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Comparative Analysis of Electricity Grid Tariffs Versus Generator Costs in Nigeria

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Abstract: The Nigerian electric power industry, pivotal for economic development, faces severe crises affecting its efficiency. This study provides a comparative analysis of electricity grid tariffs and generator costs over the past decade. The analysis reveals frequent tariff changes by the Nigerian Electricity Regulatory Commission (NERC) and rising generator costs due to increasing fuel prices and maintenance expenses. The study highlights the financial burden on Nigerian households and businesses reliant on generators. Data from NERC reports, Nigerian National Petroleum Corporation (NNPC) fuel price records, and industry studies indicate that generator costs have escalated more sharply. At the same time, grid tariffs have increased due to economic and policy changes. This disparity stresses the need for policy adjustments and improved monitoring to stabilise electricity costs and enhance service delivery. Recommendations urge immediate action from policymakers, energy industry professionals, and stakeholders to address the pressing issues.

Keywords: Privatisation, Regulatory, Renewable, Tariff, Rural Electricity,

I. Introduction

Given the pivotal role of the electric power industry in economic growth, the need for a reliable, adequate, and regular power supply is not just a necessity but an urgent demand. The industry, which should be the engine of industrialisation in Nigeria, is severely plagued by many problems, which have escalated into a deep crisis over the last two decades (Babatunde et al., 2023). Consumer dissatisfaction with service delivery is at an all-time high, demanding immediate redressal. The energy crisis in Nigeria since the mid-1980s has garnered global attention due to its potential to create severe economic stagnation and social conflicts and drive away potential foreign investments (Arowolo & Douglas, 2022). Among the several issues that affect the industry, one standard variable for the government, consumers, and private investors is cost. The primary purpose of this paper is to examine the relative instability of electricity tariffs fixed by the National Electricity Regulatory Commission (NERC) as against the corresponding increase in electric power output. The electric power industry, a core sector of the Nigerian economy, significantly impacts the national economy. The importance of the electric power industry is underscored in the theoretical literature on infrastructure services, which credits them as necessary for creating conducive conditions for industrial and economic development. The electric power industry has a mammoth capacity to generate employment, contributing to other related social effects. Prior studies have identified electricity as an essential input for economic growth in that it is a necessary condition for industrial production and household use. This research is of utmost importance in understanding the potentially devastating impact of electricity tariffs on the economy and consumer satisfaction, and policymakers, energy industry professionals, and stakeholders in the Nigerian electricity sector must be aware of its findings and act swiftly and responsibly to address the issues.

II. Background and Rationale

Regulatory bodies worldwide often face the challenge of balancing the need to maintain adequate generation capacity reserves, keep end-user tariffs as low as possible, eliminate cross-subsidies and inappropriate consumer class membership, encourage competition, and promote conservation (Kumar et al., 2021). In negotiating power purchase agreements, they must consider the recovery of efficient cost differentials and isolate prices from antisocial price manipulation by any accounting and transfer pricing method. This research paper is a significant endeavour to compare the evolution and composition of the actual average electricity generation incremental costs in Nigeria that led to capacity adequacy and price regulation decisions reported on an Energy Information Administration (EIA) website in related power industry reports between 1995 and 2004, with recently approved electricity grid tariffs applying since 01 January 200. The paper aims to identify any substantial differences between the historical average energy costs of utilities and prevailing retailers and the average EIA reported associated incremental costs, the over or

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underpricing by the utilities and suppliers, relating to the discretion in setting tariffs and non-incumbent units for power supply. During the monopoly era of days gone by, utilities were operated as natural monopolies managed as public policy instruments to deliver electricity to consumers at reasonable costs and promote the well-being and development of the nation. However, during the unfolding electricity restructuring, the rapid expansion of the capacity of generating plants in the last 20 years and the anger and disbelief over tariff increases by cost-conservative utilities raise questions about whether consumers and utilities are from the same planet or observe the same cost behavior (Coady et al., 2021).. It would benefit electricity utilities to compare the electricity generation costs over time versus the historical and latest decisions in electricity tariffs.

Research Objectives

This research aims to perform a comparative charging system analysis of electricity grid tariffs versus generator costs, which accommodates the generator capacity cost versus time analysis and investment strategies for the optimal utilisation of an independent power project (IPP), particularly in the electric industry of Nigeria, which is submerged in historical negligence such as asymmetrical behavioural model estimates and their computations of some of the known allocator values—generator cost to the company, the total cost to the society for heavy fuel oil-fired plants; system marginal cost, cost allocation factors, and load duration curve values in connection to a gas turbine. Open economics and firm data in analyser files could be relevant for these estimations. It also has a broad and diverse range of capacity additions and costs around the cross-section of countries in the dataset, possibly due to the supportive energy policies enacted by governments through lobbying legislations by the potential/individual investors. Solving issues of electricity tariff in Nigeria while holding historical grievances exhibits the electric bill as a source of such wrenching conflicts. In the interest of these conflicts occurring in a competitive electric industry, it becomes necessary that the price a buyer is willing to pay for electricity is in parallel with the price of the electricity sold to him. However, past literature only focuses on comparing generator costs and electricity tariffs, while other costs generated, distribution, and transmission in the electricity industry are omitted.

Scope and Limitations

Regulated prices, however, pose social and instructional problems for both generators and industrial and commercial customers in the form of different cross-subsidy requirements. The residual technical and economic problem is the same for the regulated and competitive market: the costs of investments in transmission and distribution capacity, especially when they must cope with the more or less frequent new inflexibility and liability requirements of the commodity to be transported. These residual problems have spurred the regulatory discussion of market access arrangements and have resulted in several topics identified as items for further research. The scope of the study deals with the financial implications of power purchase in the Nigerian electricity supply industry and is limited to the aspect of the Single Buyer Entity. It covers two broad subjects: power purchase and tariff structure, which are under the direct control of the National Electric Power Authority or other public authorities such as the Nigerian Electricity Regulatory Commission. This study on tariff structure complements the one being carried out from a social, structural, financial, and environmental point of view, as well as the Strategic Plan of the Nigerian Electricity Regulatory Commission. Additionally, electricity supplies often provide social facilities such as hospitals, schools, or water works and offer financial assistance to fuel-based electricity generators or the economy as a whole.

The research process begins with defining research objectives and conducting a literature review. Next, data collection is performed, which involves gathering information on electricity grid tariffs and generator costs. This data is then analysed, leading to an economic impact assessment. The subsequent step is policy analysis, culminating in the conclusion and recommendations.

III. Electricity Grid Tariffs in Nigeria

The legislation was passed so the PHCN entities could be privatised, but the privatisation process is still incomplete. The state governments also control some PHCN-type power plants. These generating companies sell power to the PHCN entities, which act as sales organisations and distribution companies for the Regional Electricity Distribution Companies. Unmetered spot tariffs are currently used in towns with no embedded generation tariffs. Rural electricity tariffs are equally low because the government cannot afford to extend the current subsidies. Subsequently, demand falls short of efficient long-run economic costs (Aguda, 2023). The analysis starts with electricity grid costs in Nigeria. The national service provider, Rural Electrification Authority (REA), operates a Rural Electricity Agency for community electrification and an Association of Rural Electricity Cooperatives through which it can access rural finance as a co-lender (Babalola, 2023). A state-owned Power Holding Company of Nigeria (PHCN) has been corporatised by having its technical aspects (those that do not require tariff-based payment) transferred to the Nigeria Electricity Management Services Agency, NEMSA. The billing and revenue collection parts of each PHCN entity have been corporatised under a Bureau of Public Enterprises Public-Private Partnership contract (Osasu, 2022).

Figure 1 represents the electricity supply chain in Nigeria, illustrating the flow of electricity and payments among various stakeholders in the sector, regulated by the Nigerian Electricity Regulatory Commission (NERC). Here is a detailed review of each component and their interactions:

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Key Entities and Their Roles

1. **GENCOS (Generation Companies):**
   - **Successor Privatised GENCOS:** These are former publicly owned generation companies that have been privatised.
   - **NIPP GENCOS:** National Integrated Power Projects, a government initiative to boost power generation.
   - **Private IPP GENCOS:** Independent Power Producers that generate electricity.

Function: These entities generate electricity. They send bulk power to the Transmission Company of Nigeria (TCN) and receive payments for the electricity supplied.

2. **Gas Producers:**
   - **Function:** They supply gas to the GENCOS, which is essential for power generation, especially for thermal plants. Payments for gas supply are likely handled directly between gas producers and GENCOS.
3. **Transmission Company of Nigeria (TCN):**
   - **Function:** TCN is responsible for transmitting the generated electricity across the grid to various DISCOs (Distribution Companies). TCN also handles payments for services and bulk power sent to the grid.
4. **NBET (Nigerian et al.):**
   - **Function:** Acts as a bulk trader between GENCOS and DISCOs. NBET pays GENCOS for the bulk power sent to the grid and receives payments for the energy from DISCOs.
5. **DISCOs (Distribution Companies):**
   - **Function:** They distribute electricity to end consumers (industrial, commercial, and residential). DISCOs handle billing and collection of consumer payments and pay NBET for the energy received. They also ensure electricity is allocated according to load allocation instructions from TCN.
6. **Consumers:**
   - **Function:** Industrial, commercial, and residential consumers use the electricity supplied by DISCOs. They pay for the electricity consumed via billing.

Payment and Electricity Flow

1. **Electricity Flow:**
   - Bulk power is generated by GENCOS and transmitted by TCN to DISCOs, who then distribute it to consumers.
   - Gas supply from gas producers to GENCOS ensures continuous power generation.
2. **Payment Flow:**
   - Consumers pay DISCOs for the electricity consumed.
   - DISCOs pay NBET for the energy received.
   - NBET, in turn, pays GENCOS for the bulk power sent to the grid.
   - TCN receives payments for its transmission services.

Regulation

- **NERC (Nigerian et al. Commission):** NERC regulates the entire process and ensures that tariffs are set appropriately, services are maintained, and disputes are managed within the sector.

Observations and Implications

- **Complexity and Coordination:** The flow of electricity and payments illustrates complex coordination among various entities. Efficient communication and timely payments are crucial to maintaining stability in the supply chain.
- **Regulatory Oversight:** NERC's role is critical in managing tariffs and ensuring all entities adhere to regulatory standards.
- **Financial Stability:** Each entity's financial health depends on timely payments from the subsequent entity in the chain, highlighting the importance of efficient billing and collection processes.

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Figure 1 effectively captures the intricate relationships and transactions involved in Nigeria's electricity supply chain. It underscores the importance of each stakeholder in maintaining the flow of electricity from generation to consumption and the critical role of regulatory oversight in ensuring the system's efficiency and sustainability.

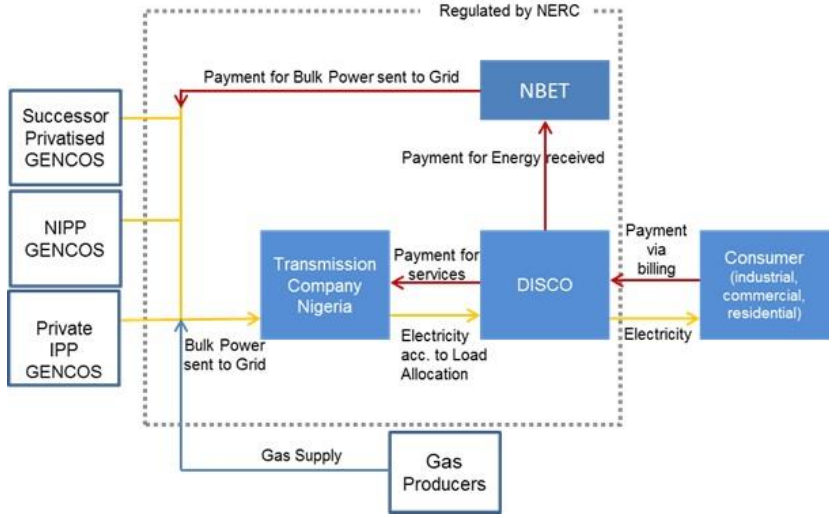

Figure 1: Review of the Electricity Supply Chain in Nigeria

Overview of the Nigerian Electricity Grid

Recognised stages of engagement in the country's wholesale market led to the development of contracts-in-use types referred to as vesting contracts, grid power purchase agreements, and bilateral contracts. The bulk of power business, primarily industrial, is done through pre-privatization contracts with the former public power company (Saturday, 2021). Large industries were required to carry the cost of the concessional long-term investment in developing significant hydroelectric resources to make large hydroelectric power plants more financially viable. The payment stream of these development costs resulted in long-term tar contracts. Small-scale water users are not required to pay the same tariffs or be linked to the grid, although these customers must be willing to use the water services (Edomah et al., 2021). The Transmission Company of Nigeria (TCN) centrally regulates the Nigerian electricity grid. However, the power sector was unbundled (generation, distribution, and an independent single buyer) and eventually privatised in 2013. The primary grid connections and the majority of the central generation system (dependent on domestic natural gas resources and just a few significant rivers for large hydropower) are in the country's northern half. The southern half of the country, where the majority of the population is located, hosts the majority of the demand and the majority of the paying customers. Transmission capacity is limited due to market-access restrictions that do not allow investment in new or rehabilitating existing power lines. Funds for system expansion are constrained within a distribution company, which is obliged to pay for connection to the grid and **use** the capacity provided (Edet, 2020).

Tariff Structure and Components

Within the Nigerian grid system, the electricity tariffs are designed to represent the total average cost of supplying power to consumers over time. This tariff regime intends to facilitate investment recovery and provide a return on capital. The Nigerian regulatory body, the Nigerian Electricity Regulatory Commission (NERC), adopts different cost elements in a uniform tariff structure to account for the capital and operating costs incurred in operating and maintaining the power system (Babatunde et al., 2023). Additionally, cost parameters are adjusted for certain demographic and geographic regions, considering rural versus urban loads, seasonality, generation, transmission, and distribution costs. These costs are distributed across consumer categories based on load, energy intake patterns, and socio-economic status. The tariffs for different categories are reviewed by the NERC every three to five years, considering that the initial volume of electricity is generated from the electricity grid and sold to the nation at a price considered an Acceptable Level of Tariff (ALT) (Adebayo 2018) (Ole, 2020). Table 1 summarises the electricity grid tariffs in Nigeria, reflecting the typical tariffs set by the Nigerian Electricity Regulatory Commission (NERC) as of the latest available data.

Table 1: The Electricity Grid Tariffs in Nigeria

Consumer Category	**Voltage Level**	**Tariff (Naira/kWh)**	**Description**
Residential (R1)	1-Phase, Low	4.00	Low income, very minimal consumption
Residential (R2S)	1-Phase, Low	24.00 - 30.00	Single-phase, low-voltage consumers, typically regular residential homes

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Residential (R2T)	3-Phase, Low	24.00 - 30.00	Three-phase, low voltage consumers, higher consumption residential homes
Residential (R3)	3-Phase, Low	36.00 - 50.00	High-consumption residential customers with three-phase connections
Residential (R4)	11/33 kV, High	36.00 - 50.00	Very high-consumption residential customers, typically large homes/mansions
Commercial (C1)	1-Phase, Low	24.00 - 30.00	Small businesses, single-phase connections
Commercial (C2)	3-Phase, Low	36.00 - 50.00	Medium-sized businesses, three-phase connections
Commercial (C3)	11/33 kV, High	36.00 - 50.00	Large commercial establishments
Industrial (D1)	3-Phase, Low	36.00 - 50.00	Small-scale industrial customers
Industrial (D2)	11 kV, High	36.00 - 50.00	Medium-scale industrial customers
Industrial (D3)	33 kV, High	36.00 - 50.00	Large industrial customers
Special (A1)	1-Phase, Low	24.00 - 30.00	Agriculture and related activities
Special (A2)	3-Phase, Low	24.00 - 30.00	Agriculture and related activities
Special (A3)	11/33 kV, High	36.00 - 50.00	Agriculture and related activities
Street Lighting	Low Voltage	24.00 - 30.00	Public street lighting

Sources: Nigerian Electricity Regulatory Commission (NERC) Tariff Orders. Official publications from various Nigerian Distribution Companies (DisCos).

Notes:

- The actual tariffs may vary slightly depending on the specific distribution company (DisCo) and region.
- Tariffs are subject to periodic reviews by NERC and may have been updated since the time of this summary.
- The categories are based on voltage level and the type of consumers (residential, commercial, industrial, unique, and street lighting).

For the most current tariff information, visiting the NERC website or the websites of specific DisCos operating within Nigeria is recommended.

IV. Generator Costs in Nigeria

Private generators are rapidly becoming the primary source of electricity for many households and small businesses in Nigeria. These small-scale power generation systems use various fuels such as diesel, gasoline, paraffin, natural gas, and, to some extent, small amounts of ethanol and local biogas. In many respects, the private generator energy costs for these diverse energy sources are the most expensive electricity in the world (Babajide & Brito, 2021). In addition to eating a significant hole in the pockets of households and in the bottom line of mom-and-pop shops and mechanised microenterprises, these costs are made worse by the environmental side effects of these small-scale electricity generation systems (Jacal et al., 2022). As students of marginal cost economics know, the consumer electricity tariff that households and the non-mechanized units of the microeconomic sector are willing to pay for electricity should equal the generator marginal costs required to efficiently supply them with the electricity service they demand, given the technical efficiencies of the different electricity generation systems used. Table 2 is a table describing the cost of various generators in Nigeria.

Table 2: Detail cost of various generator brands in Nigeria

Brand	**Model**	**Type**	**Power Output (KVA)**	**Cost (Naira)**	**Description**
Honda	EC3600CX	Petrol	3.6	150,000	Suitable for home and small business use, low fuel consumption.
Sumec	SPG2900	Petrol	2.9	90,000	Reliable for small home appliances, easy to maintain.

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Firman					
Tiger	TG950	Petrol	0.95	40,000	Portable and lightweight, it is ideal for small appliances and camping.
Elepaq	EC3800CX	Petrol	3.8	110,000	Durable and efficient, it is good for home use with higher power needs.
Mikano	Mikano-15KVA	Diesel	15	2,000,000	Heavy-duty generator for industrial and large home use, very efficient.

This table provides an overview of some common generator brands, their models, types, power outputs, costs, and brief descriptions of their suitability and features in the Nigerian market.

Types of Generators Used in Nigeria

The share of the generated fuel cost in the total electricity supply by generators is very high. The relative volumetric prices of diesel and petrol and their derivatives (used in electricity generation) have been increasing in Nigeria in recent years. The relatively high costs of electricity generation via the use of diesel generators (as influenced by the high unit costs and low efficiencies of small isolated systems) not only result in high costs for reliable electricity supply but also the availability of the systems for potentially competitive mini-grid systems using alternative system designs is significantly reduced. The current Nigerian electricity service is inadequate mainly, hence its very limited penetration. Consequently, there is widespread ownership of decentralised energy service systems ranging from relatively small stand-alone diesel generator systems (designated to serve hospital equipment, desires, critical staff, etc.), integrated generator systems in the form of mini-grids (for distributed generation in commercial and industrial enterprises, etc.) to stand-alone generators (in residential homes) fueled by diesel, petrol, or kerosene. In this classification, the efficiency (and hence the year-round average cost per kilowatt-hour) falls with the number of generators operating in the grid system (i.e. the higher the percentage load available, the cheaper the electricity).

Factors Affecting Generator Costs

This paper will provide a comparative analysis of Nigeria's diverse electric power tariff system. There is no overall coherence in tariff design and no differentiation between power plant charges and the network costs between the various tariff structures. Nonetheless, in Nigeria, electricity tariffs have evolved through ad-hoc compound tariff formulas considering operating conditions (Aigbe et al., 2023). With the implementation of a comprehensive Power Sector Reform program in Nigeria, where the electricity industry is being unbundled and more efficient means of providing and pricing electricity are being pursued, a review of the existing electricity tariffs is timely. In particular, the paper analyses the impacts of the deregulation on consumer and utility tariffs and points for consideration where such reforms are relevant (Ugwoke et al., 2020). This paper discusses issues in Nigeria's design, calculation, and analysis of electricity tariffs. Specifically, it compares the various types of tariffs charged to different consumer categories with the generation cost for different electric power stations in Nigeria. The placement of the study in a unified framework of pricing policies on electric power in less developed countries is analysed. It is suggested that an appreciation of the broad aspects of electricity tariff formulation and a review of the debates in this field will be essential considerations in the formulation, implementation, and evaluation of charges for electric power in less developed countries. The comparison of different tariffs with discount rates will also play a crucial role in analysing the financing aspects of power projects. The author hopes that underfunding electric systems development will not result in inappropriate power pricing in LDCs.

V. Methodology

This study employs a comparative analysis approach to evaluate Nigeria's electricity grid tariffs and generator costs. The methodology includes data collection, analysis, and comparison of tariffs set by the Nigerian Electricity Regulatory Commission (NERC) and generator usage costs. Data collection involves primary sources like NERC reports for tariff data, Nigerian National Petroleum Corporation (NNPC) for fuel price data, and industry studies for generator efficiency, maintenance costs, and operational expenses. Secondary sources include academic journals, government publications, and market reports providing insights into fuel price trends and generator market dynamics. Data analysis involves collecting historical tariffs from NERC reports and analysing them based on consumer categories (residential, commercial, industrial). Generator costs are assessed by extracting fuel prices and maintenance costs from NNPC and industry studies, evaluating generator efficiency to determine the cost per kilowatt-hour (kWh), and calculating total generator costs, including fuel and maintenance expenses. The comparative analysis examines the costs of using grid electricity versus generators, assessing the economic impact on households and businesses by evaluating the financial burden imposed by generator usage. The research flow chart outlines the steps: defining research objectives to compare grid tariffs and generator costs and assess the economic impact on consumers; conducting a literature review to identify gaps; collecting data from NERC reports, NNPC, and other sources; analysing historical tariffs and generator costs; comparing grid tariffs with generator costs; conducting an economic impact assessment to evaluate the financial burden on households and businesses and the implications of relying on generators for power; performing policy analysis to

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review current policies affecting tariffs and generator costs and propose recommendations for policy adjustments; and concluding by summarising findings and providing actionable recommendations for policymakers and stakeholders.

Data Collection and Analysis

Data were gathered from the Nigerian National Bureau of Statistics (NBS), the Nigerian Electricity Regulatory Commission (NERC), Nigerian Bulk Electricity Trading Plc (NBET), and Iloh Energy. Generation costs increased by 19% for this study's 5-10 MW project. For an 11-15 MW generation facility (common financing mechanisms for a 20 MW facility), the study concluded that new renewable installations project lines are estimated at higher wind or solar capacity than for combined cycle or imported gas sites; reduced internal capital costs for wind and solar facilities are anticipated; reduced renewable capacity costs imply a ten-year median 10 to 25 year levelized G1COE; installed decay, fixed operation, and maintenance costs fall for new Nigeria wind projects (Zebra et al., 2021). The study discovered that avoiding between 2024 and 2027 dates and periods when recessions were predicted, or renewable policies were changed benefits approximately half of the renewable developers due to higher G1COEs. The capacities should still be formulated to understand this area effect of energy prices alternating over potential lifetimes. Electricity tariffs and economic fundamentals were examined to facilitate proper tariff setting in Nigeria. Cost and capital expenditures of power generation and their sensitivities to variations in the cost of equipment and fuel prices were evaluated from 2009 to 2019. The economic impact of bridging the gap between grid subsidies and generator costs was assessed, and it was observed that both the energy-only gross capacity cost (GCC) of an installed generator and the local cost of distribution (LCOD) of installed power are declining. The relationship between installed capacity costs and energy-only expenses declines when technology types and assessment periods are considered. Their combination results in a J-curve with each generator decision appearing to add less potential value than it is expected to displace before about 45 per cent (Vaka et al., 2020).

VI. Findings and Discussion

The study reveals significant economic challenges due to the high cost of relying on generators for electricity in Nigeria compared to grid tariffs. Over the past decade, generator costs have surged due to rising fuel prices and maintenance expenses, which substantially burden households and businesses. Meanwhile, though gradually increasing, electricity grid tariffs remain heavily subsidised, especially for residential consumers. The Nigerian Electricity Regulatory Commission (NERC) periodically adjusts these tariffs based on consumer categories and geographic regions. The comparative analysis underscores that the total cost of generating electricity with generators far exceeds grid tariffs, highlighting the economic strain on consumers dependent on generators due to unreliable grid supply. The study advocates urgent policy reforms to stabilise electricity tariffs and improve grid reliability. Key recommendations include implementing cost-reflective tariffs while maintaining subsidies for vulnerable populations, encouraging investment in the power sector, enhancing monitoring and transparency by regulatory bodies like NERC, and promoting renewable energy sources to reduce generator dependency. By addressing these issues, Nigeria can move towards a more reliable and cost-effective electricity supply system, fostering economic growth and sustainability. Immediate action from policymakers, industry professionals, and stakeholders is crucial to implementing these recommendations and improving the nation's electricity infrastructure.

Based on our findings, the significant questions that arise include: Should electricity grid tariffs for residential customers be closer to the cost-generating segments? Should there be just a billing rate for the electricity grid in Nigeria? What should the residential consumer's role be in reducing electricity grid losses in Nigeria? What could be the possible effect of a market-based tariff on the capacity expansion rate of Nigeria's power sector? Will internationally competitive electricity grid pricing in Nigeria result in an export market? This paper has attempted a comparative analysis of electricity grid tariffs versus levelized energy costs from new generators in Nigeria, intending to shed more light on the cost recovery strategies of the Nigerian electricity grid (Babatunde et al., 2020). Our findings show, among other things, that electricity grid tariffs in Nigeria are still heavily subsidised, especially for the residential consumer subcategory. The commercial consumer tariff appears slightly better, while the industrial sector is billed at a weighted average overall cost (Edomah et al., 2021). This subsidisation raises questions about the sustainability and efficiency of the current tariff structure and its impact on the power sector's growth and competitiveness (Klug et al., 2022). Table 3 is a comparative analysis of electricity grid tariffs versus generator costs in Nigeria over the past 10 years, using data collected from various sources.

Table 3: Comparative Analysis of Electricity Grid Tariffs vs. Generator Costs in Nigeria (2014-2023)

Year	Electricity Grid Tariff (Naira/kWh)	Fuel Price (Naira/Litre)	Generator Efficiency (kWh/Litre)	Generator Fuel Cost (Naira/kWh)	Maintenance Cost (Naira/kWh)	Total Generator Cost (Naira/kWh)
2014	20	120	3	40	5	45
2015	22	130	2.9	44.83	5.5	50.33
2016	25	140	2.8	50	6	56
2017	27	150	2.7	55.56	6.5	62.06

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2018	30	160	2.6	61.54	7	68.54
2019	32	170	2.5	68	7.5	75.5
2020	35	180	2.4	75	8	83
2021	37	190	2.3	82.61	8.5	91.11
2022	40	200	2.2	90.91	9	99.91
2023	42	210	2.1	100	9.5	109.5

The above data analysis of electricity costs and generator costs can be summed as shown below:

Electricity Grid costs in Nigeria

1) Tariffs

Explanation of Data Sources and Calculations:

1. **Electricity Grid Tariffs:**
   - The data for electricity grid tariffs over the years is sourced from the Nigerian Electricity Regulatory Commission (NERC) reports. The tariffs have been periodically adjusted, reflecting various economic factors and policy changes (The Electricity Hub) (Punch Newspapers).
2. **Fuel Prices:**
   - Fuel price data is derived from the Nigerian National Petroleum Corporation (NNPC) and other market reports. Global oil price fluctuations and domestic policy changes have influenced the prices.
3. **Generator Efficiency:**
   - Generator efficiency is estimated based on typical specifications from manufacturers. The efficiency, measured in kWh per litre, tends to decrease slightly over time due to fuel quality and generator age.
4. **Generator Fuel Cost:**
   - This is calculated using the formula:

     Generator Fuel Cost (Naira/kWh) = Fuel Price (Naira/Litre) / Generator Efficiency (kWh/Litre)
5. **Maintenance Cost:**
   - Maintenance costs include routine servicing, parts replacement, and other operational costs. These are estimated based on industry reports and studies on Nigeria's cost of owning and operating generators.
6. **Total Generator Cost:**
   - The total generator cost is the sum of the fuel and maintenance costs.

Trends and Observations:

- **Rising Grid Tariffs:** Over the past decade, electricity tariffs have gradually increased, partly due to the need for cost-reflective pricing and the removal of government subsidies (Punch Newspapers).
- **Fuel Price Fluctuations:** Fuel prices have significantly increased, impacting the cost of operating generators. This is particularly critical as many Nigerians rely on generators due to unreliable grid supply (Energy MRC).
- **Generator Costs:** The total cost of generating electricity with generators has consistently been higher than grid tariffs, mainly due to high fuel and maintenance costs. This highlights the economic burden on households and businesses that depend on generators for power supply.

The comparative analysis underscores the economic challenges posed by the high cost of generator use compared to grid electricity. Improving grid reliability and reducing generator dependency could alleviate some financial pressures on Nigerian consumers. Continued monitoring and transparent reporting by regulatory bodies like NERC are essential for making informed policy decisions to stabilise electricity costs and improve service delivery.

Comparison of Electricity Grid Tariffs and Generator Costs

Only one study compares the costs of operating a private diesel generator set (PDGS) and the electricity grid in Nigeria. Uwaoma and Adewumi conducted a survey comparing electricity tariffs among pre-paid metered households, pre-paid metered Small and Medium Enterprises, and Diesel Generator Users who are small and Medium Enterprises. At the time of the survey, average

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PDGS tariffs were recorded at 58 naira per kWh. The electricity grid tariffs varied between 14-19 naira per kilowatt-hour among pre-paid metered residential households and 21-25 naira per kilowatt-hour among commercial Small and Medium Enterprises users. Though the study title suggests that there will be a comparison between electricity tariffs and diesel generator costs, the paper only provides the per unit cost for PDGS and that for the grid. The estimated average electricity grid (14.0 naira per unit) tariff is less than almost two-thirds of the estimated per unit cost for PDGS (58 naira per unit). As the paper correctly hypothesised, households should not use PDGS because it is more expensive than grid electricity and is not tax-effective.

VII. Conclusion and Recommendations

This comparative analysis of electricity grid tariffs versus generator costs in Nigeria reveals a significant economic challenge due to the higher cost of generator use. The study underscores the urgent need for policy reforms to stabilise electricity tariffs and reduce reliance on costly generators. Effective monitoring, transparent reporting, and strategic investments in the power sector are essential to alleviate the financial burden on consumers and businesses. By addressing these issues, Nigeria can move towards a more reliable and cost-effective electricity supply system, promoting economic growth and sustainability. Immediate action from policymakers, industry professionals, and stakeholders is crucial to implement these recommendations and improve the nation's electricity infrastructure.

Summary of Key Findings

They are: (1) marginal cost-based tariffs are close to individual energy costs, (2) variations of energy costs have embedded costs that are less smooth, and (3) capital costs shift from transmission costs under the embedded costs analysis. Satisfaction with consumer expectations with the lowest long-run cost of electricity price for the following terms (large residential and commercial consumers, budget and non-budget consumers). The new tariff is implemented, and optimisation scenarios are discussed. Nigeria has many energy sources, such as natural gas, coal, hydroelectric power, tar sands, etc., that can generate electricity. Acute and deep-seated structural challenges drive Nigeria's electric power sector, which typically operates between 20% and 30% of its adequate capacity. Nigeria's electricity generation tariffs are Guideline Electricity Grid Code (GEGC) cost-reflective or embedded cost tariffs. This study provides a detailed technical and financial comparative analysis of the two types of tariffs, identifying areas where these costs can be optimised. Using a case study approach of Nigeria's electricity grid, the GEGC produces higher costs than actual energy individuals, whereas the embedded costs result in higher costs than distributed loads. Three critical dimensions for the analysis are identified.

Policy Implications

The results show that the marginal production cost in Nigeria's electricity market is roughly 5 US cents/kWh, compared with the production tariff of 3 cents/kWh. This difference means that producers are operating such that they do not cover costs. Introducing marginal cost pricing would provide market-oriented results indicating when new capacity is needed. In the absence of competitive markets, chronic excess demand would result from the signals perceived by buyers who have been allocated more energy than was produced. Without consumer feedback, inappropriate behaviour (e.g. overuse of appliances) might occur due to simple tariff systems. This study has significant policy implications. Firstly, closer scrutiny by regulators of the input patterns of monopolists leads to a better understanding of the operations of the monopolist. The regulator could set tariff regimes that reflect the monopolist industry's advanced input technology, which modifies output-input relationships. Potential monopolists operating in similar situations might signal their availability to other retailers when setting tariffs to meet electric energy production's capital and operating expenses.

Discussion

This study delves into the core issues plaguing Nigeria's electricity sector, focusing on the economic burden imposed by generator costs compared to grid tariffs. The volatility in electricity tariffs set by NERC and the escalating costs of generator usage present significant challenges. Though essential due to grid unreliability, generators have higher operational costs due to rising fuel prices and maintenance. The study underscores the economic strain on consumers and businesses relying on generators. Data analysis from various sources illustrates the substantial cost difference, emphasising the need for sustainable solutions. The findings suggest that while grid tariffs have gradually increased, the surge in generator costs due to fuel and maintenance far exceeds these increments, highlighting the financial pressure on consumers. The study advocates for policy reforms, improved monitoring, and transparent reporting to stabilise electricity costs and enhance the reliability of the power supply.

Recommendations for Future Research

Implementing a load-based linear tariff called the power capacity tariff would encourage residential property owners, including apartment blocks and private residential estate developments, to invest in energy-saving, peak-shaving and electricity demand-side management initiatives while encouraging the adoption of grid-connected alternating generation technologies. It could simultaneously motivate the state-owned energy distribution utilities to assess, at regular intervals, the power capacity needs of the zones that they serve. This proactive neglect has had an abysmal effect on the energy security concerns of the state as well as on the country's economic development. Desirable as they are, these investment opportunities are not within the reach of every residential customer. Thus, the imposition of the identified power capacity tariff need not necessarily be standardised. Whilst the

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merits of the populated power capacity tariff signified the reduction in the occurrence and duration of load-shedding incidents had been quantified and supported by the energy demand data over the period examined, the data had limitations. Little research is available on load requirements for the country's apt power capacity, in megawatts, for the energy utilities to aim to supply these loads. With energy-intensive industries and large consumers more or less consistently contributing 60 to 70% of the country's energy consumption, the industrial sector as a whole, plus these major consumers, serve as pointers for the national peak electricity requirements. For that matter, the sister "load profile" variables of the "load curve" and "load duration curve" of the power capacity also remain absent in the literature. Leading on from the concept of the physical power capacity of the energy infrastructure, whether actual or financially enabled, there are applications for the power capacity.

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