2035

4. Conclusion

This research work developed the scenarios for future petroleum products demand of the Federal Capital Territory, Abuja Nigeria, through the analysis of the historical data on the consumption of the base year which is 2009 and the projection of the future demand of petroleum products. This research work also produced results for future demographic and macro-economic parameters of the FCT which were found to be determinants of energy demand. The results are in agreement with some existing works done within and outside Nigeria (Cape Town, 2011; Ojusu *et al.*, 2014; ECN 2010, 2014) which shows that as population and economic activities increase, energy demand increases too. It also agrees with other works which showed in their

findings that most modern and developing countries' capitals are usually dominated by services sector energy demand showing that the economies of such cities are service sector-driven.

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