IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331, Volume 8, Issue 1 (Nov. - Dec. 2013), PP 86-92
www.iosrjournals.org

Impact of Price Expectation on the Demand of Electric Energy

[1]Onodu Chinonso Sullivan, [2]Boniface Onyemaechi Anyaka
Department Of Electrical Engineering University Of Nigeria, Nsukka

Abstract: *This paper presents a modeling procedure which are based on historical relation between demand for electricity and its price, accompanied with other determining variables that effect changes within, (economic activities, weather input variables, tariff and demography) to predict the future path of Nigeria energy usage. It compares the growth characteristics demand of different sectors of the economy, by using the annual demand statistics in a long run study to forecast the expected change in the nations demand for electricity with its price.*
Keywords: *Tariff, Electricity commission of Nigeria, Real Time Pricing, Electricity demand, Price Elasticity*

I. Introduction

Historical trends presents the annual improvement in the Nigeria energy sector, though the Nigerian factor has for years manipulated the obscurity surrounding the national electric energy instability, the myth accompanying the deregulation syllogism has kept Nigerianselectricity consumers with the fear that in the nearest future, a few kilowatts would cost a fortune. Given the variability of the price of electrical energy over the past several years, the end users in Nigeria has been put in a position of not knowing precisely from one month to the next what the price of their electric billwould be. Consequently, this paper hypothesizes a relationship between demand for electricity and the expected price in kilowatt-hour sales [1]. The results indicate that "dynamic expectations".

The primary objective of delivering electricity to the end users is to do so at the lowest possible cost, the Provincial Government identified that, in meeting this objective, its priority ill be to meet current and future electricity needs with environmentally friendly, stable and competitively-priced power and to maximize the value of any surplus power with export to other markets [1,2,].

II. Nigeria Electricity Exporting Data

This entry is the annual electricity generated expressed in kilowatt-hours. The discrepancy between the amount of electricity generated and/or imported and the amount consumed and/or exported is accounted for as loss in transmission and distribution [4].

Exporting country -Nigeria

Period (years)	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Billion(KWH)	14.6	18.7	15.7	15.6	15.7	19.9	15.7	19.1	22.1	22.1	21.9	21.9	20.1

Table1*Table1Nigeria electricity exporting data from the year 2000*

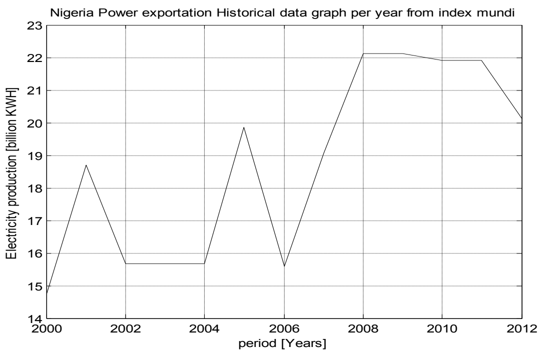


Fig 1*Nigeria power exportation historical Data graph*

III. Nigeria Electricity Generation Plants

From the past analytical data of Nigeria power generation (Shiroro hydro plant, jebba and Kainji), Hydro generation stations played their major role in the nations generated capacity in the past years, the gas and thermal power station is contributing in recent years to improving the national grid capacity, and illgradually take over the major generation capacity of the country in the nearest future. Owing to this recent improvement in the grid capacity, it will not be wrong to forecast an elastic curve in the demand price relation for power in

Nigeria, considering the consistent rise in the price of oil all over the world, however nature has placed Nigeria among the major producers of natural gas, the fuel for these generators may not be far-fetched if the resources are well managed, and therefore, the of electricity price and demand relation in Nigeria is forecasted to assume the in-elastic curve. Tables 1 and 2 below shows the trend of generation improvements, starting from the ECN managed.

Table 1 ECN Managed Generating Stations [PHCN HQ]

S/No	Power Station	Installed Capacity	Year	Type of Gen
1	Ijora A	1×3 = 3MW	1923	Steam
2		2×3 = 6MW	1923	Steam
3		2×6.5 = 13MW	1964	Gas
4	Ijora B	2×12.5 = 25MW	1956	Steam
5		2×30 = 60MW	1956	Steam
6	Ijora C	2×15 = 30MW	1965	Gas
7	Oji	3×10 = 30MW	1965	Steam
8	Delta 1	2×36 = 72MW	1966	Gas
9	Afam 1	2×10.3 = 20.6MW	1966	Gas
10		2×17.5 = 35MW	1965	Gas
	Total	294.6MW		

The demand for power kept growing over the years as the country grows and more people and states were connected to the power supply network, there was an urgency to maintain power systems stability in the Nigerian power system network and so government through NEPA made concerted effort to improving the power systems generation, transmission and distribution so as to connect more states to the national grid. This led to the building and development of both power generation stations and power transmission lines as shown in the tables below.

Table 2 Major stations in the national grid [PHCN HQ]

Historical growth of Power generation stations							
Major power stations in the national grid							
S/No	Power Station	Installed Capacity	Year	Source of Energy	Type of Gen	Type of Exciter	Remark
1	IJORA IJORA A	1×3=3MW 2×5=10MW 2×6.5=13MW	1923 1964	Coal Gas	Steam Gas Turbine		Scrapped Scrapped
2	IJORA B	2×12.5=25MW 2×30=60MW	1956	Coal Gas	Steam Turbine	Thyristor Controlled	Scrapped
3	GT4-GT6	3×20=60MW	1978	Gas/AGO	Gas Turbine		
4	**IJORA C**	2×30=60MW	1965	Gas	Gas Turbine		Scrapped
5	**OJI**	30 MW	1956	Coal Gas	Steam Turbine		Scrapped
7	**DELTA**Delta 1 Delta II DeltaIIIDeltaI V DELTA	2×36=72MW 6×20=120MW 6×20=120MW 1×100=100MW 5×100=500MW	1966 1975 1978 1989 1990	Gas/Oil Gas/Oil Gas/Oil Gas	Gas Turbine	Rotating Thyristor controlled	
8	**AFAM** Afam I Afam II AfamIIIAfam IV	2×10.3=20.6MW 2×17.5=35MW 4×23.9=96.6MW 4×27.3=109.2MW 6×75=450MW	1965 1976 1978 1982	Gas/Oil Gas/Oil Gas/Oil Gas	Gas Turbine	Rotating Thyristor controlled	GTII Scrapped

9	**KAINJI** IG5-IG6, IG7-IG10 IG11-IG12	2×120=240MW 4×80=320MW 2×100=200MW	1967 1968	Hydro	Hydro Turbine	Rotating Thyristor controlled	
10	**SAPELE** ST1-ST6 GT1-GT4	6×120=720MW 4×75=300MW	1978 1981	Gas/Oi Gas	Steam Gas Turbine	Thyristor Controlled	
11	**JEBBA** 291-296	6×90=540MW	1986	Hydro	Hydro Turbine	Thyristor Controlled	
12	**EGBIN** ST1-ST6	6×220=1320MW	1986	Gas/Oil	Steam	Thyristor Controlled	
13	**SHIRORO** 494 491-493	1×150=150MW 3×150=450MW	1986 1990	Hydro	Hydro Turbine	Thyristor Controlled	
Total Installed capacity = 5923.2MW.							

IV. Demand-Price Determining Factors – Control Variables

There is a wide range of potential drivers/determinants of long term electricity demand, ranging from immigration rates to long term weather trends. The drivers can be split into 4 broad areas:[1, 6]

- Economic activity (measured by GDP),
- Demographics
- Demand responsiveness to price.
- Energy intensity (Generation and end user technology).

The availability of reliable series of historical and forecast data largely determines the effects of these control variables to the expected demand of electricity in the country.

V. Reviews

In the past, studies have presented many modeling approaches in this field of science. An alternative modeling approach is time series forecasting. This approach uses a detailed analysis of patterns in historical demand to produce a forecast of future demand [1].

There are also alternative approaches available such as neural network and hybrid models. These typically use multiple techniques and inputs, and produce forecasts based on the mix that produces the best results given the input data available at the time [1, 3, 6].

Time series models are useful for short term forecasting and for developing a picture of underlying patterns in data (hydrology patterns and changes in half hourly load patterns at individual points of supply are good examples). However they are of limited use for long term forecasts in some situations, such as where there are underlying changes in the key drivers of demand as is being considered here.

Hybrid and neural network models have the potential to produce forecasts that perform well compared to the more traditional modeling approaches. Their main disadvantage is their “black box” nature. Given that the forecasts will be made publicly available through the centralized data set, and will face public scrutiny through consent processes, the forecasting model needs to be intuitive and easily explained to “non-experts”. At this stage we believe that neural networks and the like do not meet these criteria, although they may be useful as a validation tool for the forecasts. The use of such models may be assessed in more detail at a later date. For the reasons noted above, the assessment of alternative models carried out as part of this process has been restricted to those using an econometric approach [4, 6]

VI. Resaerch Methodology

This paper employed models capable of combining the consumer activities, such as multi-industrial and household activities, their different growth characteristics. Growth in demand sourced from the basic metals industry and growth associated domestic residences. The ability to model specific areas of demand is reliant on the availability of relevant historical and forecast data. The breakdowns of demand are presented on a year by year basis. While there may be scope for additional analysis in the future.This paper centers on demand modeling considered in these three key demand groups:

- Residential
- Commercial and Light Industrial
- Heavy Industrial

Forecasts are at grid exit point and demand entry points as shown in the figure below. Therefore they include local lines losses, but exclude consumption that is met by generation embedded in the local lines networks [1, 6]
The figure below shows Nigeria gross generation, the distribution scheme, taking note of the losses within.

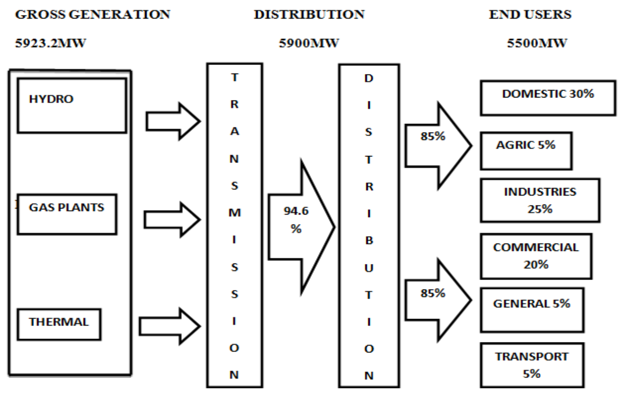


Fig 2 Nigeria *Generation and Distribution Scheme [PHCN HQ.]*

The models assessed in this analysis are focused at producing forecasts that reflect changes in historical demand and its drivers (factors that affect changes), the pricing method that favors a few and pinches many electricity consumers in Nigeria.Historical demand data is available in a consolidated form from the 1920s.

VII. Electricity Pricing Method In Nigeria

Quite a large number of tariff plans have been proposed from time to time and are in use.
Among which are;

- The flat demand rate
- Strate meter rate
- Block meter rate
- Hopkinson demand rate
- Doherty rate
- Wright demand rate

They are all derived from the following equation;
$A = cx + dy + f$……………………………………..(1)
Where, A = total amount of bill for a certain period, normally one month.
X = maximum demand during the period (KW or KVA)
C = unit charge for maximum demand (₦ per KW or ₦ per KVA)
D = unit cost of energy ₦ per KWh
Y = total energy consumed during the period (KWh)
F = constant charge, ₦
Thus the total bills consist of three parts, one depending on total energy consumed and the third being a constant figure.

VIII. Flat Demand Rate

The flat demand rate can be expressed in the form,
$A = cx$…………………………………….(2)

Meaning the bill depend only on the maximum demand irrespective of the amount of energy consumed. This is the earliest form of tariff and the bill in those days was based on the total number of lamps installed in the premises. Now-a-days, the use of this tariff is restricted to sign lighting, signal systems, street lighting, etc. Where the number of hours is fixed and energy consumption can easily be predicted. Its use is very common to supplies in irrigation tube, since the numberof hours for which the pump feeders are turned on are fixed. The charge is made according to horse power of the motor installed. The cost of metering equipment and meter reading is eliminated by the use of this form of tariff

IX. Strate Meter Rate

This can be represented by the equation
$A = dy$…………………………………………….(3)

The changes depend on the energy used. This tariff is sometimes used for residential and commercial customers. It has the advantage of simplicity. However, the main disadvantage of this tariff is that a customer who does not use energy has zero bills though he has caused the utility to incur a definite expenditure due to its readiness to serve him. Another disadvantage is that this method does not encourage the use of electricity.

Various types of pricing method exist in order to facilitate the activities of theparticipation programs. The above mentioned remains the means through which Nigeria Electricity commission mandate their energy users to pay for their usedenergy, certain procedures differentiates the two methods [3,6].

A simple observation of historical residential demand shows a clear step change in the rate of growth experienced before and after the1970's (Nigeria Civil war Effective Period). The following graph shows residential demand by year [PHCN].

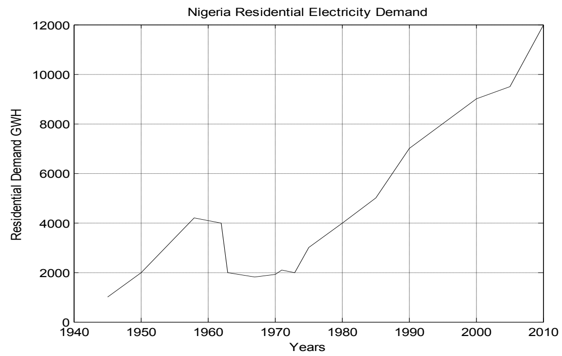


Fig 3 *Residential electricity demand curve*

Examining a plot of Residential Demand per Household highlights the extent of the underlying change. Demand per household has risen rapidly as households have gone from a state of having few electricity using appliances in the post war period, to the point of reaching a state of "saturation" in the 1970s. This has been bolstered by the large reduction in real electricity prices that occurred across that period and a subsequent rise after the Nigeria war effective period as shown below.

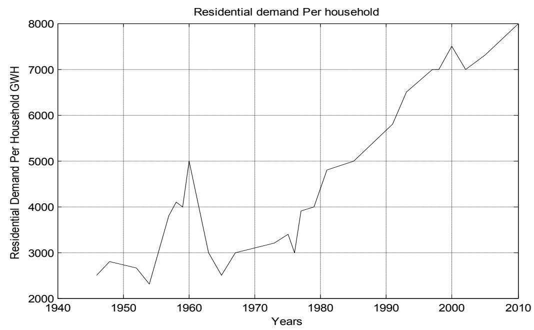


Fig 4*Residential demand per household*

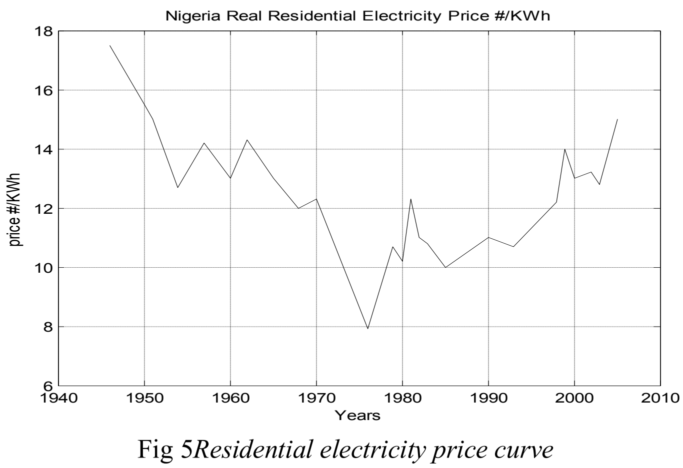
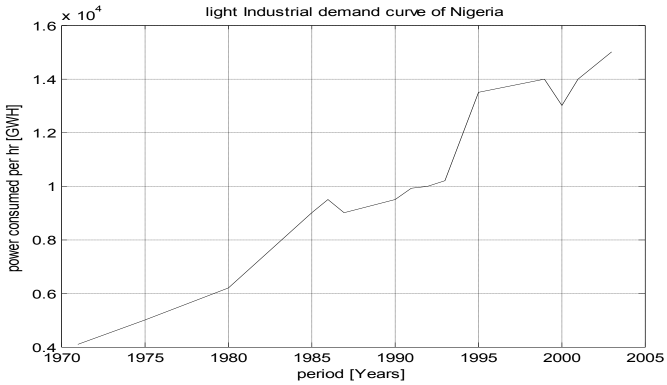


Fig 5*Residential electricity price curve*

Consistent light industrial and commercial demand data is available from 1970/71 and is shown in below



[PHCN].

Fig 6 Nigeria light Industrial Demand Curve

Heavy industrial demand covers the large industrial direct connect customers. The trend of the yearly demand is shows below [PHCN].

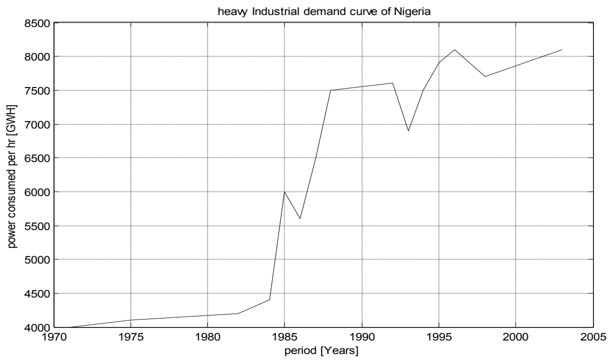


Fig 7heavy industrial demand curve

change in the growth rate over a periodcovered by the historical data, with the break point sitting in the late 1980s [PHCN] The relatively rapid growth seen up until then reflects the impact of government polices at the time and the advent of gas generating stations in the country, where indirect subsidies and direct support for "think Big" projects resulted in the building and/or expansion of a number of heavy industrial users such as the rubber producing companies,aluminum smelters and roofing companies. Growth in the heavy industrial sector slowed significantly in the late 1980s, although it continues to show a gradual upwards trend. Modeling of heavy demand has been based on data from 1989 onwards.

X. Conclusion

From the above presented scenarios, it have been noted that customers response to this pricing signal was positive since price elasticity within the considered sectors took on a value of a fair look in the nearest years. Furthermore, in the long-run the manufacturing sector experienced a price elasticity value closer to unity, which shows an elastic demand curve in the long run and inelastic on the short-run.It also became clear that the future expectation on the demand for electricity is not only a function of price, but also by economic factors, this was evident in the demand slope around the Nigeria civil war period, therefore the nation's demand for electricity will always take a rising path notwithstanding the alongside movement of the price paid for electric energy, if and only if all other factor effecting demand for electric power are not considered.

References

[1] Demand Forecast Model Review (2004) by NZIER and Statistics Research Associates, www.ea.govt.nz/dmsdocument/10031

[2] Opportunity of Investment in power, Transmission Company of Nigeria (TCN) Plc. (2010)

[3] Electricity Rates Forecasting:" muskrat falls will stabilize rates for consumers"Department of Natural Resources, New found land Labrador(November 2012)

[4] The impact of increased Electricity price on consumer demand, byEzzard de Lange, Gordon institute of business Science, University of Pretoria, South Africa (2007/08)

[5] Response of Residential Electricity Demand to Price: The Effect of Measurement Error,CEPE Working Paper No. 75, Anna Alberini, Department of Agricultural Economics,

[6] Price Impacts on Peak Demand, Christopher Ivanov Power System Engineering, Inc. Web Site: www.powersystem.org Power System Engineering, (2009)

[7] The Relationship Between Electricity Power and Unemployment Rates in Nigeria, by E.O. George, Faculty of Management and Social Sciences, OlabisiOnabanjo University, Ago – Iwoye, Nigeria Australian Journal of Business and Management Research Vol.2 No.02 [10-19] | May (2012)

[8] Economic Outlook Information Paper, National Electricity Forecasting (2012) Published by AEMO Australian Energy Market Operator

[9] Electric Power Investors' forumby. Bureau of Public Enterprises (BPE).*Power Generation*. (Status and Outlook) ...www.nigeriaelectricityprivatisation.com

[10] The impact of price expectations on the demand for electrical energy in the United States Noel D. Uri Department of Energy, Office of Energy Source Analysis, Oil and Gas Analysis Division, Washington, DC 20461 USA.