



ELECTRICITY INFRASTRUCTURE FINANCING AND INCOME INEQUALITY IN NIGERIA

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Abstract

This study investigated the impact of electricity infrastructure financing on income inequality in Nigeria. The autoregressive distributed lag (ARDL) model was applied to annual data spanning from 1990 to 2024. Further, the study extended this investigation by disaggregating electricity infrastructure financing into government capital investment in electricity and government recurrent electricity expenditure, controlling for the role of governance effectiveness. The study applied the unit root test to examine the stationarity of the variables. The study also found evidence for long-run relationship among electricity infrastructure financing and income inequality by applying the bounds test. The findings of the study from the long run results indicate that government capital electricity expenditure has negative significant impact on income inequality in Nigeria. In addition, the study found evidence of negative and significant impact of government recurrent electricity expenditure on income inequality in the long run while the government effectiveness had a negative but insignificant impact on income inequality. In the short run dynamic, government capital expenditure had a negative and insignificant impact on income inequality in Nigeria. The study concluded that long-term public investment and operational financing for the electricity sector has a significant effect in addressing income inequality in Nigeria, and targeted power sector spending is an important instrument for economic inclusion. The study recommended that among others that the federal government should increase significantly its annual budgetary allocation for capital investment in the power sector (generation, transmission and distribution) and ensure that funds are timely disbursed to provide access, particularly in low-income and rural communities.

Keywords:

Government Capital Electricity Expenditure; Government Recurrent Electricity Expenditure; Governance Effectiveness; Income Inequality.

1. INTRODUCTION

Infrastructure is widely acknowledged as a critical pillar for economic development, serving as a major predictor of growth and social inclusion, particularly in emerging nations such as Nigeria. This recognition is widespread throughout the worldwide community. In addition to functioning as a crucial accelerator for the delivery of healthcare, transport, education, electricity and food security, its impact extends across a wide range of aspects of the state's agenda. A substantial contribution to the promotion of private investment, the generation of

wealth, and the reduction of poverty is made by the collective capacity of these assets, which may be broadly classified into two categories: physical infrastructure (which includes electricity, roads, and transportation) and social infrastructure (which includes health and education). Some academics, such as Barro (1990), laid the theoretical groundwork for this connection by claiming that investments in public capital have a powerful growth-generating impact by increasing the productivity of private inputs. This is especially true in countries whose starting infrastructure stocks are low. Therefore, policymakers are firmly of the belief that the key to unlocking sustained social and economic growth is the provision of adequate and considerable finance for infrastructure construction (Egwu et al., 2024).

Among all types of physical infrastructure, the electrical sub-sector has a position that is singularly important. It serves as the core of operations and the driving force behind expansion for all sectors of a contemporary economy. When it comes to achieving sustainable development, it is very necessary for an economy to have a reliable power infrastructure. According to Awe et al. (2019), contemporary research has shifted the viewpoint of electricity from that of a simple intermediate input to that of a fundamental factor that acts as a facilitator for the efficiency of both labour and capital. Current research conducted by Adenle (2020) and Uchechukwu and Ugwuoke (2024) draws attention to the fact that a dependable supply of power is the most essential infrastructure for speeding the expansion of the industrial sector. Because energy is a factor that is necessary for production, conversion, and commercialisation across all industries, a rise in energy consumption is a fundamental indicator of increasing economic activity. As a consequence of this, the majority of economists are in agreement that the industrial sector needs electrical infrastructure as an essential component for fostering economic expansion and increase the number of job possibilities available in contemporary society.

Funding the infrastructure of the energy industry acts as an important instrument for tackling the issue of income disparity. According to Fuso Nerini et al. (2018), empirical research reveals that having access to electricity is a strategic doorway for the eradication of poverty and the narrowing of wealth inequality. The productive benefits that are supplied by reliable electricity are the source of economic empowerment, which includes the availability of a diverse range of job options. In contrast, Nteegah and Ihejirika (2025) point out that the high prices of accessing energy and epileptic supply force international businesses to relocate to locations with a more reliable supply, which results in the loss of jobs inside the country and an increase in economic disparity. It has been shown that asset-based wealth scores may be improved by the provision of financing that increases home energy access and provides closer proximity to power plants. According to Akinyemi and Jung (2023), increasing finance for electricity speeds up access, which has a clear correlation with higher family wealth and a significant decrease in income disparities between urban and rural people because of the improved availability.

The United States Energy Information Administration (USEIA) estimates that Nigeria has over 200 trillion cubic feet of natural gas reserves and a substantial solar potential. Nigeria is richly endowed with basic energy resources. In order to finance the expansion of this vital sector, it is necessary to raise long-term capital for generation, transmission, and distribution assets. This is a difficult effort that requires legislative frameworks that are consistent with one another (Odetunde, 2021). Despite the availability of these resources, Nigeria has had difficulty converting potential into a supply that can be relied upon. The functional generating capacity has remained unchanged between 4,000 and 5,500 megawatts (TCN, 2024), which is a significant underachievement in comparison to the national requirement of 20,000 megawatts.

In terms of the magnitude of the financial intervention that is necessary, significant amounts are required from budget allocation. In the year 2025, Bayo Adedun, who had previously served as the Minister of Power, said that in order to restore the power industry, Nigeria needs to spend more than one hundred billion dollars in a combination of government and private sector investments throughout the upstream, midstream, and downstream value chains. It is estimated by the government that increasing the amount of power generation by 20,000 megawatts would cost approximately \$30 billion, with an average cost of \$1.5 billion for each 1,000-megawatt plant. The transmission infrastructure requires an extra twenty billion dollars, while the distribution and gas pipeline investments are anticipated to be around twenty-five billion dollars and twenty-two billion dollars, respectively by the experts. Compared to South Africa, which has a population of sixty million people and is contemplating an investment of twenty-five billion dollars from the private sector, Nigeria, which has a population of over two hundred million people, requires a substantially larger amount of capital infusion. Additionally, the current infrastructure is constrained by significant bottlenecks in both financial and operational support. Approximately seventy-five percent of Nigeria's gas-fired plants have been impacted by the recent power outages. With just two of the thirty-two power plants now having such agreements, global gas shortages, unpaid payments to gas suppliers, local supply commitments, and a lack of formal gas supply contracts are all examples of how financial limitations directly affect day-to-day operations (NBS, 2025).

Therefore, the amount of power that is used by each individual in Nigeria is among the lowest in the world, with an expected consumption of just 144 kWh as of the year 2022 (World Bank, 2023). Both this insufficiency in supply and the underlying malfunction in the financial system have detrimental consequences that are felt across the board in the economic sphere. As a result of institutional inefficiencies, the supply is unreliable, which forces homes and businesses to depend on private generators that are both costly and hazardous to the environment. According to the projections provided by the International Monetary Fund (IMF, 2022), this causes the economy to incur about \$14 billion in costs on an annual basis. This kind of self-generation is a significant waste of resources that, under other circumstances, might be invested in businesses that are capable of producing employment opportunities. Furthermore, successive administrations have often prioritised expenditures that are politically driven rather than those that are economically feasible, which has resulted in excessive debt without comparable results in terms of productive output (World Bank, 2024). Corrupt practices at the systemic level are contributing to this breakdown inside the ecosystem of funding. In the 2023 Corruption Perception Index, which was compiled by Transparency International, Nigeria was ranked 144th out of 180 countries. This ranking exemplifies a high-risk environment that discourages transparent private investment and leads to a massive waste of public dollars. At the end of the day, a low level of involvement from the private sector and a lack of cost-reflective rates restrict the capital that is required for capacity development and needed maintenance, which cements a continuing cycle of underinvestment. Over the past three decades, Nigeria according to World Bank (2022) has recorded a Gini index on average of 0.35 with values as high as 0.42 recorded. This reflects the extent of income inequality in Africa's most populous nation - Nigeria. The National Bureau of Statistics (NBS) revealed that as of 2019, 40% of the total population i.e. almost 83 million people, lived below the poverty line per year in Nigeria (NBS, 2020).

Empirical studies have concentrated on the relationship between infrastructure investment, energy usage, and economic development at the country level, particularly at the global level (Satrianto et al., 2025; Ndukwe & Odungweru, 2024; Xiaofei et al., 2023) and in Nigeria

(Adamu et al., 2025; Mairafi et al., 2025; Shuaib et al., 2024; Awe et al., 2022). This literature tends to be growth-oriented, however. It is driven by the volume of production, and ignores the distributional side effects of infrastructure investment, or who benefits and who is left out from expanded electricity supply. This omission is significant in Nigeria's context because of a combination of persistent electricity shortages, a significant population with no access to electricity and high-income inequality. However, to the best of the researcher's knowledge, there has been no empirical study using econometric methodology that has directly investigated the impact of financing of electricity infrastructure on income inequality in Nigeria. On this background, this study aims at examining the effect of financing of electricity infrastructure on income inequality in Nigeria.

2. LITERATURE REVIEW

Conceptual Clarification

Income Inequality

Income inequality is defined as the extent to which income is unevenly distributed throughout a population. Inequality refers to a lack of uniformity or equality (Sakai, 2019) and involves differences in how something is distributed among individuals, with some having larger portions than others. This concept can manifest in various forms, including disparities in income, consumption, wealth, and gender (Bilan et al., 2020). It is much pronounced in developing countries in general and Sub-Saharan Africa 59(SSA) countries including Nigeria in particular (Adeleye et al., 2020).

Bakare (2011) describes income inequality as a situation where earnings over a specific period, particularly from labor or investments, are distributed unevenly, leading to unjust rankings among individuals. Such inequality can undermine social cohesion and escalate conflicts. Adegoke (2013) notes that Graham (1995) viewed income disparity as a divide between the wealthy and the impoverished. Income inequality is commonly assessed through comparisons of individuals' overall well-being throughout their lives, with consumption being arguably the most effective measure of this well-being. Todaro & Smith (2020) highlight various measures of income inequality including the Lorenz curve, and the Gini coefficient alternatively referred to as the Gini Index. The aforementioned measures can be used to compare income inequality across cities, countries, country regions, and continents of the world.

Electricity infrastructure

Electricity infrastructure encompasses the entire ecosystem of assets, institutions, and processes that enable the generation, transmission, distribution, and regulation of electrical power. It integrates both the physical components such as generation plants (thermal, hydro, solar, wind, biomass), transmission lines, substations, transformers, and distribution networks and the institutional mechanisms that govern their operation, including regulatory frameworks, pricing structures, and market operators. The effectiveness of an electricity system depends not only on the technical integrity and reliability of these assets but also on governance quality, tariff adequacy, investment incentives, and the financial health of utilities across the value chain (Sadiku, 2019).

Government Expenditure

Government expenditure can be classified into narrow, budgetary and broad definitions. The budgetary definition restricts public expenditure to items of budgetary transactions covering expenses to maintain the government, society and economy; the costs of providing goods and services spanning appropriations to public enterprises and regulatory agencies; and of grants-in-aid to other countries. This is the amount that appears at the expenditure side of the public budget which can be designated the direct expenditure of the government. This less transfer payments provides the most restricted (narrow) definition of the size of the public sector by the level of expenditure. The broad definition seeks to add to the budgetary expenditure the incidence of government intervention in the economy on private sector spending to arrive at the size of public sector (Agiobenebo, 1998). In this study, the government financing electricity sector is the focal point.

Government Recurrent Electricity Expenditure (GREE)

Government recurrent electricity expenditure encompasses the ongoing, short-term financial allocations required to sustain the day-to-day operations and maintenance of existing power infrastructure (Foster & Briceño-Garmendia, 2010). This category includes expenditures such as staff salaries, fuel procurement for thermal power plants, and routine maintenance of existing transmission and distribution hardware (World Bank, 2020). Recurrent expenditure is essential for the functionality of existing capital; without sufficient allocation to these operational needs, the efficiency of capital assets diminishes over time (Barro, 1990).

Government Capital Electricity Expenditure (GCEE)

Government capital electricity expenditure is defined as outlays directed toward the acquisition, construction, or improvement of long-term physical assets, such as power generation plants, transmission networks, and distribution infrastructure (World Bank, 2020). These expenditures are characterized by their multi-year impact, as they are intended to expand the nation's total energy capacity and improve the quality of the power grid (Foster & Briceño-Garmendia, 2010). Unlike operational spending, capital expenditure focuses on the accumulation of physical capital stock, which serves as the foundation for future economic development (Aschauer, 1989).

Theoretical Literature

Public Expenditure Theory

The theory of public expenditure has its origins in the seminal work of Paul Samuelson in 1955 and has since been advanced by Hindrizia and Myles in 2005. The basic premise of the theory is that the state has to take an active role in the economy to achieve efficiency and equity in the delivery and allocation of public services and goods. Efficiency—the coordinated and effective collection and use of public money to facilitate the efficient operation of economic activities—and equity—the equitable distribution of public benefits to all citizens whatever their income or location—the two are not mutually exclusive, but interrelated. The body of the theory has been expressed, among others, in Wagner's Law (also called Law of Increasing State Activity), which states that public expenditure grows faster than national income, and that, as the country becomes more prosperous, the share of public expenditure in the Gross Domestic Product (GDP) will be constantly increasing over time (Magazzino, Giolli, & Mele, 2015). This expansion is due to several closely connected mechanisms (Cosimo, Lorenzo, & Marco, 2015).

For one, a developing economy gets more complex, leading to the need for greater administrative and legal control, and thus more public investment. Secondly, economic growth drives urbanization and industrialization, while causing externalities or negative side-effects (e.g. pollution and social issues) which can only be reduced by state expenditure. Thirdly, it is said that public goods such as electricity and transportation services have a high income elasticity of demand, meaning that a proportionately higher amount of the goods are demanded by consumers as their income increases (Babatunde, 2018).

The main objection to Wagner's Law, however, is that it is descriptive, not explanatory: it is not always simply the increase of public expenditure, but it may be the result of political choice, social changes, or external changes, such as the oil price rises of the 1970s. In Nigeria's context of financing power infrastructure and its effects on income inequality, public expenditure theory offers a strong argument for public investment in power as a means to achieve redistributive justice. An inequity principle is intrinsic to this theory, which calls for public funding of electricity infrastructure to be focused on serving the marginalized and low income, with a special focus on rural areas, where less than half of the population has access to the grid. The theory goes that if the public does not invest in electricity infrastructure and the investments are not sustained, then income inequality will increase because rich people and big cities will get electricity from their own generators, while the poor will stay in energy poverty. Wagner's law also implies that Nigeria's electricity demand will continue to increase at a higher rate as its economy expands, making the government's financial investment in the electricity sector more necessary than ever if it is to counteract the threat of infrastructural weakness to the nation's quest for equitable economic development. Public expenditure theory can thus be used directly to connect the issue of electricity infrastructure financing with the reduction of income inequality, by defining access to reliable electricity as a basic public good, and as such, not to be left to the vagaries of market forces or private profitability.

The Infrastructure-Led Growth (ILG) Hypothesis

In 1989, David Aschauer worked out a number of empirical tests supporting the Infrastructure-Led Growth Hypothesis, which had been developed out of the structuralist and Keynesian economic theories of earlier times. The theory is based on the premise that public investment in durable economic infrastructure—like electricity grids, roads and telecoms—is fundamentally different from other government spending, offering a short-term boost to the economy as well as a long-term increase in supply. The hypothesis's underlying premise is that core infrastructure is a key and fundamental catalyst of the overall economic growth, with a clearly unidirectional cause-effect relationship. The body of the theory argues that infrastructure investments has a key dual role. During the short run, the construction of infrastructure brings a boost to aggregate demand by increasing public spending, jobs, and income multiplier effects in the economy. In the long run, infrastructure may be regarded as a public good that raises the overall productivity and competitiveness in the economy and hence increases the aggregate supply. Infrastructure as a threshold variable: if underdeveloped, it severely restricts output, and the level of private activity; if developed, it promotes industrialisation and technology. The function is discussed in terms of several different modes of transmission. The production channel works at a location where a reliable power supply lowers the production cost and downtime, which enhances the productivity of the factory. The investment channel operates when there is an adequate energy signal for stability, drawing foreign direct investment. The innovation channel is the place where electrification facilitates the use of modern technology in agriculture and/or services.

The hypothesis thus builds on endogenous growth theory by offering a physical basis for sustained growth based on human capital and innovation. The hypothesis has, however, been subject to a number of criticisms, largely related to problems that surround empirical measurement and implementation risk. The question of causality and endogeneity is another one of the issues that needs to be addressed: if infrastructure is important for growth, then wealthy, growing economies are better equipped to provide the funds for such infrastructure (Calderón & Servén, 2010).

One of the other criticisms is that the effect is very much quality and efficiency dependent, that is, poor project governance, technical inadequacy and political agendas can lead to unsuccessful projects where the productivity benefits are not realised. Also, the theory offers no insights regarding distributional aspects; infrastructure gains may be unevenly distributed, therefore exacerbating regional inequality. In the context of financing electricity infrastructure and its role in reducing income inequality in Nigeria, the Infrastructure-Led Growth Hypothesis seems to offer the most advanced justification for investing a huge amount of money in the electricity sector since lack of proper and consistent electricity supply is considered as the single most important factor that limits the country's economic potential. This connection is substantiated by empirical evidence for Nigeria as a whole, namely that modest gains in industrial output have been linked to periods of increased investment, for example, during the National Integrated Power Projects. The theory's key weakness is that investment quantity is important, but it is not enough, as is the case in Nigeria where technical losses, governance inefficiencies, and non-cost-reflective tariffs have hindered full utilization of the potential benefits of infrastructure-led growth. The theory suggests that, for income inequality, the failure to intentionally target investment in electricity infrastructure means that the costs of the investments could increase inequality, by focusing on the urban and industrial centers, while leaving rural and low-income populations neglected. Thus, the ability of infrastructure-led growth to reduce income inequality in Nigeria is not only dependent on the ability to secure funding but on complementary policies that promote institutional coherence, equitable distribution of power assets and efficient operation of the electricity infrastructure to fully realize the electricity's strong multiplier and productivity effects (Aschauer, 1989).

The Energy-Led Growth Hypothesis

The Energy-Led Growth Hypothesis was first formulated in 1978 by John Kraft and Arthur Kraft in their paper entitled, *On the Relationship between Energy and GNP*, and expanded on by David Stern in 2000. The key premise of the theory is that energy is not just a raw material consumed but is also a primary factor of production along with labour and capital. It assumes that there exists a unidirectional causality from energy consumption to economic activity with the implication that an increase in energy supply causes an increase in real Gross Domestic Product. This framework assumes that contemporary industrial and service-based economies are inherently energy intensive and that therefore energy supply is a de facto constraint on a nation's production frontier (Kraft & Kraft, 1978; Stern, 2000).

The body of the hypothesis suggests that a complex and effective energy system can support the productivity of the modern machines of industry, transportation and vital services. The use of a reliable and sufficient energy supply increases during the transition from traditional to high-tech production in a country (Asafu-Adjaye, 2000). The hypothesis continues to be that changes in energy usage lead to proportional changes in GDP, so that an increase in energy leads to a multiplicative increase in GDP. The effects of robust energy financing are far

reaching in that the final impact is a boost in industrial output, an increase in the efficiency of service delivery, and therefore a boost in the total economic output and the Human Development Index of the population as energy is considered a building block for socio-economic development (Khobai & Le Roux, 2017).

The theory, however, has been subject to great criticism, especially in its failure to present a complex power-wealth dynamic. There are arguments to the contrary: some people have proposed that the growth of economy could be responsible for the increase in energy demand and not the other way around, and that there is no causal relationship between electricity demand and economic growth (Ozturk, 2010; Payne, 2010). The efforts to reduce energy consumption through energy conservation regulations can have negative effects on economic growth, which in turn can affect energy consumption (Nenubari and Godsgrace, 2019). Moreover, the theory often ignores the quality of infrastructure and the importance of institutional factors; just funding energy projects does not ensure growth, as energy projects can suffer from losses through ageing and technically leaky power grids if funds are misused or mismanaged (Akinlo, 2008).

The Energy-Led Growth Hypothesis is a very pertinent concept for Nigeria given the country's prevailing challenge of electricity shortage. The inadequacy of the manufacturing sector and high cost of doing business are direct consequences of the fact that Nigeria's electricity infrastructure is underfinanced (Iwayemi, 2008; Akinlo, 2009). This hypothesis can partially be confirmed by the empirical evidence in Nigeria which demonstrated that there is a long run positive relationship between electricity consumption and real GDP in Nigeria (Akinlo, 2009; Olusegun, 2008). The Energy-Led Growth Hypothesis suggests that financing electricity infrastructure in Nigeria, particularly by extending it to low income and rural communities would create huge untapped economic potential, increase incomes and reduce income inequality. This theory suggests that in countries where many businesses and households depend on the use of costly private generating units, a shift of the national grid to a stable grid would have a disproportionate impact on low-income households and small businesses, thus reducing income inequality. The theory, however, has a weakness as it does not necessarily imply equitable distribution of the growth; if the financing strategies are not pro-poor, the growth generated may well leave the poor behind. The Energy-Led Growth Hypothesis has therefore offered a good economic argument for increasing investments in electricity infrastructure in Nigeria, but it could be successful in reducing income inequality only if complementing policies are put in place to ensure that the benefits of energy-led growth are distributed fairly among the various groups of society, especially the poor and marginalized groups that presently lack access to reliable and affordable electricity.

Empirical Review

Globally, Satrianto et al. (2025) examined the influence of energy consumption and economic growth in Asian countries. The analysis in this research was carried out using panel data with the simultaneous equation method. Research data were collected between 2003 and 2022 in Asian countries (Bahrain, Bangladesh, Cambodian, China, India, Indonesia, Iran, Jordan, Kyrgyz Republic, Lebanon, Malaysia, Nepal, Oman, Pakistan, Philippines, Qatar, Tajikistan, Thailand, United Arab Emirates and Vietnam) obtained from the World Development Indicator, World Bank. The simultaneous equation method was chosen to provide more comprehensive results in conducting complete research and interpretation. The empirical

results of the study provide economic growth, household expenditure, inflation, military expenditure and total greenhouse have a significant effect, while manufacturing does not have a significant effect on energy consumption. Then, government debt, domestic credit and manufacturing have a significant effect, but energy consumption and inflation do not have a significant effect on economic growth.

From 2011 to 2022, Ndukwu and Odungweru (2024) investigated the impact of energy consumption, financial development and economic growth in Sub-Saharan Africa. The empirical paper employed seven (7) Sub-Saharan Africa nations. The study considers panel data set for Real Gross Domestic Product (RGDP) and few economic variables that are theoretically expected to determine the economic growth in Sub Saharan Africa. The data used in the study were generated from World Bank indicators, while the data analysis was expedited by econometric views (E-views) statistical software 12. The variables for the study were subjected to stationary test using Im, Pesara n & Shin Test and Levin, Lin & Chu display that all variables were integrated at order zero $I(0)$ and order one $I(1)$. Therefore, the result finds absence of multicollinearity. The Hausman test were conducted to determine whether either fixed or random effect model is suitable for the study. While the two-system Generalized Method of moment (GMM) approach were also employed to test the hypotheses and the presence of a long-run co-integration connection was indicated. The finding reveals that energy consumption and Domestic Credit to Private Sector have a positive and significant effect on Real Gross Domestic Product of sub-Saharan Africa. While, electricity consumption and money supply have a joint negative and significant effect on Real Gross Domestic Product of sub-Saharan Africa.

Using the Cointegration analysis, Xiaofei et al. (2023) examined the relationship between electricity consumption and economic growth in China. The study employed both the Johansen cointegration test and Engle-Granger cointegration test. It was discovered that there is a long-run relationship between electricity consumption and economic growth in China. The study also found that the relationship between electricity consumption and economic growth is stronger in the manufacturing sector than in the service sector.

Maciulyte-Sniukiene & Butkus (2022) analyze the effect of infrastructural development including energy infrastructure on economic growth of the EU countries covering the period 2000 2019. Specifically, the study investigated the impact of transport infrastructure, ICT infrastructure, energy infrastructure, and water infrastructure on economic growth. Using the Huber–White Sandwich correction, the study finds a positive correlation between energy infrastructure and economic growth in EU countries, similar to other types of infrastructure. Additionally, the results indicate that transport infrastructure contributes to economic growth across all regions examined. The robustness of these findings is supported by evidence of a positive feedback effect, as demonstrated through the D-H Granger causality approach.

In Nigeria, Adamu et al. (2025) examined the impact of energy infrastructure and human capital on economic growth, incorporating the moderating effect of oil price uncertainty. The specific objectives investigated the impact of energy infrastructure, human capital, institutional quality, inflation rate and oil price uncertainty on economic growth. Using annual time series data from 1996 to 2022, the analysis employs Fully Modified Ordinary Least Squares (FMOLS) and Canonical Cointegration Regression (CCR) techniques. The findings from both models indicate that energy infrastructure and human capital have a positive and statistically significant influence on economic growth. Additionally, the FMOLS results reveal a negative and

statistically significant coefficient for oil price uncertainty. However, the inclusion of the interaction term yields a positive and significant coefficient across the models, indicating that energy infrastructure investment can partially offset the negative impact of oil price uncertainty. These findings are confirmed by the results of dynamic Autoregressive Distributed Lag (ARDL) simulations.

From 1986 to 2021, Mairafi et al. (2025) evaluated the impact of power sector expenditures on economic growth in Nigeria using a time series data. Secondary data were used and sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin December 2021. the Autoregressive Distributed Lagged (ARDL) and the Error Correction Model (ECM) were used to determine the relationship and impact of power sector expenditures on economic growth in Nigeria. The findings found that there is a long-run, short-run and significant impact on power sector expenditure indicators especially the power sector capital expenditure in Nigeria and power sector recurrent expenditure in Nigeria. This depicts that power sector expenditure is advantageous to economic growth in Nigeria. In other words, the leading drivers of economic growth in Nigeria are power sector capital expenditure in Nigeria and power sector recurrent expenditure in Nigeria. Therefore, the study recommended that the government should increase the power capital and recurrent expenditure through the annual budget in Nigeria to improve the quality and adequate supply of electricity and the level of economic growth and development in Nigeria.

Osakunih et al. (2025) investigated the impact of renewable energy consumption as a source of clean energy on quality of life in Nigeria. The theoretical framework of the study was the Grossman's theory of healthcare demand. The study used the Autoregressive Distributive Lag (ARDL) bounds testing approach. Time series data were sourced from the International Energy Agency (IEA), the Human Development Report of the World Bank and the Central Bank of Nigeria (CBN) for a period of 1990 to 2023. From the empirical results, the study found renewable energy consumption (REC) to be crucial driver of quality of life and also trade openness was found to have mixed effects quality of life which reflected the dual nature of globalization. The study therefore recommends among others that there should be prioritization of renewable energy infrastructure development in Nigeria by all Stakeholders

Shuaib et al. (2024) investigated the relationship between electricity power consumption and economic growth in Nigeria from 1990 to 2022. The study specifically investigated the impact of electricity power consumption and population growth rate on economic growth. The paper employed a Threshold Regression Approach. The results revealed that the paper observed a negative relationship with economic growth in the regime characterized by low electricity power consumption values of -0.2381. Conversely, higher electricity power consumption values of 0.2556 established a positive relationship in the regime. These findings underscored a nonlinear relationship between economic growth and electricity power consumption following the endogeneously determined threshold value of 0.1301. The study's implications for policy and investment decisions in Nigeria are profound. The results highlighted the critical role of electricity power consumption growth in shaping economic growth. Policymakers and stakeholders are urged to consider initiatives promoting the expansion and modernization of the power sector, involving infrastructure investment and attracting private sector involvement. Policy recommendations include a focus on workforce development, education, and training to enhance the skills and productivity of the labor force.

Sunday et al. (2024) investigated the impact of electricity consumption on economic growth in Nigeria from 1980 to 2023. The study used time series analysis. Real Gross Domestic Product (RGDP) was used as a proxy for Economic Growth while residential electricity consumption (REC) and special tariff electricity consumption (STEC) were used as the explanatory variables. The study adopted ex-post facto research design and the model adopted for the study was Fully Modified Ordinary Least Square (FMOLS) model. The methods of data analysis adopted for study are the Augmented Dickey Fuller test, Johansen Co-Integration Test, Granger causality, Descriptive Statistics and Trend analysis. The findings from the study revealed that there is an impact of electricity consumption on economic growth in Nigeria. The REC has positive and insignificant impact RGDP in Nigeria. The STEC has negative and significant impact on RGDP in Nigeria.

Awe et al., (2022) analysed the impact of electricity infrastructure on economic growth in Nigeria. The specific objectives of the study seek to investigate the impact of electricity generation, labour force and manufacturing contribution on economic growth in Nigeria. Using Ordinary Least Square as a method of analysis and the study revealed a positive relationship between electricity infrastructure and economic growth in Nigeria. Also, revealed that the poor state of electricity supply in Nigeria has imposed significant costs on the business sector. The bulk of these costs relates to the firm's acquisition of the very expensive backup capacity to cushion them against the even larger losses arising from frequent and long power fluctuations. Small-scale operators are more heavily affected by infrastructure failures as they are unable to finance the cost of backup power necessary to mitigate the impact of frequent outages, The study therefore recommended for institutional reforms of the power sector in Nigeria.

Empirical studies have concentrated on the relationship between infrastructure investment, energy usage, and economic development at the country level, particularly at the global level (Satrianto et al., 2025; Ndukwu & Odungweru, 2024; Xiaofei et al., 2023) and in Nigeria (Adamu et al., 2025; Mairafi et al., 2025; Shuaib et al., 2024; Awe et al., 2022). This literature tends to be growth-oriented, however. However, to the best of the researcher's knowledge, there has been no empirical study using econometric methodology that has directly investigated the impact of financing of electricity infrastructure on income inequality in Nigeria. On this background, this study aims at examining the effect of financing of electricity infrastructure on income inequality in Nigeria.

3. METHODOLOGY

The study utilized the Ex-post facto research design, incorporating both descriptive and explanatory components. The preference for this approach relates directly to the nature of data to be used for this. The intended data for this study are historical or past data, generated by well recognized statistical bodies and as such their observed form cannot be manipulated by the researcher. This research design fits into the purpose of this study which focuses on impact analysis between the predictor variables and outcome variable. The government capital and recurrent expenditure are measure in billions of Naira and collected from the CBN statistical bulletin (2025); governance effectiveness measured perceptions of the quality of public services, the quality of the civil service, the independence of the civil service from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to policy implementation. The scores vary from 0 to 100 with a better performance in public institutions being represented by a higher percentage and sourced from and World Governance Indicator (WGI, 2025); and gini coefficient measured by on a

scale of 0 to 1, with 0 representing perfect equality and 1 representing perfect inequality economically and sourced from World Bank Development Indicator. The descriptive analysis examines patterns in the selected variables: government capital expenditure on electricity, government recurrent expenditure on electricity, and the government institutional effectiveness on income inequality. To determine the order of integration, the econometric methods of the Unit Root Test Kwiatkowski, Phillips, Schmidt and Shin (KPSS) (1992) and the preliminary diagnostics test of OLS were employed. The functional specification of the model is expressed as:

$$GINI_t = f(\beta_0 LnGCEX_t^{\beta_1}, LnGREX_t^{\beta_2}, QIN_t^{\beta_3}) \quad (3.1)$$

Econometrically, the above equation 3.1 becomes:

$$GINI_t = \beta_0 + \beta_1 LnGCEX_t + \beta_2 LnGREX_t + \beta_3 QIN_t + \mu_{2t} \quad (3.2)$$

Gini = Gini coefficient proxied for Income inequality; $GCEX$ = Government Capital Investment in electricity; $GREX$ = Government Recurrent Electricity Expenditure; QIN = Quality of Institutional Effectiveness proxy by governance effectiveness; $\beta_1 - \beta_4$, = slope coefficients; α_0 , = intercepts and μ_{it} = error term. The rational of including quality of institutional effectiveness in the model is because of effectiveness of an electricity system depends not only on the technical and reliability of these assets but to ensure accountability and transparency of capital and recurrent government spending on the public infrastructure. Also, the inclusion is justified by the infrastructural led growth hypothesis.

Autoregressive Distributed Lag (ARDL) Model

The Autoregressive Distributed Lag (ARDL) model which uses a bounds test approach based on unrestricted error correction mechanism was employed here to measure the effect of electricity infrastructure financing on income inequality proxied by Gini coefficient (GINI) and also to test for a long run relationship among the relevant variables. The main advantage of this approach lies in the fact that it can be applied irrespective of whether the variables are $I(0)$ or $I(1)$. This approach also allows for the model to take a sufficient number of lags to capture the data generating process in a general-to-specific modeling framework. Also, it provides very efficient and consistent test results in small and large small sizes. Therefore, the ARDL models based on models 3.2 is presented thus: The ARDL long run and short-run model that examine the relationship between electricity infrastructure financing and economic development is expressed as:

$$\begin{aligned} \Delta GINI_t = & \phi_0 + \sum_{i=1}^r \phi_1 \Delta GINI_{t-i} + \sum_{i=0}^s \phi_2 \Delta LnGCEX_{t-i} + \sum_{i=0}^s \phi_3 \Delta LnGREX_{t-i} \\ & + \sum_{i=0}^s \phi_4 \Delta QIN_{t-i} + \beta_1 GINI_{t-1} + \beta_2 LnGCEX_{t-1} + \beta_3 LnGREX_{t-1} \\ & + \beta_4 QIN_{t-1} + \mu_{2t} \end{aligned} \quad (3.3)$$

4. RESULTS AND DISCUSSION

Table 4.1: Descriptive statistics

	GINI	GCEX	GREX	QIN
Mean	0.5359	93.3313	147.0451	18.7082
Median	0.5120	78.68	31.03	18.27
Maximum	0.7432	264.6	412.37	27.4
Minimum	0.3500	1.49	0.49	12.02
Std. Dev.	0.1379	78.4705	161.8181	4.2688
Skewness	0.1025	0.3946	0.5516	0.4520
Kurtosis	1.5585	1.8542	1.6934	2.1547
J.B	3.0914	2.8228	4.2648	1.8508
Prob.	0.2135	0.2437	0.1185	0.3963
Obs.	35	35	35	29

Note: GINI = Gini coefficient; GCEX = government capital electricity expenditure; GREX = government recurrent electricity expenditure; QIN = governance effectiveness. Source: Authors' computation (2026)

The study carried out descriptive analyses for Gini coefficient, Government Capital Investment in electricity, government recurrent electricity spending, and governance effectiveness from 1990 to 2024. As shown in Table 4.1, GINI coefficient from the descriptive results averaged 0.5359 and this mean value falls within the range of 0.35 to 0.7432 during the period studied. These statistics suggests unequal distribution of income in Nigeria during the period covering from 1990 to 2024. Government Capital Investment in electricity averaged N93.3313 billion over the 35 years. The maximum amount of government capital electricity expenditure was N264.6 billion and the minimum Government Capital Investment in electricity was N1.49 billion. In terms of government recurrent capital electricity expenditure, the descriptive analysis revealed an average value of N147.0451 billion; with a maximum amount of N412.37 billion and a minimum amount of N0.49 billion. As shown in Table 4.1, governance effectiveness averaged 18.7082 and the mean value falls within the range of 12.02 to 27.4.

Table 4.2 Lag Length Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-334.8040	NA	2447293.	26.06185	26.25540	26.11759
1	-251.2159	135.0270	13775.56	20.86276	21.83053*	21.14144
2	-239.0297	15.93578	20413.11	21.15613	22.89811	21.65776
3	-209.7928	29.23688*	9709.420*	20.13791*	22.65410	20.86248*

Source: Authors' computation (2026)

The table 4.2 shows the optimum lag length selection criteria. The lowest AIC value, indicated with the asterisk (asterisk) is the model with the fewest parameters, Lag 3 (20.13791). Considering that the sample size is small ($T = 35$) and based on Pesaran et al. (2001) who proposed AIC for ARDL bounds testing in small samples, it is recommended to use Lag 3 as the optimum number of lags since it is appropriate enough to capture the dynamic adjustment

of income inequality to electricity infrastructure financing and still maintains degrees of freedom.

Table 4.3: Unit Roots Result

Variable	KPSS			I(d)
	Level	1 st Diff	5% Critical Value	
$gini_t$	0.6621	0.1542***	0.4630	I(1)
$lngcex_t$	0.6295	0.3337***	0.4630	I(1)
$lngrex_t$	0.6635	0.1639***	0.4630	I(1)
qin_t	0.2630**	-	0.4630	I(0)

Note: *, **, and *** denote significance at 10%, 5% and 1%, respectively

Source: Authors' computation (2026)

The unit root stationary test was evaluated using Kwiatkowski, Phillips, Schmidt and Shin (KPSS) (1992). The outcomes show that income inequality (GINI), government capital investment in electricity (GCEX), and government recurrent electricity expenditure (GREX) became stationary after first differencing, while only governance effectiveness (QIN) was stationary at level form. Thus, the series combine the integration of I(0) and I(1) fulfilling the requirement for the use of bounds test cointegrating relationship.

Table 4.4: Bound Test Result

Estimated Model	F-statistics	
$F_{GINI}(gini/lngcex, lngrex, qin)$	4.472391**	
	K = 4	
Critical Value	I(0)	I(1)
1%	3.65	4.66
5%	2.79	3.67
2.5%	3.15	4.08
10%	2.37	3.2

Note: Null hypothesis: No level relationship; K = number of regressors; *, ** and *** denote significance at 10%, 5% and 1% level, respectively.

Source: Author's computation (2026)

Table 4.4 provides the of the bounds test conducted to determine the existence of possible cointegration relationship between government capital investment in electricity (GCEX), government recurrent electricity expenditure (GREX), governance effectiveness (QIN) and income inequality (the index of economic development). The result above indicates cointegrating relationship given the fact that F-statistics obtained as 4.472391 is higher than the critical value at level I(0) and I(1) series at 5% levels of significance. Based on this, the null hypothesis which assumes that there is no cointegration among the series is rejected. This implies further that in the long run government capital investment in electricity (GCEX), government recurrent electricity expenditure (GREX), governance effectiveness (QIN) and income inequality (the index of economic development) have similar trend.

Table 4.5: ARDL long- and short-run results for income inequality model

Maximum dependent lags: 2 (Automatic selection)

Model selection method: Akaike info criterion (AIC)

Selected Model: ARDL(2, 2, 0, 0)

Panel A: Long run				
Variable	Coefficient	Std. Error	t-Stats	Prob.
$\ln GCEX_t$	-0.0947***	0.0335	-2.8239	0.0085
$\ln GREX_t$	-0.0706***	0.0174	-4.0446	0.0006
QIN_t	-0.0025	0.0032	-0.7974	0.4341
C	0.8758	0.0874	10.0127	0.0000
Panel B: Short run				
Variable	Coefficient	Std. Error	t-Stats	Prob.
$D(GINI_{t-1})$	0.4005**	0.1570	2.5498	0.0187
$D(\ln GCEX_t)$	-0.0125	0.0182	-0.6866	0.4998
$D(\ln GREX_{t-1})$	0.0283	0.0172	1.64 -49	0.1149
ECM_{t-1}	-0.7959***	0.1542	-5.1595	0.0000
$R^2 = 0.5127$			Adj. $R^2 = 0.4543$	

Note: *, ** and *** denote significance at 10%, 5% and 1% level, respectively.*Source: Author's computation (2026)*

The ARDL result of Table 4.5 is presented in two parts – Panel A and Panel B. The results are presented in a single table given that the ARDL model is a single equation model, with both long run relationship and short run relationship modelled together in a single equation. Panel A of Table 4.5 presents the long run results which provide insight into the impact of government capital electricity expenditure (GCEX), government recurrent electricity expenditure (GREX), and governance effectiveness (QIN) on income inequality in the long run. Panel B pertains to the dynamic impact of government capital electricity expenditure (GCEX), government recurrent electricity expenditure (GREX), and governance effectiveness (QIN) on income. Also reported in Panel B of Table 4.5 is the short run of the estimated ARDL model, which provides detailed information on the speed at which the model corrects to long run equilibrium following short term disturbances.

As presented in Table 4.5, government capital electricity expenditure (GCEX) had negative impact on income inequality. This finding asserts that government capital investment in electricity (GCEX) has corrective effect on income inequality and an increase in government capital electricity expenditure (GCEX) reduces the level of income inequality in Nigeria over the long run. The results indicates that 1 percent increase in government capital electricity expenditure (GCEX) leads to 0.0947 percent reduction in income inequality in the long run. From the estimated results, the study found that government capital electricity expenditure (GCEX) has significant negative effect on income inequality. For policy implication, government should channel long term investment in critical power assets such as generation plants, transmission grids and distribution networks. This will have a direct impact on reduction of income inequality in Nigeria. This indicates that investments in the long-term in physical electricity assets will unlock access to reliable electricity, thereby opening up economic opportunities, increasing productivity and enhancing incomes for disadvantaged groups.

Policymakers need to make a stronger priority of consistent capital allocation in the power sector as a re-distributive tool.

In the long run, the study found that there is a negative relationship between government recurrent electricity expenditure (GREX) and income inequality. The estimated coefficient of 0.0706 for government recurrent electricity expenditure (GREX) suggests that 1 percent increase in government recurrent electricity expenditure (GREX) results in 0.0706 percent decrease in income inequality in the long run. The implication of this result is that an increase in government recurrent electricity expenditure (GREX) reduces the level of income inequality in the long run. Importantly, the study observed that the negative impact of government recurrent electricity expenditure (GREX) on income inequality is statistically significant. For policy, there is need for sustaining existing infrastructure including repairing infrastructure, maintaining infrastructure, paying wages, and buying fuel is equally important as construction. Reliable operating resources will keep the grid running and make sure that electricity supply is not interrupted, which would affect both lower income workers and small businesses who don't have the capital needed to invest in alternative energy sources.

Next, the study probed the effect of governance effectiveness on income inequality in the long run, exploring whether an improvement in the quality of institutions has the capacity of reducing the divergence in the distribution of income in Nigeria. The outcome of the estimation reveals that governance effectiveness is negatively related to income inequality, indicating that an increase in governance effectiveness leads to a reduction in income inequality. The result speaks to the ability of good institutional quality in addressing the widespread divergence in the distribution of income in Nigeria over the long-run. According to regression result, 1 unit increase in governance effectiveness reduces the GINI coefficient by 0.0025%. As revealed by the result, the negative impact of governance effectiveness on income inequality is statistically insignificant.

Referring to Panel B of the ARDL results presented in Table 4.5, the short run dynamic results shows that income inequality (as measured by GINI coefficient) has lag effect on income inequality in the current period. Table 4.5 reveals that GINI coefficient lagged one year positively influence income inequality in the current year and the impact on the level of income inequality in the current year is significant. The study noticed that 1% increase in income inequality lagged one year exacerbate the current level of income inequality by 0.40050 percent. Based on the short run result presented in Table 4.5, the study observed that government capital electricity expenditure has negative impact on income inequality in the short run. The result indicates that increasing government capital expenditure on electricity lead to 0.0125% reduction in income inequality. However, the impact of government capital electricity financing had no statistical and significance impact on reduction of income inequality in Nigeria

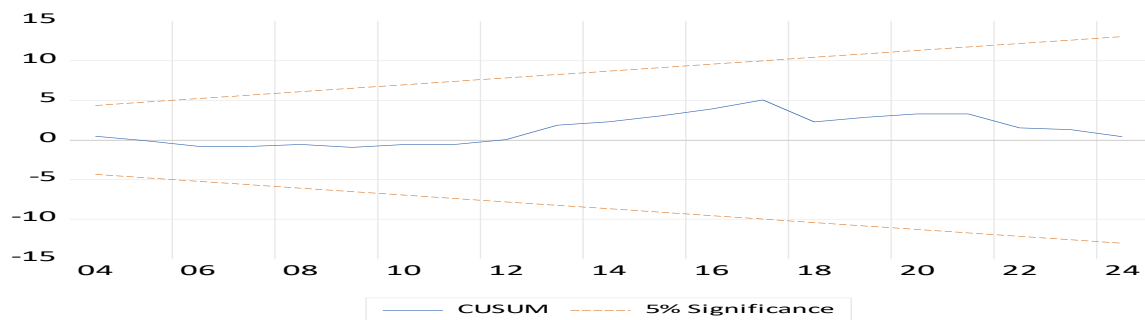
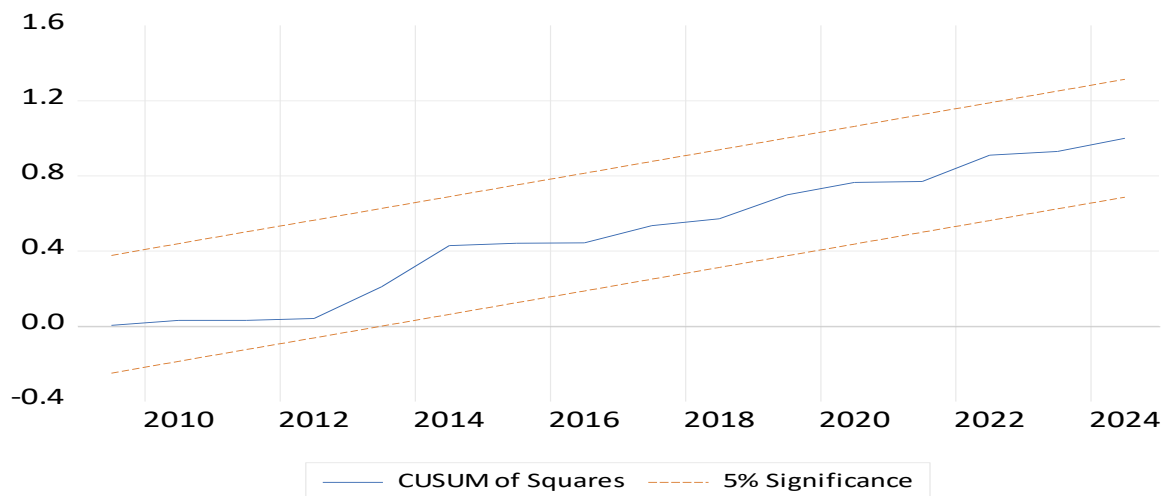
In the dynamic results presented in Table 4.5, the error correction coefficient is, as expected, negative and significant. The error correction coefficient of -0.7959 indicate that speed of adjustment to equilibrium level in the first year for any shocks to the estimated level of income inequality is approximately 80%. The result indicates that the model is fast to return to equilibrium in the long run following short run disturbances in the model variables.

Table 4.6: Diagnostic Test Results

Tests	CLRM Problem	χ^2 Value	χ^2 Prob.	Decision
Breusch-Godfrey LM	Serial Correlation	0.0758	0.9628	Serial independence
ARCH	Heteroscedasticity	0.8014	0.3707	Constant Variance
Jarque-Bera	Normality	0.5851	0.7463	Normal residuals
CUSUM	Stability	-	-	Stable Model

Note: CLRM stands for classical linear regression model

Source: Authors' compilation (2026)

**Figure 4.1: CUSUM Plot****Figure 4.2: CUSUM of Squares Plot**

The Breusch-Pagan LM test was used to test for any serial correlation among the residuals. As reported in Table 4.6, the probability value of the calculated Breusch-Pagan LM Chi-square statistics of 0.0758 is greater than 5 percent level of significance. Hence, the study failed to reject the null hypothesis which indicate that there is no evidence of serial dependence of the errors. In testing for constant variance of the errors, the ARCH test was adopted. The result showed no evidence of heteroscedasticity of the errors as the probability of the ARCH Chi-Square statistics of 0.8014 is higher than the 5 percent level of significance. The residual normality test, which followed the Jarque-Bera method, indicated that the estimated residuals followed a normal distribution. Both the cumulative sum (CUSUM) and cumulative sum (CUSUM) of squares tests carried out indicated that the income inequality model and parameter

estimates are stable. This is shown by Figure 4.1 and 4.2, revealing that the CUSUM and CUSUM of Square plots lie within the 5 percent level of significance.

5. Conclusion and Recommendations

This study investigated the impact of electricity infrastructure financing on income inequality in Nigeria. The autoregressive distributed lag (ARDL) model was applied to annual data spanning from 1990 to 2024. Further, the study extended this investigation by disaggregating electricity infrastructure financing into government capital investment in electricity and government recurrent electricity expenditure, controlling for the role of governance effectiveness. The study applied the unit root test to examine the stationarity of the variables. The study also found evidence for long-run relationship among electricity infrastructure financing and income inequality by applying the bounds test. The findings of the study from the long run results indicate that government capital electricity expenditure has negative significant impact on income inequality in Nigeria. In addition, the study found evidence of negative and significant impact of government recurrent electricity expenditure on income inequality in the long run while the government effectiveness had a negative but insignificant impact on income inequality. In the short run dynamic, government capital expenditure had a negative and insignificant impact on income inequality in Nigeria. The study concluded that long-term public investment and operational financing for the electricity sector has a significant effect in addressing income inequality in Nigeria, and targeted power sector spending is an important instrument for economic inclusion. The study recommended that (1) The federal government should increase significantly its annual budgetary allocation for capital investment in the power sector (generation, transmission and distribution) and ensure that funds are timely disbursed to provide access, particularly in low-income and rural communities. (2) Policymakers need to ensure that adequate recurrent expenditure is provided for routine maintenance, salaries of staff, fuel supply, etc., in order to prevent infrastructure deterioration and to facilitate uninterrupted electricity supply, particularly to the poor. (3) Electricity financing should be accompanied by anti-corruption measures, transparency in procurement and institutional capacity building to guarantee efficient use of funds. But the governance reforms have to be accompanied by an increase in investment, not be seen as a replacement, in order to meaningfully curtail income inequality.

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