Macroeconomic and Institutional Reforms of Energy Pricing Policies in Nigeria; How Effective?

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DOI: https://dx.doi.org/10.47772/IJRISS.2023.7012049

Received: 16 November 2023; Revised: 24 November 2023; Accepted: 28 November 2023; Published: 02 January 2024

ABSTRACT

The objective of this paper is to examine the impact of institutional reforms in Nigeria on energy pricing policies, energy supply, and fossil fuel subsidy initiatives, comparing them with global practices. This assessment scrutinizes Nigeria's commitment to its predetermined goals by evaluating how these policies influence socioeconomic welfare, consumer productivity, and empowerment. Furthermore, the study reviews the primary challenges facing Nigeria's energy sector, examining their macroeconomic dimensions and the impact of governmental institutional reforms. By utilizing variance decomposition (VDC) within the vector error correction model (VECM), the paper tests the influence of energy pricing and various reforms on key macroeconomic variables. This analysis is complemented by Granger causality tests to explore long-term cause-and-effect relationships among the variables. Additionally, the assessment employs inverse roots of AR to estimate the marginal social cost of reduced energy subsidies. The investigation also extends to using impulse response function techniques to explore the economic and environmental implications of energy subsidies and carbon emissions in Nigeria. The study highlights limitations such as technological constraints and inadequate regulatory or market-based policies, which diminish policy effectiveness. Consequently, the study recommends the development of more robust energy conservation policies, emphasizing the need for well-coordinated frameworks addressing climate change. It also calls for diversification in energy mixes."

Keywords: Macroeconomic variables, Institutional reforms, energy pricing, environmental externalities

INTRODUCTION

Energy pricing reforms have become a common trend in the Middle East and Northern African (MENA) countries, including those rich in oil. Both oil-importing and exporting countries in this region have been making changes in recent years. Over the past decade, the unpredictable changes in international oil prices have made these reforms necessary for most countries.

Before the oil price drop in 2014, countries in MENA that imported oil were spending a lot to subsidize energy for their own people. They had to bridge the gap between lower local prices and the higher international oil prices, which were more than USD 100 per barrel for many years. Meanwhile, countries

that exported oil were making huge profits by selling oil globally, although some of them began experiencing problems due to low local energy prices

Based on information from the Organization of the Petroleum Exporting Countries (OPEC), Nigeria, the biggest oil producer in Africa, possesses approximately 37 billion barrels of confirmed oil reserves and 187 trillion cubic feet of verified natural gas reserves. Producing an average of around 1.8 to 2.4 million barrels of oil per day, Nigeria was ranked as the seventh largest crude oil producer among OPEC countries from 2009 to 2013. In recent times, there have been significant changes in Nigeria's energy sector. The Nigerian Government has expressed its intention to deregulate and restructure the sector, aiming to completely reorganize the oil and gas sector and privatize the power sector in Nigeria has been evident. One indication of this approach was the reduction of a significant portion of the petrol subsidy in January 2012. This move followed the deregulation of the diesel market in the summer of 2009. The goal was to free up revenue for infrastructure investments. In Nigeria, various forms of consumer energy subsidies are implemented, particularly for gasoline (Premium Motor Spirit –PMS), household kerosene (HHK), and electricity.

For petroleum products (PMS and HHK), the government provided subsidies by paying petroleum product marketers the difference between market rates and the government-approved retail price. In the case of electricity, the government required state utility companies to charge tariffs below the costs of electricity production. It then compensated these companies as part of a lump sum and by undercharging. However, despite an installed capacity of 13,308 MW, only 6,158 MW were operational in 2014. Due to gas unavailability, only between 3,000 MW to 4,500 MW were actually generated. As of June 2022, electricity production in Nigeria reached 7,637 GWH, compared to 8,787 GWH in the previous quarter, due to breakdowns, water shortages, and grid constraints. This poor performance has led to severe power shortages across the country.

The oil sector has significantly influenced Nigeria's economic growth since 1970, contributing over US$391.6 billion to government revenue between 1970 and 2005. Before the COVID-19 pandemic, the oil sector typically accounted for about nine percent of the country's GDP. However, in the third quarter of 2022, the oil sector's contribution to the GDP decreased to 6.33 percent. Nigeria's daily oil production exceeded two million barrels at the beginning of 2020, but it dropped to 1.14 million barrels per day in January 2021, the lowest in recent years, due to oil theft in oil-producing regions. Nigeria's oil history has seen both progress and setbacks, blessings and curses, hope and hopelessness, wealth and poverty, and an inability to transform oil luck into building an efficient modern society.

Besides its direct fiscal effects, the energy sector is vital for enhancing Nigeria's economic competitiveness. Efforts have been made worldwide to ensure the efficiency of energy sectors. This paper focuses on analyzing Nigeria's energy resource pricing efficiency over time, particularly in the power sub-sector, petroleum pricing regulations, natural gas, solar radiation, and their environmental and macroeconomic impact on Nigeria's competitiveness. Nigeria is fortunate to possess vast energy resources, including over 35 billion barrels of oil, 187 trillion cubic feet of gas, 4 billion metric tons of coal and lignite, as well as significant reserves of tar sands, hydropower, and solar radiation, among others.

Electricity in Nigeria primarily comes from thermal and hydropower sources. Fossil fuels, especially gas, contribute 86% to Nigeria's electricity generation, with the rest coming from hydropower. The power generation was primarily the federal government's responsibility until the beginning of the Fourth Nigerian Republic, after which reforms began in 2005 with the Electric Power Sector Reform Act (EPSRA). The industry was subsequently opened to private investors. In 2010, the Nigerian Bulk Electricity Trading Plc (NBET) was established as a credible off-taker of electric power from generation companies. By 2014, the sector was privatized, with three groups responsible for providing power, although the Federal Government retained ownership of the transmission company.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VII Issue XII December 2023

Table 1:

Generation	Pre-1999	Post- 1999	Mid-2000	Mid-2017	Mid-2022
Thermal	4,058 MW	5,010 MW	3,247		7,637 MW
Hydro	1,900 MW	1,900 MW	–	1,938 MW	22,000 MW
Installed capacity	5,996 MW	6,910 MW	6,200 MW	10,396 MW	1,938.4 MW
Available capacity	1,010 MW	4,451 MW	–	4,959 MW	1,060 MW
Transmission 330 kv Lines 132 kv lines	4,800 km 6,100 km	4,889.2 km 6,284.06 km	4,867.1 km 7,431.0 km	6,341.2 km 8,242.1 km	5.956.0 km 6,145.2 km
Transformer Capacity 330/132Kv 132/33kv	5,618 MVA 6,230 MVA	6,098 MVA 7,805 MVA	4,634 MVA	*4,000 MVA* 2000 MVA	6,216 MVA 5,4112 MVA
Distribution -33 kv lines -11 kv lines -415 v lines	37,173 km 29,055 km 70,799 km	48,409.62 km 32,581.49 km 126,032.79 km	62,231.12 km 40,561.61 km	74,341 km 76,432km	75,342 MVA 81,2376 MVA
Transformer Capacity	8,342.56 MVA	12,219 MVA	14,642 MVA	15,532 MVA	16,451 MVA

Source: NESI Compiled by the Author

A key salient point that emerge from the above table is that there has been very marginal improvement in electricity infrastructure in Nigeria over years, between 1999 and Mid-2022, electricity generation capacity grew by a mere 10 percent in Nigeria compare to other countries of the world like Indonesia 237 percent Indonesia has a 441.7 GW renewable energy potential, made up of 94.3 GW of hydro power, 28.5 GW of geothermal energy, 32.6 GW of bio-power, 207.8 GWP of solar power, 60.6 GW of wind power, and 17.9 GW of ocean power.

Energy sources in Nigeria and their estimates reserves

Table 2

Energy type	Estimated reserves
Wave and tidal energy	150,000tj/(16.6 x 106 toe/year
Crude oil	36 billion barrels
Biomass	144 million tons/year
Hydro	14,750 MW
Natural gas	185 trillion cubic feet
Solar radiation	3.5-7.0 kmh/ m^2/day

Coal	2.75 billion metric tons
Wind energy	2.0-4.0 m/s

The primary goal of the power sector reform in Nigeria is to establish an electricity supply industry capable of meeting the citizens' needs in the twenty-first century. Other objectives include modernizing and expanding electricity coverage to support the country's economic and social development. Despite both public and private sectors' commitments to improving the power system through investment, increased competitiveness, and deregulation since the reform began in 2010, there has been little to no significant improvement in the power sector. The core issue of insufficient power remains unresolved, leading to ongoing price increases without visible progress. Nigeria's power infrastructure still lags far behind that of other emerging economies, and there's a pressing need to address the main obstacles hindering power generation, transmission, and distribution nationwide.

The current collection of power plants in Nigeria consists of both older plants constructed before the 1990s and newer ones built from the mid-1990s to the present. However, the underperformance of these power plants has resulted in severe electricity shortages throughout the country, leading to daily power outages lasting several hours. This situation has become a significant impediment to Nigeria's socio-economic development, especially considering the country's rapidly growing population, which has surpassed 223,804,632 million as of 2023 (Adegbulugbe, 2007). The challenges faced in meeting the electricity needs of this expanding population pose a bottleneck to overall development.

Table 3

Power Station	**Type**	**Year Completed**	**Installed Capacity (MW)**	**Installed Available Capacity (MW)**	**Peak Gen. (MW) as at March 2022**
AES	SCGT	2001	270	267	0
Afam IV – V	SCGT	1982	580	98	450
Afam VI	SCGT	2009	980	559	281
Alaoji NIPP	CCGT	2015	197	127	0
Delta	SCGT	1990	539	453	507
Egbin	Gas Fired Steam Turbine	1985	1,050	282	478
Geregu	SCGT	2007	136	282	71
Geregu NIPP	SCGT	2012	136	424	100
Ibom Power	SCGT	2009	75.10	115	82.1
Ihovbor NIPP	SCGT	2012	450	327	107
Jebba	Hydro	1986	89	427	412
Kainji	Hydro	1968	760	180	384
Okpai	CCGT	2005	480	424	195
Olorunsogo	SCGT	2007	335	244	123
Olorunsogo NIPP	CCGT	2012	109.20	356	0
Omoku	SCGT	2005	45.40	0	78.4
Omotosho	SCGT	2005	152.90	242	168.1
Omotosho NIPP	SCGT	2012	450	318	107.8

River IPP	SCGT	2009	136	166	125
Sapele	Gas Fired Steam Turbine	1978	88.90	145	55
Sapele NIPP	SCGT	2012	88.90	205	212.2
Shiroro	Hydro	1989	600	480	131
Odukpani	SCGT	2013	187.60	400	392.4
ASCO	SCGT	2016	294	270	0
Trans Amadi NIPP	SCGT	2017	150	100	41.3
Azura Edo IPP	SCGT	2018	418	400	301
Gbarain NIPP	SCGT	2017	225	200	74.4
Total			**13234**	**8140**	**4529.7**

Source: NERC 2022,

According to (NSO, 2022) At the distribution end data from NSO showed that load allocation to the distribution companies was 2,330WM with Ikeja Electric (342.62MW), Ibadan disco (317.93MW) and Abuja disco (262.67MW) topping the allocation chart

KEY PLAYERS IN NIGERIA'S POWER SECTORS REFORM

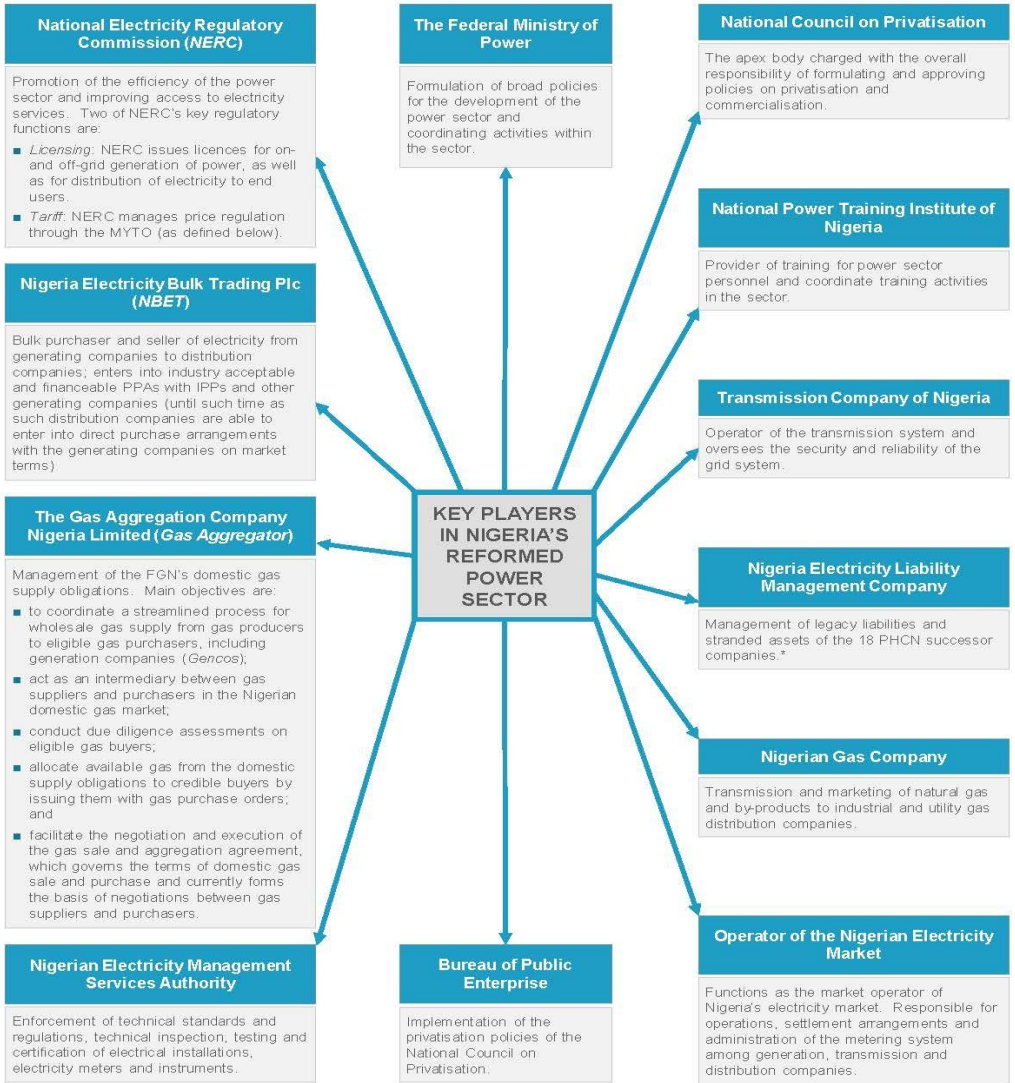


Figure 1. The current key players in Nigeria's reformed power sector,
Source: NERC

There was a major restructure in the sector in 1972. All electricity generation, transmission, distribution and utilization responsibilities were assigned to one organization. The rationale for this reform was to improve effectiveness, minimize operational risks, and share financial obligations. As such, the ECN and NDA were merged to become the National Electric Power Authority (NEPA).

Unfortunately, several macroeconomic and institutional policies of government on energy pricing that are driven basically by either fiscal or monetary policies (or both) have not yielded the desired results. Therefore, the unanswered questions remains; (i) what exactly constitutes the economic rationale/advantage of energy pricing reforms (ii) What are the socio-economic impact of this policies on the well-being of the consumers and it environmental gains in reducing the existential issues of global warming , (iii) How effective has the extant policies measure improves the overall economic performance of Nigeria?

The objective of the paper is to (i) review energy resources in Nigeria and present status of energy usage in Nigeria and it environment (ii) review the potentials and utilization of renewable energy sources (solar, wind, hydro and biomass) in Nigeria, and then,(iii)investigates the macroeconomic impacts of several institutional reforms of government in Nigeria overtime

This paper which seeks to outline the current status of the Nigeria energy sector and analyze which opportunities this spells for the subsectors of on-grid renewable energy, energy efficiency and off-grid rural electrification. Because The paper is structured in such that, section1 provides an insight into Nigeria energy sector and various energy pricing policies of government overtime immediately following this, is the overview of several literatures on energy reforms beyond the shores of Nigeria follows by the theoretical considerations and model specifications, data analyzes and source while the last section dwells much more on analyzing the institutional impacts of this policies reforms and on key areas of the economy. Summaries and recommendations of some policy options as well as conclusions on the study

REVIEW OF LITERATURE

This essay reviews series of conceptual and qualitative literatures on energy reforms and it efficient system of fossil fuel energy prices in different countries for reflecting supply and environmental costs, as well as the environmental, fiscal, and economic benefits from energy price reform. Drawing on recent experiences in numerous countries, the ingredients for successful reform are then discussed CSEA (2017), “Energy Subsides Reforms in Nigeria: Opportunities and Challenges” in which the paper provided an overview reforms of Nigeria energy products such as gasoline (Premium Motor Spirit – PMS), household Kerosene (HHK), and electricity, highlighted how government of Nigeria provided subsidies by paying petroleum products marketers the difference between the market rate and the government approved retail price, for electricity. The paper emphasis on how government required state utility companies to charge tariffs below the costs of electricity production, then it reimbursed as part of a lump sum and by under-charging the electricity sector for the sector for the cost of natural gas, while petroleum (fuel) subsidy has increased other forms of energy subsidies (such as kerosene) have relatively fallen over the years. The paper focused on petroleum subsidies reforms in Nigeria considering several years of Nigeria Administrations of government efforts on petroleum sector reforms, it weighs most heavily on the Nigerian economy and the welfare of the citizens.

Wakeel (2016). The paper examines the challenges of power sector reforms in Nigeria overtime and suggests the way forward in Nigeria, by evaluating the first decade of the enactment of the law backing up the initiative. According to the paper which examined Power Sector Reforms in Nigeria: Challenges and the Way Forward, the main thrust of the reforms is to ensure a system of generation, transmission, distribution and marketing, that is it must be efficient, safe, and affordable also be cost effective throughout

the industry. The paper opined that the realization of this lofty goal of transforming the sector has remained mixed owing to a number of challenges, there has been no spectacular change in terms of the operational performance between the pre- and post-power sector reforms in Nigeria. The problem posed by inadequate and unreliable power supply is that the production frontier of the economy has been unnecessarily curtailed

The paper also discusses such issues as the need for an appropriate energy mix in generation, workable tariffs and the supply gap in the industry, at least in the generation segment among others.

Oyedepo (2018).This paper pin points the significance of decentralization of renewable energy systems in Nigeria and needs for the government to review the policies on renewable energy development in the country, in the study, comprehensive review of accessibility to clean and modern energy in Nigeria has been carried out. Also, this paper examines the potential of renewable energy (RE) resources in Nigeria that can be harnessed for continuous energy supply and the government's efforts to ensure RE's sustainability. Nigeria is endowed with abundant energy resources but the existing electric energy infrastructures are unable to meet the energy demands of teeming population. There is imbalance in energy supply and demand in the country. Over the period from 2000 to 2014, there was an average of about 2.35 billion kWh of energy gap between energy production and energy consumption. The highest electricity consumption per capita recorded so far was 156 kWh in 2012. This makes Nigeria one of the country with the lowest electricity consumption on per capita basis in the world.

The research concluded that energy demand is very high and continuously increasing because of the continuous increase in the population. The researcher further recommended exploiting the renewable energies available and diversifying the energy supply.

Adenikinju 2012) discusses the environmental implications of various policy approaches, especially concerning essential environmental management strategies. The paper aims to explore how energy pricing policies, such as reforming fuel subsidies, can positively impact environmental quality in Nigeria. It delves into the controversies surrounding government attempts to eliminate fuel subsidies, using an economy-wide model like the computable general equilibrium (CGE) model.

The Nigerian government has a vision to position the economy among the top 20 by the year 2020, as outlined in its Vision 20:2020 blueprint. A crucial aspect of this plan involves transitioning towards a low-carbon industrial growth strategy. This raises critical questions. For instance, what happens if subsidies on refined oil are decreased or completely removed by increasing import tariffs on refined oil? How does this affect carbon emissions levels? To what extent can fossil fuel subsidy reform drive the agenda for green growth (a low-carbon strategy) to improve environmental quality, especially considering the global challenge of climate change? In essence, can the reformation of fuel subsidies significantly reduce carbon emissions for environmental sustainability? The paper aims to analyze various CO2 emission scenarios resulting from imposing shocks on import tariffs for refined oil in the Nigerian economy.

Summary of other literatures reviewed

Author /Year	Study Area	Methodology	Conclusion
Abouleinein et al. (2009)	Egypt	CGE Model	Household welfare across all distribution is Depressed, but rural households suffer the largest impact.

Kpodar,K(2006)	Mali	Price –Shifting Model	High oil price impact negatively on household welfare
Oliver and Gibson(2008)	Indonesia	Marginal Social Cost Approach	There is need to reduce large subsidies on kerosene
Hope and Singh(1995)	6 developing countries	CGE Model	There was no large change in the consumer price index during the period of energy reform in all six countries
Coady et al. (2006)	5 developing countries	Micro simulation approach	The impact is progressive in Mali and Bolivia while regressive in Ghana, Jordan and Sri Lanka
Manzoor et al. (2009)	Iran	CGE	The price of energy products should be increased on both equity and efficiency grounds
Adenikinju 2000)	Nigeria	CGE	The recessionary impact of efficient energy Pricing is limited.
Oktaviani et al. (2007)	Indonesia	A Recursive Dynamic GCE model	The short to medium term macroeconomic Performance of the economy was impaired by the removal of subsidies.
Adenikinju et al.(2012)	Nigeria	Energy Environment CGE	Explored the economy-wide impacts of pursuing a green growth strategy using carbon tax policy

Sources: Author's Compilation

EMPIRICAL LITERATURE ON INSTITUTIONAL REFORMS OF ENERGY PRICING POLICIES IN NIGERIA.

Under the 2015 Paris Climate Agreement, 190 countries submitted pledges to mitigate emissions of carbon dioxide (CO_2) and other greenhouse gases. Aligning energy prices with mitigation targets is central to making progress on achieving these pledges. At the same time, there is increasing recognition of the broader environmental, fiscal, macroeconomic, and social harm from underpricing fossil fuels For example, there is a widespread concern about the health effects of local air pollution (much of it from fuel combustion), especially in rapidly industrializing countries.

In addition, The Nigeria Federal ministry of finance is interested in energy price reform from a fiscal

perspective, especially in light of the recent rise in debt, from 35.3 per cent of GDP from 22.97 per cent with the loan conversion. "The conversion and new borrowings would also take domestic debt to 70 per cent of total public debt in 2023, from 61.1 per cent currently gross domestic product (GDP) ratios (which are set to worsen with aging populations) and, in energy exporting countries, the collapse in revenues from falling international energy prices. These concerns suggest that this is an especially opportune time to examine both the efficient level of fossil fuel prices and the challenges of moving reform forward.

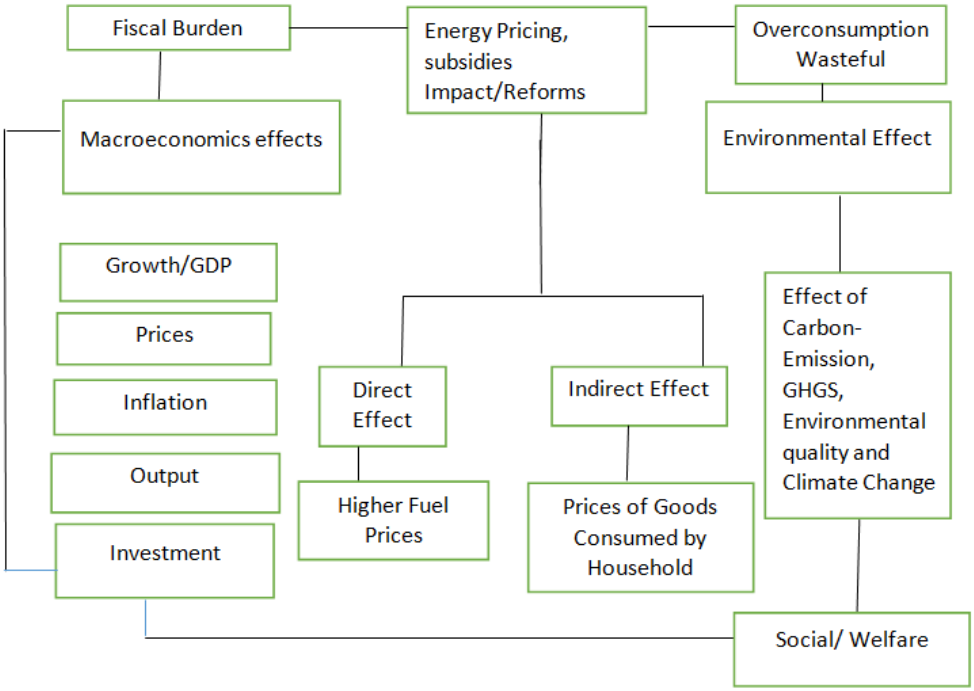
Inefficient Energy Pricing Policies In Nigeria: Conceptual Issues, Stylized Facts And Way Forward

Although fossil fuel usage causes a variety of environmental impacts, CO_2 emissions, premature deaths from local air pollution, and broader externalities (e.g., congestion) associated with the use of road transport fuels are generally considered to be the most important. This negative influence of the energy sector on the environment has necessitated the need for the transformation of the sector. This has become crucial especially in the face of the threats to human health and environmental quality that continues to grow globally (UNEP, 2004). This transformation has the ability to deliver a greener growth and cleaner environment. Many reports from international organizations such as the International Energy Agency (IEA), Organization for Economic Co-operation and Development (OECD), United Nations, European Union, G-20, World Bank, African Development Bank, among others, have shown that rising energy demand coupled with increased emission of GHGs (e.g., CO2) calls for urgent need to reassess the interaction of the energy sector and the environment. Thus, driving a green growth agenda will require a low carbon industrial strategy which had been the emphasis in many sustainable growth/development literatures.

One of the key policies identified for transforming the energy sector for efficiency and environmental quality is the reform of environmentally harmful subsidies such as fossil fuel subsidies. This is given that current energy systems in many economies are fossil fuel dependent. Thus, the clamor for the need to lower the carbon intensity of the energy sector can be achieved through the reform of this class of subsidies even for developing African economies like Nigeria that may not be contributing much too global emissions

Conceptual Overview of Macroeconomic Implication of Nigeria Energy pricing Policies and Strategies Overtime

Figure 2:



Source: Illustrated by the authors

Figure 2: Above shows the conceptual framework and mechanics of the impact that Energy pricing, fuel

subsidy has on the economy through various parameters. From the diagram, policy change such as the reform of fossil fuel subsidy influences the economy, economically, socially (welfare), and environmentally. Also, there is the political dimension. The economic impact will be in terms of effect on macroeconomic aggregates such as prices, output, trade, investment, inflation, growth, among others. Social or welfare effects would be in terms of direct effects of increases in fuel prices and indirectly on the prices of other commodities. On the environmental aspect which is the focus of this study, the impact can be traceable from production and consumption. For production, producers will use energy inputs optimally and in an efficient manner due to the rise in fuel price as a result of subsidy reform depending on the nature and level of substitutability. They can even switch to other energy alternatives that are less carbon intensive, thereby gradually cutting down the levels of carbon emission. At the household level, fuel consumption from fossil fuel sources such as petrol can reduce with the increase in price. If the reform targeted the diversion of subsidy funds into the development and commercialization of renewables, then there can be substantial reduction in carbon emissions. As demand falls, CO_2 emissions are expected to fall as well.

We first discuss the charges needed to reflect environmental impacts of various energy reforms and the overall efficient energy prices, Institutions set up to mitigate this impacts followed by procedures for measuring them The most important point here is that the environmental costs of fossil fuel use in Nigeria are potentially large and (even if more uncertain) are just as real as the supply costs and therefore should be take into account in determining efficient energy prices. A possible counter argument is that policymakers might prefer reducing environmental damages with regulatory measures (e.g., because they are perceived as politically more acceptable). Economic analysis with evidence demonstrates, however, that pricing policies are substantially more effective and cost effective than regulatory approaches 1 and even the presence of regulations (which are implicit, for example, in observed emission rates) reduces—but does not eliminate—efficient charges on energy use to reflect unpriced environmental damages.2 Although fossil fuel use causes a diversity of environmental impacts, three are generally the most important to reflect in energy prices: CO_2 emissions, premature deaths from local air pollution, and broader externalities (e.g., congestion) associated with the use of road fuels. 3

The more controversial charge is the one for road fuels to reflect broader externalities— traffic congestion, accidents, and (less importantly) road damage—because these externalities are much more efficiently addressed through taxing vehicle mileage, mileage (e.g., congestion fees rising and falling during the rush hours in Lagos and it environ and on other busy roads). At present, however, it is difficult to imagine these externalities being comprehensively internalized on a nationwide basis through finely-in tuned mileage taxes in Nigeria.

Beyond environmental and supply costs, efficient fuel prices also include a fiscal component reflecting the rate of value added tax (VAT) or general taxes applied to consumer goods. These taxes should be applied to both supply and environmental costs (i.e., the full social cost of production) but only to fuels consumed at the household level to avoid distorting firm's input choices 6 (rebates for intermediate fuels like those used in power generation and trucking are automatic under normal VAT procedures).

Overview Of Nigerian Energy Pricing Policies and It Institutional Set-Up

The legacy of Energy, oil has imposed significant costs on the Nigeria economy, price distortions, volatilities, Dutch-diseases, Corruption and inefficiencies. A major features of the sector is the dominance of the government in pricing, supply and investment. In spite, of several cumulative efforts by successive governments of Nigeria oil subsidy, tariffs on electricity remains one of the most intricate socio-economic policy issues in Nigeria. More so, with the sharp falls in world oil prices (WTI crude oil as of January 27, 2023 to $79.38 per barrel).

Nigeria energy policies and strategies is out-listed below to provide much insight on the status quo of energy

polies system in Nigeria and it effectiveness overtime

Table 4

	NIGERIA ENERGY POLICIES	STRATEGIES	REMARKS
1	National Electric Power policy(NEPP 2001)	NEPP was the first of its kind in the wake of the reform in the Nigeria power sector with the recommendation of (EPIC),Electrical power implementation Committee with three fundamental goals of reforming Energy sector in Nigeria · Privatize the then NEPA by the introduction of (IPPS) Integrated Power Producers of electricity · Increase competition by the removal of subsidies and sales of excess power to the **Discos**	With this reforms, it was so expected that the market and it competitiveness would have more intensity and allow for full cost pricing of supply and demand and even liberalization of the electricity market But it happens to be otherwise
2	National Energy Policy(NEP), 2003-2013	NEP which was developed by the Energy Commision of Nigeria (ECN), The NEP sets out government policy on the production, supply and consumption of energy reflecting the perspective of its overall needs and options, with the goal of creating energy security through a robust energy supply mix	Overtime this policy option hasn't been much effective due to several political bottlenecks of government, and the immense insecurities ravaging round energy sector in Nigeria
3	National Economic Empowerment and Development Strategy (NEEDS) 2004	NEEDs was developed by the National Planing Commisions (NPA) in 2004 with the whole intend of developing and alleviating poverty in the country, NEEDs promotes the privatization of government infrastructure as key instrument in achieving a revamped service delivery.	This was a major milestone towards the adoption of renewable energy in the power sector and its utilization for rural electrification But hampered by several unfunded projects resulted in low attractiveness and high investment cost to any investors
4	National Power Sector Reform Act(NPSRA) 2005	NPSRA was established to liberalized Nigeria power sector which made room for further provision of legal and regulatory framework within the power sector	The act gave way to unbundling and privatization of the power sector to increase competitiveness in the energy market

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VII Issue XII December 2023

5	Renewable Electricity policy Guidelines(REPG 2006),	This was initiated by federal ministry of power and steel in December 2006 REPG mandated the Government on the need for expansion of electricity generation from renewables to at least 5% of total electricity generated	This policy option presents the Nigeria government's plans,policies and strategies to promoterenewable energy especially in thepower sector but the political will toit execution was eroded
6	Nigeria Biofuel policy and incentives (NBPI) 2007	The aim of this policy was to develop and promote the domestic fuel ethanol industry through the utilization of agricultural products, in-line with the government's directive on an Automotive Biomass programmed for Nigeria in August 2005 Benefit of this policy option includes · Additional tax revenue · Provision of jobs to reduce poverty · Boost economic development and empower rural development · Improves Agricultural activities · Energy and environmental benefits through the reduction of fossil fuel related GHGs	The policy option which aim at the gradual reduction of the nation's dependence on imported gasoline, reduction in environmental pollution also to create more commercially viable industry that can necessitate sustainable domestic jobs has not be very effective due to over dependence on imported oil and comatose nature of Nigeria refineries
7	Renewable Energy Master Plan (REMP) 2005 and 2012.	REMP was developed by the energy commission of Nigeria (ECN), in collaboration with UNDP (United Nations Development programmed) anchored on the mounting convergence of values principles and targets as embedded in the above NEEDs it stress the need for the integration of renewable in building electricity grids and for off-grid electrical systems. The Renewable Energy Master Plan (REMP) **seeks to increase the share of renewable electricity in Nigeria, from 13% of electricity generation** -mainly met by large hydro- in 2015, to 23% in 2025 and 36% by 2030. A main driver for such increase is the diversification of the national electricity mix	With this policy option REMP have not been approved by the national assembly to be passed into law Nnaemeka 2016)

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VII Issue XII December 2023

8	National RenewableEnergy andEnergy policy (NREEP 2014)	Set out a framework for action to address Nigerians challenge of inclusive access to modern and clean energy resources, improved energy security and climate objectives	**Policy Focus**: Based on the resource situation and the technological base of the country, this policy focus on hydropower, biomass, solar, wind, geothermal, wave and tidal energy power plants and cogenerationplants for energy production, as wellas the improvement of energyefficiency as an additional source ofenergy. It is expected thatsubsequent versions of this policydocument will expand the renewable energy window usage in Nigeria, subject to international and local technology developments
9	Multi-Year Tariff Order(MYTO) 2008,2012	The Multi-Year Tariff Order (MYTO) is a tariff model for incentive-based regulation that seeks to reward performance above certain benchmarks, reduces technical and non-technical/commercial losses and leads to cost recovery and improved performance standards from all industry operators in the Nigerian Electricity	One of the primary functions of the Commission as contained in Section 32 (d) of the Electric Power Sector Reform (EPSR) Act, 2005 is to ensure that the prices charged by licensees are fair to customers and sufficient to allow the licensees to finance their activities and to allow for reasonable earnings for efficient operation. The policy measures has been so contradictory to present day energy users.
10	Draft Rural Electrification Strategy and Implementation Plan(RESIP 2014)	The primary objective of the Nigerian Rural Electrification Policy and by extension this Rural Electrification Strategy and Implementation Plan is to expand access to electricity as rapidly as possible in a cost-effective manner. This implies full use of both grid and off-grid approaches, with subsidies being primarily focused on expanding access rather than consumption. It is assumed that private sector providers will be heavily involved in enhancing access through – both the Power Holding Company of Nigeria (PHCN) successor distribution companies recently privatized and a range of other public and private companies.	The Ministry of Power will continue to be responsible for laying down policies on increasing access and rural electrification, including (a) setting–out policy guidelines and (b) monitoring and evaluating the performance of the programme and its agencies Which has not been actively implemented.

Compiled: by the Author

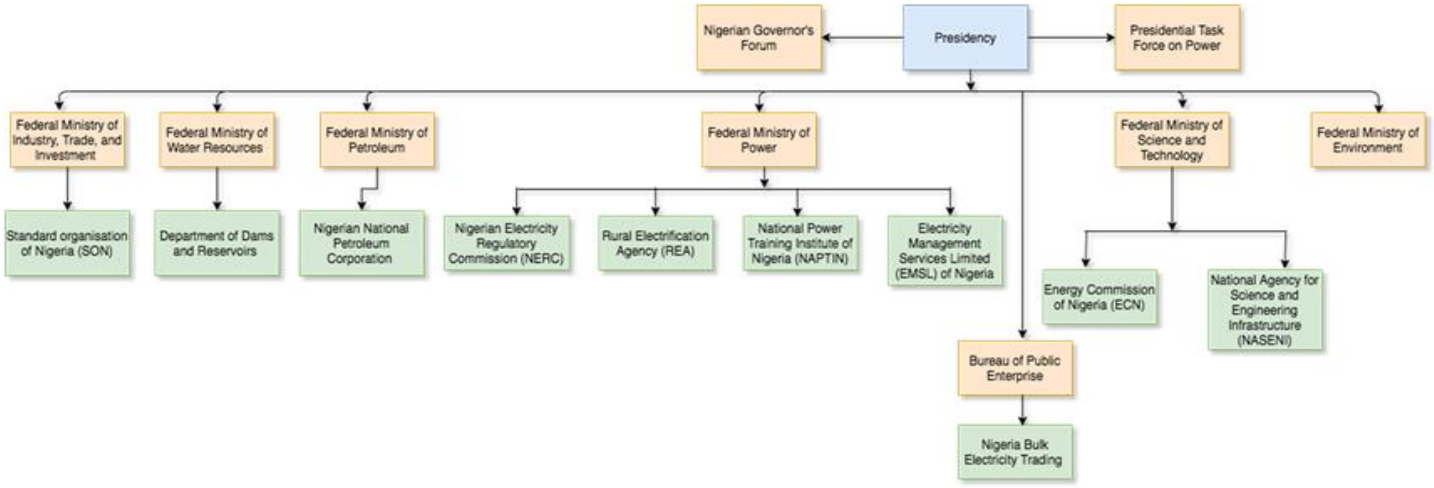
From the above it can be seen that government has prioritized energy generations, transmission and consumption efficiency as key actions in its Nationally Determined Contributions (NDCs), as there is a necessary need to formulate and implement energy efficiency programs in various sectors to reduce power shortage and also increase the competitiveness of the industrial sector by reducing energy intensity per unit product. Nationally coordinated energy efficiency measures are not yet in place, although several policies

exist as shown above, and several research has been conducted on energy conservation and efficiency, the promotion of energy efficient appliances and light bulbs, and on improved cook stove performance.

Efficient energy policies is important in addressing energy insecurity and meeting present and future energy demands. However, the overarching barrier that must be overcome is the complexity of introducing energy sector reforms across industry, commerce and transport, where activities are highly fragmented

Institutional Set-Up of Energy System in Nigeria.

The energy sectors is overseen by the presidency of the republic and associated offices (Nigerian Governor's Forum, presidential Task Force on power), below are ministries and departments, then commissions, programmes and other stakeholders. The figure 3 below shows the hierarchical Institutional setup of the Power sector in Nigeria.



Source: https://www.power.gov.ng/

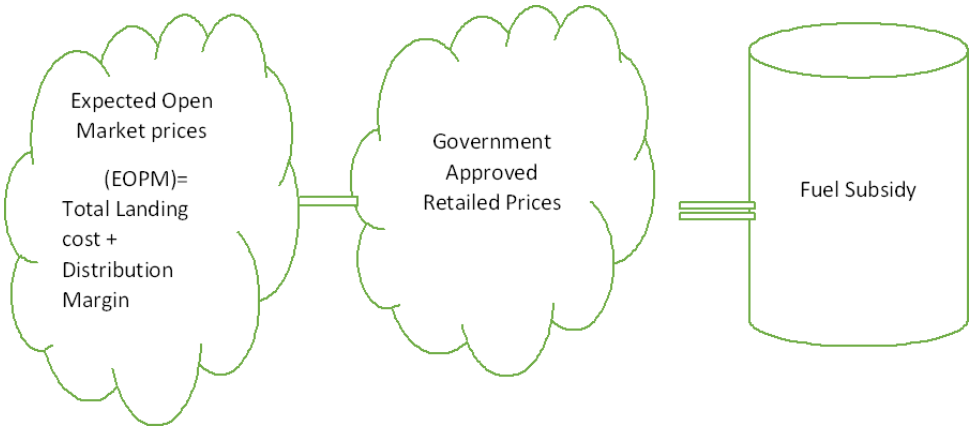
Evaluating The Mechanisms of Setting Energy Prices in Nigeria

The methodology in setting energy prices in Nigeria has been ill-defined and opaque since the Nigerian energy sector was established. Electricity for example was considered a public welfare service to be provided by the government. Therefore, the electricity price had traditionally been subsidized superficially but adversely so ineffective

While subsidies on petroleum products were first introduced in Nigeria by the federal Government of Nigeria in the 1980's as temporary measures to control the prices of petroleum products while the refineries underwent rehabilitation. However the payment of subsidies for refined petroleum products continued afterwards and most attempts by successive government to remove the subsidies and increases prices to reflect actual market prices were met with stiff resistance by labor union and the citizens. Essentially, subsidies for petroleum products are provide by paying the difference between the market prices (Expected Open Market Prices EOMP) and the government –stipulated retail prices in order for the petroleum to be products marketers to sell fuel below the EOMP, The government through the "Petroleum Products Pricing Regulatory Agency (PPRA) sets the maximum retail prices for petrol arbitrarily

The EOMP is market-based determined and comprises of product costs, freight costs, lightering expenses, depot charges, financing, distributor margins among others, in which landing cost alone represent over 85% of total allowable costs in the calculation and therefore factors that affect landing costs will also affect the eventual subsidy paid "The pricing Mechanism is based on import Parity Pricing Adjusted for cost of transportation, distribution and marketing as show below Petrol subsidy pricing mechanisms

Figure: 3



Over the past years, price control mechanism has been used in the determination of petroleum prices in Nigeria, prices control involves government setting a fixed petroleum price over long time span, irrespective of the EOMP, and since welfare concern is the rationale for introducing price control, petroleum price is usually set below the EOMP, leading to subsidy regime. Thus while the EOMP typically fluctuates with the global crude oil prices, the government approved price is altered less frequently at the discretion of the presidency, given that domestic prices for petroleum products do not quickly adjust to market prices, there is usually a gap between budgeted subsidy payments and the actual amount paid as subsidies. The deviation in budgeted and actual subsidy payment is typically driven by three main factors (i) Changes in rate of inflation, (ii) changes in the Naira –Dollar exchange rate (iii) Changes in global crude oil prices.

Subsidy as shown above is the difference between the Petroleum Products Pricing Regulatory Agency (PPPRA) determined price (landed product cost + regulated margins) of petroleum products and the Ex-Depot price at which Government directs NNPC to sell the products. Ex-Depot price is the price at which the products leave NNPC Depots. This is different from the pump price (Pump price is the price at the filling station). Pump Price = Ex-Depot Prices + Approved Margins. The Subsidy is calculated based on the PPPRA Template for the petroleum products as shown below

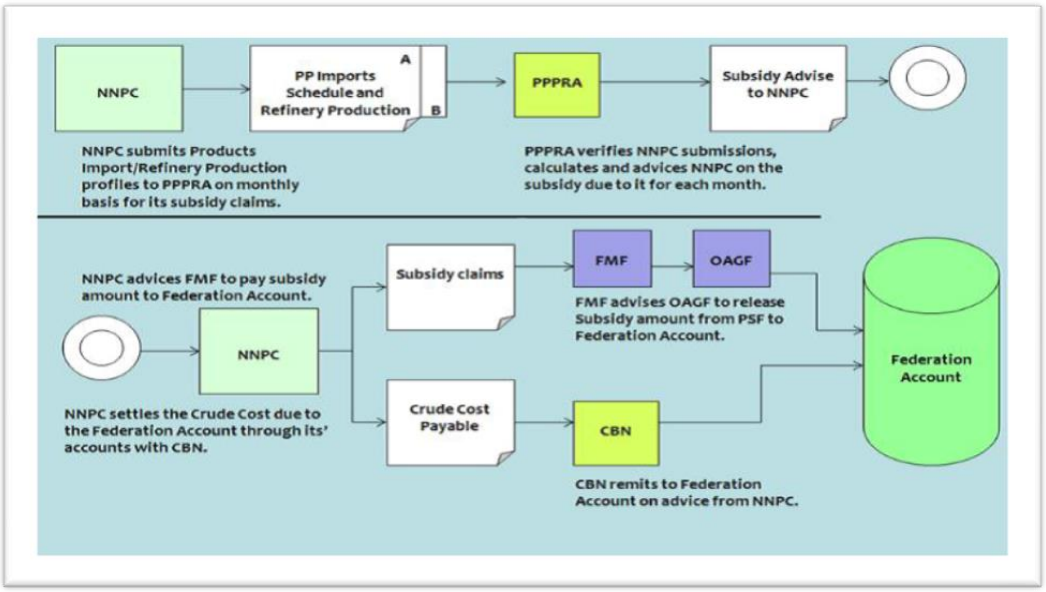


Figure 4: Source: Gylych Jelilov (2017)

Pump Prices of fuels (in particular PMS) are administratively determined, prices have lagged behind inflation rate, exchange rate changes as well as changes in product costs leading to substantial subsidy, the petroleum Products Pricing Regulatory Agency (PPPRA) as shown above is the agency charged with the determination of the pricing of petroleum products, the pricing structure is based on import parity pricing

adjusted for cost of transportation, distribution and marketing.

The difference between the PPPRA determined prices and the government regulated price yields the amount of subsidy per-liter that the government incurs

Key Observations About Pricing Structure in Nigeria

The PPPRA pricing templates has a number of deficiencies that cumulatively duplicates some item and unduly increase the landed cost of petroleum products, these deficiencies normally discourage competition amongst products importers, while some elements in the pricing template transfer business and financial risks from operators in the sector to consumers of the government. In addition, a number of the components, for example margins are not empirically determined which could guarantees rate of returns to everybody in the supply chain the government plans to deregulate operations and infuse competition into petroleum products marketing

However, in January 2016, the Nigeria government introduced a new petroleum pricing mechanism described as 'Price modulation" The idea of pricing modulation scheme was aiming towards instituting a formal mechanism for determining petroleum prices within a short –run preset band, this was introduced in order to phased out the subsidy regime of petroleum products, which has been widely considered to be inefficient and immensely prone to corruption.

The implication of this policy of price modulation framework is to ensure the negative effect of subsidy arising from increasing price oil prices is at minimal although recent fluctuation in exchange regime of Nigeria has deeply reverse this trend overtime which has led to inflation pressure with oil prices in January 2023 rises exponentially. With the National Assembly recently passed a N21.8 trillion budget, pegging Nigeria's crude oil benchmark at **$75 per barrel** from the previous $70 per barrel while production for 2023 was put at 1.69 million barrels per day

The key and distinct component of the above energy pricing policy reforms is aim at eliminating fuel subsidy, which is being replaced with a price modulation framework

Comparison of the present and past pricing policy regime in Nigeria
Table 5

Current price Modulation	Subsidy Regime in Nigeria overtime
PRICING POLICY • Price is set at within a band, over which individual marketers can set their pump prices	The price is fixed at a given rate
REVIEW PERIOD • Pricing template is be quarterly revised, to reflect market fundamentals	Pricing template was not reviewed, until subsidy payment becomes a burden to the government
DEREGULATION OF SUPPLY CHAIN • The market is deregulated to allow all Nigeria entity to import, subject to existing quality specification and guidelines from the regulatory agencies	Importation was restricted to NNPC and selected oil marketers
SUBSIDY PAYMENT Petroleum price is adjusted more regularly in line with EOMP; hence subsidy payment could be incurred in the interim,	Since petroleum price is set below the EOMP, subsidy is always paid by government

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VII Issue XII December 2023

Compared to the past subsidy regime as shown above, the present pricing approach has a number of advantages.

- It ameliorates the effect of crude oil volatility on consumers and marketers
- With government participation significantly limited, the subsidy regime could be gradually phased out
- The new pricing approach inculcates the best features of both price control and deregulation regimes, it retains temporary role for government intervention

Tied to the problem of erratic power supply is the issue of having a workable electricity tariffs. Although, this has been a recurring challenge in Nigeria even before the implementation of the power sector reforms. Ayodele (1999) admitted that the electricity tariff structure in Nigeria has alwaysbeen below the marginal cost. In order to fix this challenge, in 1988 the National Electric Power Authority (NEPA) was partially commercialized, supported by an upward review of tariffs. Since then, there have been several upward reviews in 2000 and 2002. Yet, when compared with tariffs in other countries in Africa, electricity tariff in Nigeria is not cost-reflective. As part of the restructuring effort of the powersector, the Electric Power Sector Act 2005 was enacted, which adopted a Multi- Year Tariffs Order (MYTO) to estimate end-user tariff in Nigeria. To date, MYTO has been reviewed several times since inception in 2008. Nevertheless, the issue of adopting a workable tariff structure in Nigeria is still elusive as consumers are dissatisfied with the exorbitant bills and poor service delivery. The recent amendment of the MYTO (2022) representing a 45 per cent hike in electricity tariff as show in the table below

TARIFF CLASSIFICATION IN NIGERIA

Table 6

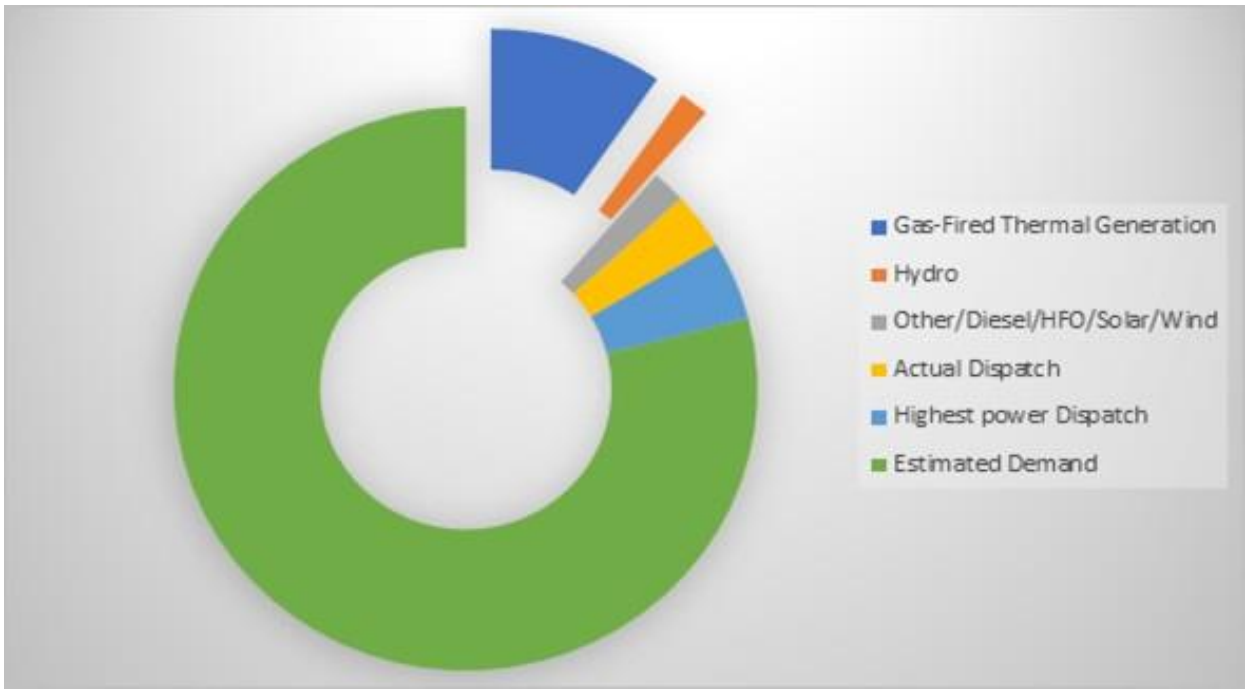
CUSTOMER CLASSIFICATION	DESCRIPTION	REMARKS
Residential		
R_1	Life-line (50kwh)	A consumer who uses his premises exclusively as a residence- house, flat or multi- storied house
R_2	Single and 3-phase	
R_3	LV Maximum Demand	
R_4	HV Maximum Demand (11/33	
Commercial		
C_1	Single and 3-phase	A consumer who uses his premises for manufacturing goods including welding and ironmongery
C_2	LV Maximum Demand	
C_3	HV Maximum Demand(11/33 KV)	
Industrial		
D_1	Single and 3-phase	A consumer who uses his premises for manufacturing goods including welding and ironmongery
D_2	LV Maximum Demand	
D_3		
Special		
A_1		Customers such as agriculture and agro-allied industries, water boards, religious houses, government and teaching hospitals, government research institutes and educational establishments.

Source: NERC MYTO 2023

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VII Issue XII December 2023

The quantity of electricity generated in Nigeria is still very meager while the quality of the service deliveryis very poor. Despite the private sector's participation in the business of power sector, the general consensusof the people is that power supply has not significantly improved. A substantial supply gap for electricity generation exists in Nigeria. Currently, electricity generation in Nigeria has a total installed powergeneration capacity of 16,384MW. Power generation in Nigeria is mainly from hydro and gas-fired thermalpower plants, with the hydro plants providing 2,062MW and the gas-fired 11,972MW (Figure below). Solar,wind, and other sources such as diesel and Heavy Fuel Oil (HFO) constitute the remainder with 2,350MW

Figure 5



Source: NERC

Despite the figures above, Nigeria continues to struggle in dispatching at full capacity. On the 28th of February, 2022, the country recorded the highest ever dispatch power of 5,615.40MW, which was 22MW higher than, and came just three days after the previous peak of 5,593.40MW was recorded (The Guardian news, Nigeria). This is very dismal for a country with an estimated energy demand of more than 98,000MW. This shows the huge gap between demand and supply of electricity in Nigeria.

Electricity Tariffs for Residential, Industrial, Commercial and Special Consumers

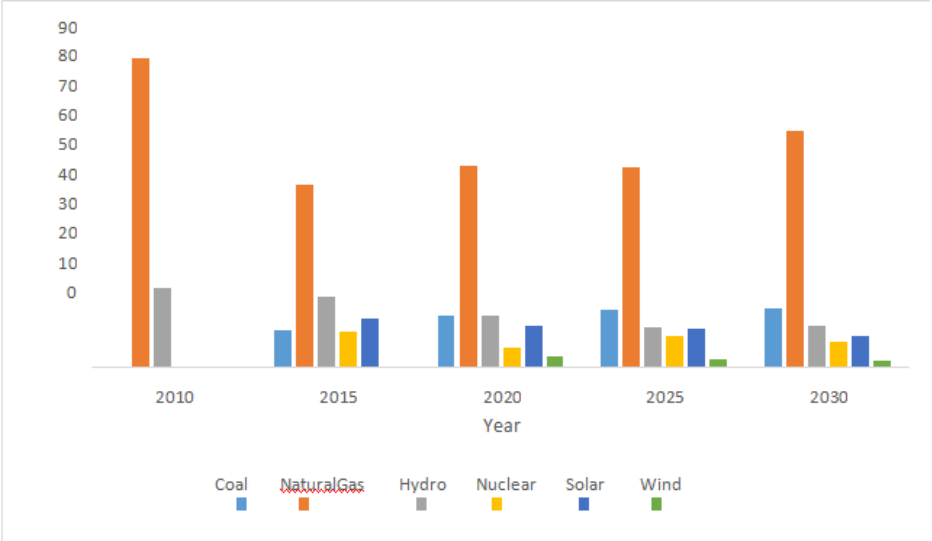
Table 7

DISCOS – ₦/kWh	**20(R2)**	**20(R2)**	**2**						
Abuja	14.70	24.30	24.30	24.03	20.40	19.69	19.74	19.51	19.40
Benin- single phase	14.82	24.08	31.27	31.26	30.98	30.88	27.29	24.49	24.34
Three phase	14.82	24.45	34.40	34.40	34.08	33.97	30.02	26.94	26.78

Enugu-single phase	16.44	27.13	30.93	31.00	22.91	23.27	23.29	23.01	22.87
Three phase	16.44	27.13	34.36	34.36	25.40	32.66	32.70	32.30	32.10
Ibadan	16.11	23.09	24.97	25.71	25.76	22.63	21.21	20.98	20.89
Jos	16.75	26.93	29.81	30.93	32.05	32.84	33.79	34.78	36.67
Kaduna-single phase	17.00	26.37	27.40	28.75	20.45	19.74	19.75	19.50	19.37
Three phase	17.00	28.05	32.33	33.93	24.13	23.29	23.30	23.01	22.86
Kano – single phase	16.01	20.26	22.50	25.46	24.82	18.75	18.81	18.60	18.49
Three phase	16.01	26.41	29.61	33.50	32.65	24.67	24.75	24.47	24.33
Ikeja – single phase	13.21	21.30	21.10	18.94	18.45	18.39	18.51	18.34	18.27
– Three phase	13.21	21.80	21.73	20.59	20.59	20.53	20.67	20.47	20.39
Port Harcourt	15.09	24.91	30.23	31.78	31.93	32.27	32.07	26.02	25.86
Eko – single phase	15.63	24.00	22.34	20.47	20.06	20.07	20.17	19.18	19.90
Three phase	25.63	25.79	28.39	26.02	25.49	25.51	25.64	25.39	25.29
Yola – single phase	15.00	23.25	25.73	26.57	27.82	27.74	24.05	22.25	22.13
– Three phase	15.00	24.75	28.17	29.02	30.46	30.37	26.34	24.36	24.24

The inability to satisfy the domestic(R's) from the above table 6 and, to a large extent, the industrial (D's) needs for electricity is reported to have had debilitating impact on the growth potentials of the Nigerian economy (World Bank, 2018). Even so, the demand for electricity, according to the defunct PHCN, is projected to increase from 5746 MW in 2005 to nearly 297,900 MW by the end of 2030. This implies that the Nigerian power sector needs to add approximately 11,686 MW of e electricity to its stock each year in order to match this projection, as projected graphically below using internationally accepted energy modelling techniques of Energy Commission of Nigeria (ECN) to analysed the energy demand and supply projections in Nigeria as reported by Sambo (2018)

Figure 6



In this study, seven different fuel types (natural gas, large hydro, coal, nuclear, small hydro, solar, and wind) are consider for optimization. The shares of the different power generation technologies in the total installed capacity for the Reference Case are shown in **table 3 above** From **Figure 6**, the share of hydropower (large and small) in the total installed capacity will decrease from 31.30% in 2005 to about 11% in 2030, while the share of natural gas based power capacity will increase from 68.30% in 2005 to 82.15% in 2010 and thereafter decrease to 62.95% in 2030. Coal and nuclear, which are not used for power generation at all at present in Nigeria, will account for 15.6 and 6.7% by 2030, respectively. Solar and wind are also projected to account for 8.3% and 1.8% respectively by 2030 (Sambo, 2009)

Recent Energy Pricing Reforms: In Few Selected Countries of the world 2023

Table 8

Country	Reform
Angola	Liberalize domestic fuel prices by 2022 with also the aims to add 800 megawatts of renewable energy, incentives for and investment in solar, small-hydro, wind, and other renewable energy technologies have been low. The Angolan government seeks to mobilize USD $23 billion of public and private investments in grid and generation infrastructure to meet increasing demand for energy and extend grid infrastructure into rural areas of the country.
Egypt	Fuel and gas prices increased 40-78%, electricity prices 20-50% in 2014, and the price of 92 octane gasoline would be 2.60 Egyptian pounds (36 cents) per liter, up 40 percent from its current price of 1.85 pounds, while 80 octane gasoline would rise to 1.60 pounds per liter, up 78 percent. 2023 Diesel will rise to 1.80 pounds per liter, an increase of 63 percent, while the less commonly used natural gas for vehicles will rise by 175 percent to 1.10 pounds per cubic meter.2023
Ghana	Petroleum prices liberalized 2019, Prices are therefore, set to reach Gh¢9.50p and Gh¢11.60p per litre for Gasoline and Gasoil respectively, and Gh¢9 per kilogram for LPG According to the National Energy Policy, Ghana's renewable energy development shall mainly focus on the vast mini hydro potential of the country. Twenty-one micro- and medium-hydro power sites, with generation capacities ranging from 4kW to 325 kW, have already been identified as suitable for power generation
Haiti	Gasoline, diesel, kerosene prices increased 6-8% in 2021, 9-11% in 2022
India	Gasoline prices liberalized in 2010 and diesel prices in 2014, Gasoline Prices in India increased to 1.18 USD/Liter in January of 2023 from 1.17 USD/Liter in December of 2022
Indonesia	Abolished gasoline subsidies and capped diesel subsidies in 2015, Fuel prices increased by about 30% across Indonesia, The hike — the first in eight years — raised the price of gasoline from about 51 cents to 67 cents per liter and diesel fuel from 35 cents to 46 cents
Kuwait	Raised diesel and kerosene prices 210% in 2015 (partially reversed) 2022 On a longer term view, a medium-term (five-year) economic reform agenda was recently approved by the Government. The reform agenda focuses on public financial management, privatization, PPPs, SMEs, investment reform, civil service and labor market reforms – and if implemented as a package could help begin the process of rebalancing the Kuwaiti economy away from oil.

International Prices of Oil, Coal and Natural Gas, 2010-2030 (Current prices; indexed 2023

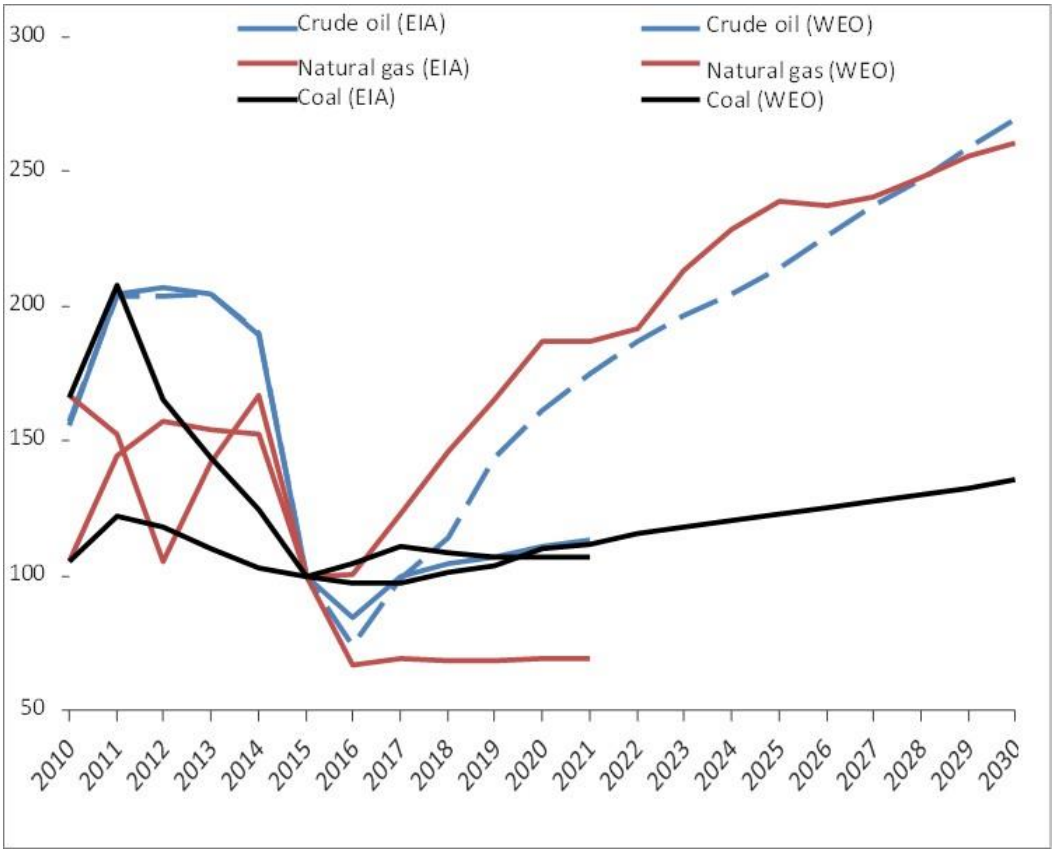


Figure 7. Source: IMF.

World Economic Outlook (WEO); and U.S. Energy Information Administration (EIA). Note: EIA crude oil spot prices are the average of Brent and West Texas Intermediate prices and WEO crude oil prices are the average of Brent, Dubai, and West Texas Intermediate prices; EIA natural gas prices are the spot prices at the Henry Hub terminal in Louisiana and WEO natural gas prices are the average of Russian natural gas border prices in Germany, Indonesian liquified natural gas prices in Japan, and natural gas spot price at the Henry Hub terminal in Louisiana; and EIA coal prices are the average nine mouth prices in United States and WEO coal prices are the average of Australia and South Africa export prices

THEORETICAL FRAMEWORK AND MODEL SPECIFICATION

Marginal cost pricing and average cost pricing are two basic concepts of energy pricing that are widely used (Bhattacharyya, 2011). Although long-run average cost is sometimes a proxy for marginal cost both concepts are fundamental to determining the most profitable level of output from a given plant. Marginal variable cost, or simply marginal cost MC(y) is the increase in variable cost incurred when output (y) is increased by one unit:

$$MC(y) = VC(y + 1) - VC(y) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

Theoretically, a more precise definition can be obtained by regarding VC(y) as a continuous function of output (Dorfman, 2006). The “marginal cost pricing doctrine” is shorthand for the proposition that utility rates should be predicated upon marginal costs for the purpose of attaining economic efficiency by means of accurate price signals. The doctrine stems from Professor Alfred E. Kahn’s hugely influential two-volume book, *The Economics of Regulation* (1970 and 1971). Kahn espoused marginal cost pricing as a means of

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VII Issue XII December 2023

bringing "economic efficiency" to regulated utilities. This pricing would result in "price signals" to consumers of sufficient accuracy that they could evaluate the appropriate economic level and timing of their use of utility services. Thus, the buying decisions of consumers is the means by which the end purpose of economic efficiency would be reached.

The basis for the theory is clear-cut: Since productive resources are limited, making the most effective use of these limited resources is a logical goal. In a competitive economy, consumers direct the use of resources by their buying choices. When they buy any given product or buy more of that product, they direct the economy to produce less of other products. The production of other products must be sacrificed in favor of the chosen product

Model Specification

Following the theoretical framework and study by Alfred E. (1970) a regression model that relates Macroeconomics variables and institution reforms of energy pricing overtime with the welfare of the consumer are specified as:

$RGDP=F(Ep, Q_T, S_W, I_t)$……………………………………………(2)

Where RGDP is used to proxy all Macroeconomic variables involved in the study to which the effect of energy pricing (EP) policies are measured, Output (Qt) measures the efficiency of government energy pricing polies on the consumer aggregate demand in Nigeria overtime, with the overall effect on "Social, Economic Welfare (Sw) living standard of the consumer, and capital ratio investment (It) of the economy

Given the inter-relationship between macroeconomic variables involved an unrestricted VAR model in line with Sim (1980) is specified in a compacted form as

$$Z_t = \alpha + \psi(L)Z_t + \varepsilon_t \qquad (3)$$

Where Z_t is a vector of the □ (Stationary endogenous), Variable, α is n $\times$ 1 vector of constants $\psi(L)$ is a n$\times$n matrix of (lagged) polynomial coefficients and μ_t is an n$\times 1$ vector of white noise innovation terms with $E(\mu_{tk})$ = 0 and $E(\mu_{tk}, \mu_{sk})$ = 0 for $(t \neq s)$. More specifically, the model which also incorporates the above direct and indirect linkages is presented as:

$$\left.\begin{aligned}
RGDP_t &= \alpha_{it} + \sum_{j=1}^{n-i} \beta it\, RGDP_{t-j} + \sum_{j=1}^{n-i} \delta it Ep_{t-j} + \sum_{j=1}^{n-i} \gamma it Qt_{t-j} + \sum_{j=1}^{n-i} \phi it SW_{t-j} + \sum_{j=1}^{n-i} \psi it I_{t-j} + \mu_{1t}\\
EP_t &= \alpha_{it} + \sum_{j=1}^{n-i} \beta it\, RGDP_{t-j} + \sum_{j=1}^{n-i} \delta it Ep_{t-j} + \sum_{j=1}^{n-i} \gamma it Qt_{t-j} + \sum_{j=1}^{n-i} \phi it SW_{t-j} + \sum_{j=1}^{n-i} \psi it I_{t-j} + \mu_{2t}\\
QT_t &= \alpha_{it} + \sum_{j=1}^{n-i} \beta it\, RGDP_{t-j} + \sum_{j=1}^{n-i} \delta it Ep_{t-j} + \sum_{j=1}^{n-i} \gamma it Qt_{t-j} + \sum_{j=1}^{n-i} \phi it SW_{t-j} + \sum_{j=1}^{n-i} \psi it I_{t-j} + \mu_{3t}\\
SW_t &= \alpha_{it} + \sum_{j=1}^{n-i} \beta it\, RGDP_{t-j} + \sum_{j=1}^{n-i} \delta it Ep_{t-j} + \sum_{j=1}^{n-i} \gamma it Qt_{t-j} + \sum_{j=1}^{n-i} \phi it SW_{t-j} + \sum_{j=1}^{n-i} \psi it I_{t-j} + \mu_{4t}\\
I_t &= \alpha_{it} + \sum_{j=1}^{n-i} \beta it\, RGDP_{t-j} + \sum_{j=1}^{n-i} \delta it Ep_{t-j} + \sum_{j=1}^{n-i} \gamma it Qt_{t-j} + \sum_{j=1}^{n-i} \phi it SW_{t-j} + \sum_{j=1}^{n-i} \psi it I_{t-j} + \mu_{5t}
\end{aligned}\right\} \ldots (4)$$

Where $\boldsymbol{\alpha}$ is the constant term while ϕ,Y, $\delta\beta, and\ \psi$ are the coefficients of the variables, $\sum\beta_{it}\, RGDP_{t-j}$ = sum

of the lags of macroeconomics and institutional reforms of energy pricing stability from period t to j $\sum\delta_{it}\, EP_{t-j}$ = sum of the lags in the policies of the Energy pricing from period t to j $\sum\gamma itQt_{t-j}$= Sum of the lags in the output of energy reforms in Nigeria overtime from period t to j $\sum\ \phi itSW_{t-j}$ = Sum of the lags of Social economic welfare of energy consumption in Nigeria overtime, $\sum\psi itI_{t-j}$= Sum of the lags of energy sector pricing on investment

Sources of Data

The study employed annual time series data over the period 1999 -2023. The macroeconomic variables used for the study, their definition, as well as their sources are presented below

Table 9 Description and Sources of data used in this study

Variable	Definition and Measurement	Sources
RGDP	Gross Domestic Product is the market value of economic effect of energy pricing on various macroeconomics factors .i.e GDP is used as proxy of all macroeconomic variables involved adjusted for inflation and it measures of economic growth	CBN, Statistical Bulletin, 2023,
EP	Energy pricing policies of government in Nigeria and selected countries of the world, understand the variables that affect energy market pricing the rates per unit of it measurement, mechanism of setting the prices	NERC. ECN, MYTO,PPPRA 2022,IMF
Qt	Energy Output means the amount of energy (in kWh) generated by the Project and delivered to the Delivery Point from and after the Initial Delivery Date, as metered by the Metering Equipment or by billing	NERC, MYTO 2023
S_w	Social welfare of how energy pricing policies is primarily considered for its social and economic benefits, local value creation, How domestic energy policies shaped the enabling environment through distribution and sustainability	National Bureau of Statistics2022, REA 2023, NERC 2022 , EMSL, ECN 2023,
I_t	Investment which measures the “capital output ratio” of energy output to it prices in Nigeria and other countries overtime	CBN Bulletin, DMO(2022),NBS

RESULTS AND DISCUSSION

Unit root test

Table 1 shows the outcome of the Augmented Dickey Fuller (ADF) and the Phillip – Peron (PP) test results. The ADF and PP results show that real gross domestic product (RGDP) which is used to proxy all macroeconomic variables involves becomes stationary at first difference and 5 percent level of significance. The ADF and PP tests also reveal that (EP) energy pricing becomes stationary at first difference and at 1 percent level of significance. Also the Energy Output () becomes stationary at first difference. However Social welfare (),which is also used to proxy the dividend and marginal benefits of energy outputs, becomes stationary at level using trend and intercept, but not stationary at intercept, which is used also as proxy for economic growth, through capital and human investments is becomes stationary also using trend and intercept but not stationary at intercept. (PP), however, shows that the variable was not stationary. It can be concluded from the unit root tests that all the variables are integrated to the order of I(1), that is, the variables are stationary at first differences. Hence, the study proceeds to test if the variables are co-integrated

Table 10: Unit root test results

Test	Augmented Dickey Fuller				Philip-Peron			
Variable	level	First Difference	First Difference		Level		First Difference	
	Intercept	Trend and Intercept	Intercept	Trend and Intercept	Intercept	Trend and Intercept	Intercept	Trend and Intercept
Log (RGDP)	0.7244	-2.2194	-3.3787	-3.6029	1.7992	-2.3113	-3.2202	-3.4618
	(0.9903)	(0.5639)	(0.0191)*	(0.0450)*	(0.9997)	(0.04369)	(0.0277)*	(0.0605)
Log (	-1.6371	-3.4982	-5.1210	-5.4498	-1.1156	-3.2218	-10.7880	-11.023
	(0.4518)	(0.0557)	(0.0003)***	(0.0005)**	(0.6981)	(0.0624)	(0.0000)***	(0.0000)***
Log ()	-0.0176	-1.6637	-3.8023	-3.4663	-1.1936	-3.2654	-4.5562	-4.9641
	(0.9215)	(0.7432)	(0.0072)***	(0.0621)	(0.6661)	(0.0875)	(0.0009)**	(0.0017)**
Log ()	-0.6307	-1.5680	-5.2472	-3.3791	-1.0474	-1.9740	-2.6086	-25395
	(0.8481)	(0.0000)***	(0.0002)**	(0.0770)	(0.7247)	(0.5942)	(0.01014)	(0.03084)
Log()	-0.5233	-0.4231	-3.6321	-7.2361	-0.6723	-0.3351	-4.2311	-2.5612
	(0.3121)	(0.9123)	(0.5132)	(0.0008)***	(0.0000)**	(0.3412)*	(0.0023)	(0.2131)

Notes: *** Significant level at 1% level of confidence, ** Significance at 5% level of confidence

VAR lag selection criteria

Before the cointegration test, there is the need to determine the optimum lag using the criteria presented in the table below (Table 11). The determination of the optimum lag will help estimate both cointegration and VAR (VECM). The outcome of the lag selection criteria, as depicted in (Table 11), reveals that the optimum lag is 2. This is because most of the lag selection criteria (i.e, FPE, AIC and HQ) Indicate the lag length to be 2. Hence, the lag length of 2 would be used to estimate the cointegration and VAR (VECM)

Table 11: VAR lag selection criteria

Schwarz Lag Length Test	Hannan-Quinn Final Prediction Error (EPE)	Akaike Information Criterion (AIC)	Information Criterion (SIC)	Information Criterion (HQ)
0	0.001448	4.806841	4.988236	4.867875
1	1.59e-08	-4.310687	-3.403712*	-4.005517
2	1.26e-07*	-4.599220	-2.966667	-4.049916*

Cointegration test

Table 12, below depicts the Johansen cointegration test results. The data consists of the trace and maximum eigenvalue tests. The tests determine the number of cointegration vectors. Both test evaluated the null hypothesis that the number of cointegrating vectors is less than or equal to 0, 1,2 or 3. For each case, the null hypothesis is tested against the alternative. For instance, if the value of the trace statistic of a cointegration vector exceeds the critical value at 5 percent, the null hypothesis of no cointegration is rejected in favour of the alternative hypothesis, in the same vein, if the value of the maximum Eigen is greater than the critical value at 5 per cent, the null hypothesis of no cointegration is rejected in favour of the alternative hypothesis.

Table 12: Cointegration test results

Model	Null Hypothesis	Trace Statistical	Critical Value (5%)	Maximum Eigen	Critical Value (5%)	Results
Lag	r	66.3601	47.8561	31.9802	27.5843	Trace test showed the presence of two
Length :2	r	34. 3798	29.7970	20.6094	21.1316	Cointegrating vectors
	r	13.7703	15.4947	11.8712	14.2646	While the Maximum Eigen showed
	r	1.8990	3.8414	1.8990	3.8414	One cointegrating vector

For $r \leq 0$ and $r \leq 1$ under the trace statistic, the null hypothesis of no cointegration is rejected. This implies that the there is presence of cointegration. Similarly, for $r \leq 0$ under the maximum Eigen, the null hypothesis of no cointegration is rejected. In essence, both the trace and maximum Eigen tests showed that long-run relationship exists between the variables. Hence, the vector error correction (VEC) becomes more appropriate to be used.

However, it is important to state that the study focuses on the impulse response function to evaluate the environmental impact of increased energy prices and variance decomposition of VECM using inverse roots of autoregression (AR) to evaluate the marginal social cost of energy pricing policy reforms in Nigeria overtime.

Impulse response function

Figures 8, below depicts the reaction of real gross domestic product (RGDP) to the shocks in several environmental problems directly related to energy pricing, investment, production, output and consumption including **air pollution, climate change, water pollution, thermal pollution, and solid waste disposal**, RGDP which proxy macroeconomic variables used in the study respectively.

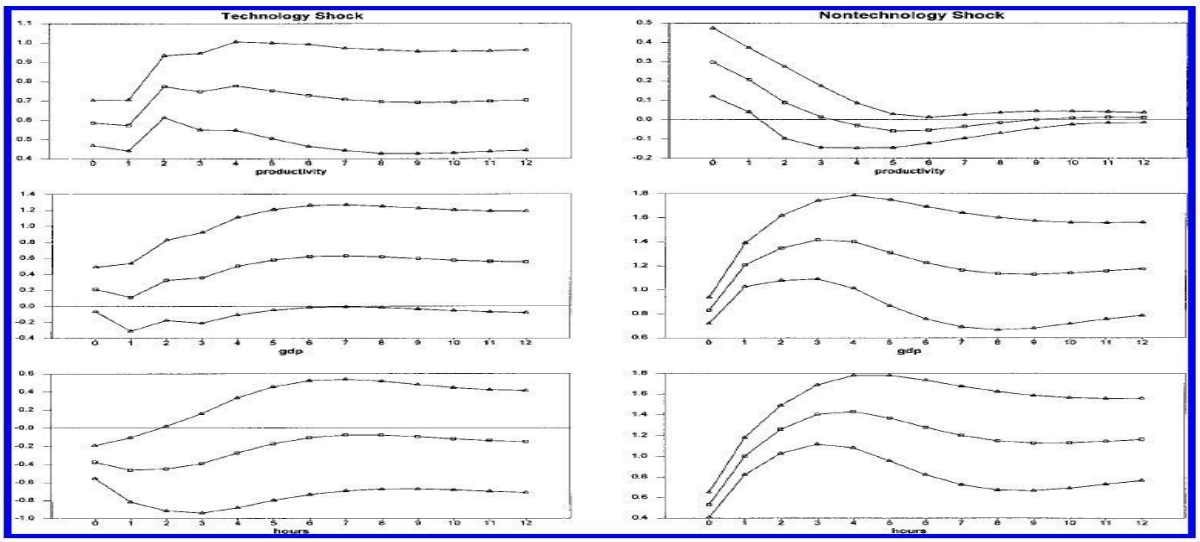


Figure 8: Authors' computation using Eviews 9

The figure below shows the response of RGDP to the technological and non-technological Environmental consequences of energy subsidies and carbon emissions in Nigeria due to the limitations in technological know-how, the IRF reveals that the RGDP responds negatively to the Shock in an increase in energy pricing due to an ineffective environmental policy measures to curtail the adverse effect of this energy consumption (e.g The dichotomy between pricing versus regulation or taxes versus trading)

Variance decomposition

The variance decomposition (VDC) separates the variance in an endogenous variable into component shocks to VAR. Hence, VDC provides information on the relative importance of each random innovation in affecting the variables in VAR (Anetor et al…2018)

Table 13 shows the variance decomposition of RGDP for 5th periods. It can be noted in the 5th period that Energy pricing accounts for over 27% increase in Q4 0f 2022 and Q1 of 2023 as depicted below, the energy pricing cap going further up by 20% in Q1 February 2023 with no much positive effect on the RGDP of 30.68%. It can be noted in the 5 th period that Energy pricing accounts for 60% variation in RGDP, Energy output accounts for only 40% variation, while social welfare derivatives of the consumer accounts for only 16% variation and level of investment intracted by the energy products accounts for the short fall of 40% variation of the RGDP

Table 13: Variance decomposition

Period	S.E	LOG(RGDP)	LOG(EP)	LOG(Qt)	LOG(Sw)	LOG(It)
1	0.032430	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.055732	91.80990	0.271025	3.771893	4.417186	75.55505
3	0.076858	84.12433	1.890991	7.201910	0.132902	73.45101
4	0.096798	80.43492	2.571078	8.489645	0.149652	72.29871
5	0.115275	30.68207	60.16103	40.85475	16.5566	40.25056

As shown above, this outcome presupposes that the macroeconomics variables of social economic growth e.g increase energy supplies, low carbon emission and other various energy mix of development proxied by the RGDP as shown above exerts extremely low impacts if not negatively on the RGDP with as low as 30% rate in comparison with other countries of the world energy regulated pricing reforms policies. This is followed by Energy pricing 0f 60% increase in energy subsidies, tariff e.tc without the attributive increase in efficiency and equitable distribution of energy mix, while the least is on investment rate at 40% rate. This implies that even though successive government of Nigeria had overtime put in all measure to attract investors through several energy policies incentives measure the sector still remains extremely inefficient due to over-politicization of the energy pricing which causes much gap in the fiscal space of the energy sector

VECM Granger causality

Table 14 depicts the vector error correction model (VECM) Granger causality test, the test was conducted to ascertain the existence of causal relationship between the endogenous variables under study. The result shows that there is a unidirectional causal relationship running from RGDP to EP. This implies that energy pricing reforms has a much more causal effect on macroeconomic well-being of the consumers which lend credence to the Wagner's law of public expenditure that as the economy develops overtime more increase in energy

marginal social cost increases such as increased taxes on energy usage, tariff on electricity and low energy subsidies, the below results also indicates that there's a unidirectional (inverse) causal relationship running from RGDP to energy pricing output in Nigeria over years

Table 14

Dependent Variables	*Probability Values*					*Direction of Causality*
	LOG(RGDP)	*LOG(EP)*	*LOG(Qt)*	*LOG(SW)*	*LOG(It)*	
LOG(RGDP)	–	0.2696	0.7620	0.1870	0.1673	
LOG(EP)	0.0134	–	0.2414	0.5231	0.4121	LOG (RGDP)?
						LOG (EP)
LOG(Qt)	0.0222	–	0.4672	0.5801	0.6412	
LOG(Sw)	0.0377	0.4708	0.3217	0.2113	–	LOG (RGDP)? Sw
LOG(It)	0.0426	–	0.4706	0.2031	–	LOG(It)

Source: Authors' computation using E-view 9

Inverse roots of AR

Figure 9: Shows the inverse roots of AR. The below graph helps ascertain if the estimated impulse response function and variance decomposition of VAR (VECM) are stable. These are said to be stable if none of the polynomial roots are found outside the circle. A cursory look at figure 8 below reveals that none of the polynomial roots are outside the circle, meaning that the estimated variance decomposition of VECM and the impulse response function are stable and can be used as basis for the above decision

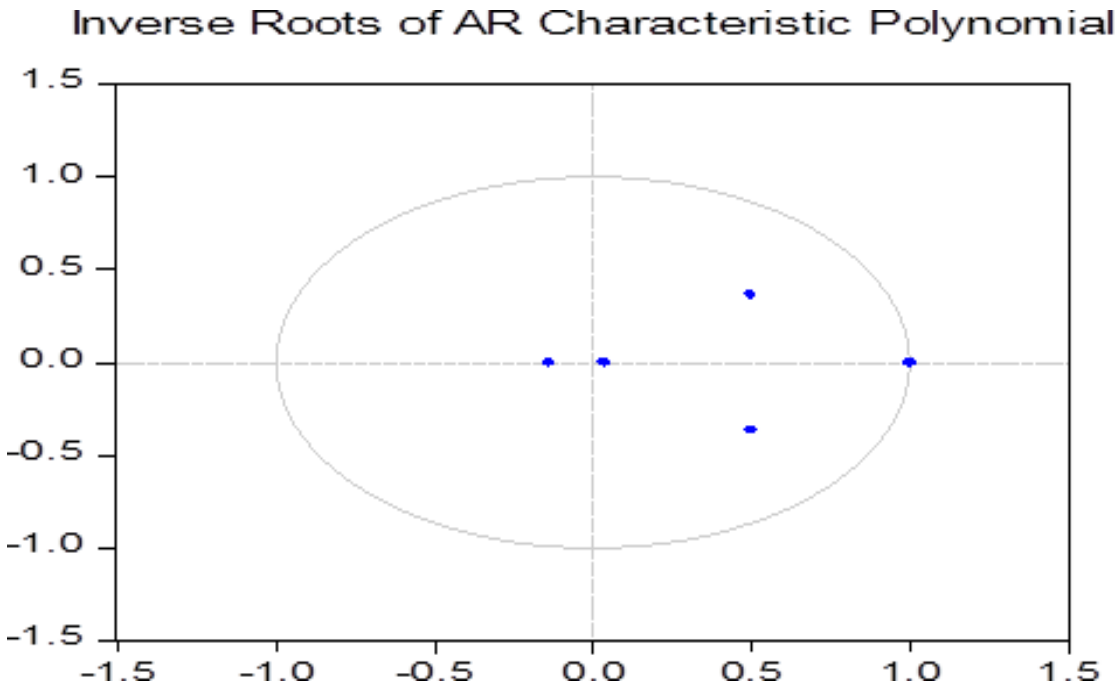


Figure 9: Inverse roots of AR

Source: Authors' computation using e-view 9

CONCLUSION AND RECOMMENDATIONS

The study which investigates the macroeconomic impact of Nigeria's institutional reforms of energy pricing policies, energy supply, fossil fuel subsidies initiatives of Nigeria and it effectiveness on socio-economic welfare of the consumers in comparison with other countries of the world, using annual time series data over the period 1999- 2023 employ the variance decomposition (VDC) of the vector error correction model VECM) in testing the validity of this policies measures with the results shown above with the VDC response reflecting much negative effect of high energy pricing measure on macroeconomic as proxy by RGDP in the study, and also it effects on investment (It) , Output (Qt) and social-economic welfare(Sw) of the consumer, implying that government expenditures on energy sector in Nigeria, through several policies measures of regulations, subsidizing and mitigations of successive governments has not been effective in yielding any positive improvement due to the following attributive factors

- Many literatures reviewed in this study has shown that successful and durable energy pricing reform is hard to achieve. Many countries have started on the path of energy reforms only to abandon these efforts, Most often in the context of sharply and inadvertent increase in international energy prices and other social unrest (increased social agitations) due to fear of inflationary pressure on the welfare of the consumers, also the absence of multi-stakeholders approach in several policies engagement, poor communication strategy with the public, also poor complementary social safety net to cushion the effects of this policies initiatives
- Coincidence of reforms timing with Economic, social, fiscal crisis, many of the energy policies initiatives measures were introduced at a period of enormous fiscal stress, as a result of crash in the crude-oil prices as related above, reforms are difficult to implement during economic boom. However , the dynamics change during economic crisis, as lack of reform imposes a higher cost on the economy
- Government Credibility and anti-corruption stance, a key factor this study cited in the failure of the above policies reforms is the perceived perverted corruption and lack of political will regarding government intentions (see IMF, 2013) also in a survey regionally conducted by the author using questionnaire in which 62% of the respondents perceptions of energy pricing policies effectiveness in Nigeria is as shown below

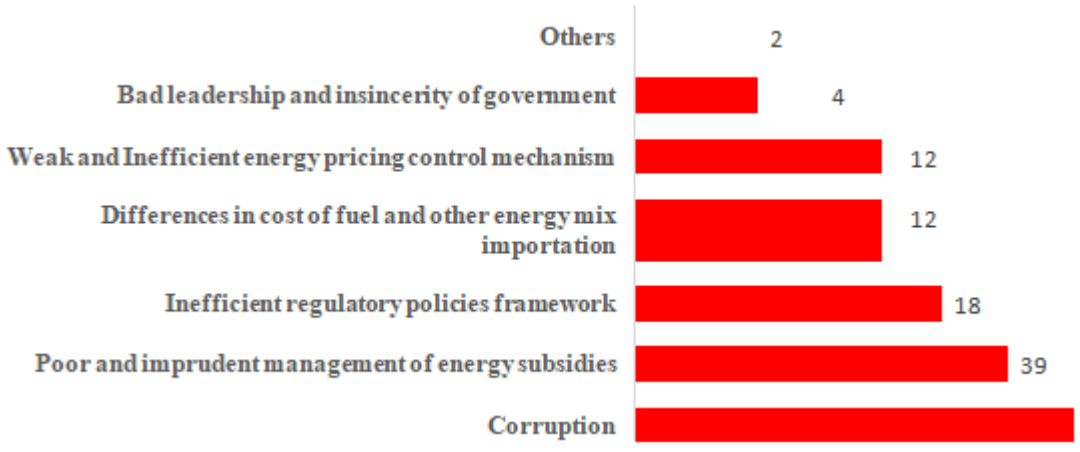


Figure 10: Factors affecting energy pricing policies effectiveness in Nigeria.

POLICY RECOMMENDATIONS

With the reviews of several reforms on energy pricing policies the study identify how energy subsidy reform strategies can be redesigned to enhance the likelihood of successful and durable energy subsidy reform. While these has largely drawn from several country reform experiences of pre-tax subsidies, they could potentially also be useful for countries like Nigeria to further reform energy pricing to a more efficient levels. This six key ingredients are deemed fit in enhancing the effectiveness of "Macroeconomic and Institutional Reforms of Energy pricing policies of Nigeria"

- Qualitative assessments by energy policy makers of the trade-offs between alternative mitigation instruments (e.g., pricing versus regulation or taxes versus trading) to enhance an effective preference for pricing measures in Nigeria
- Reassessments of extant policy measures specifically for other components of the reform strategy like increase in taxies enabled by the new revenues and the form and amount of measures to relieve households and firms especially those vulnerable to higher energy So far Nigeria does not levy an explicit carbon price. **No fuel excise taxes are levied**. Fossil fuel subsidies cover 14.2% of emissions in 2021, unchanged since 2018, this will goes a long way in mitigating the adverse effect of outright energy subsidies removal.
- Lessons from reform experiences in other countries that policymakers can incorporate into their own policy packages also a well communicated strategies by ***Undertaking a gradual and sequential reforms***. A gradual approach to energy subsidy reform is desirable when large price increases are needed since the public often react very negatively to large price increases (as in Indonesia in the late 1990s, Mauritania in 2008, and Nigeria in 2012)
- Flexible tools and better pricing mechanism that covers specific pricing trajectories that also reflect other externalities, such as (pollutions), Most externalities fall into the category of so-called *technical externalities*; that is, the indirect effects have an impact on the consumption and production opportunities of others as well as the impacts of price reform on the energy system, emissions, fiscal balances, and the broader economy
- Government strategies for setting energy prices which proves inconsistent across regions over years spanning a full spectrum from discretionary price fixing must be of pure market-based approaches(subject to the price mechanism of demand and supply)
- Regular Evaluation of Existing Energy Policies and Plans, The government should plan to review, periodically assess and evaluate the existing National Energy Policy, Renewable Energy Master Plan, Solar PV Master Plan, Energy Master Plan, and Renewable Electricity Master Plan by Establishing a Legal and Regulatory Framework if fully implemented, will help solve the energy poverty issue in Nigeria. NERC must monitor the activities of all participants in the electricity market and ensure that all rules, regulations, and codes are enforced in a fair, transparent and equitable way. It is also crucial to institutionalize and improve the relevant legal and administrative framework by creating a more Technological and Environmental Support based system in energy markets

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