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# Energy Infrastructure as a Driver of Real Estate Value in Nigeria: An Econometric and Policy Analysis

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## Abstract

The importance of energy infrastructure has become widely recognized for its role in determining the value of real estate in emerging economies with unreliable electricity systems. In Nigeria, the chronic unreliability of the national electrical grid, widespread use of generators, and increasing cost of electricity create several barriers to residential and commercial real estate development and property pricing. Therefore, this research investigates the relationship between energy system reliability and real estate value (both residential and commercial) in the larger cities of Nigeria (i.e., Lagos, Abuja and Port Harcourt). This research employs a hedonic pricing model and a comparative case approach to determine how much increased reliability of the energy system can increase rental income (premiums), reduce vacancy rates and enhance capital appreciation. Additionally, based on empirical evidence, we find that developments that are supported by their own generating capacity, renewable energy sources, or independent power project demonstrate statistically superior performance characteristics compared to those reliant upon the national grid. These results indicate that energy reliability acts as a form of locational asset, a risk management tool and a form of sustainable differentiation for real estate. Finally, the study concludes with several policy recommendations related to improving the availability of decentralized power, incorporating energy metrics into professional appraisal practices and supporting public private partnerships to improve the financing of infrastructure development.

**Keywords: Energy infrastructure, hedonic pricing, property value, infrastructure economics, Nigeria, urban development, embedded generation.**

## 1. Introduction

Infrastructure has been recognized for many years as a fundamental factor influencing the economic performance of cities and the creation of land values. Classic urban economics theory states that property values capture the benefits of accessibility, productive advantages and the availability of public goods (Alonso, 1964; Muth, 1969). In this context, infrastructure acts as spatial capital which increases location attractiveness and decreases transaction costs. However, in developed countries where the reliability of electricity services is generally taken for granted, the quality of electricity services is rarely considered a key explanatory variable in models of property price. On the contrary, in emerging economies characterized by chronic shortages of infrastructure, energy reliability can become a significant -- and measurable -- factor in determining real estate performance.

Nigeria represents a particularly compelling example of this. As the largest economy in Africa by Gross Domestic Product (GDP) and the most populated country in the region, Nigeria has experienced persistent power shortages over the last several decades, despite numerous reforms of the electricity sector. The National Electric Power Authority's transmission system continues to experience systemic instability, voltage fluctuations and repeated collapse of the electric grid. Although installed generating capacity is estimated to exceed 12,000 Megawatts (MW), actual power delivered to consumers is frequently less than their total demand. This supply-demand imbalance has transformed electricity from a typical public service to a strategically important input in the production process of businesses, with implications for property valuations.

The implications for real estate markets are far-reaching. Developers and institutional investors in Nigeria's leading commercial centers -- Lagos, Abuja and Port Harcourt -- now increasingly treat the provision of electricity as part of their overall cost structure through the use of embedded generators, captive gas turbines, solar photovoltaic (PV) systems and hybrid energy solutions. Therefore, the reliability of electricity is no longer simply a matter of utility services; it has become a key differentiating factor in the pricing of rentals, absorption rates, retention of tenants, and the potential for capital appreciation in the properties.

From a theoretical perspective, the introduction of energy reliability as a quasi-private infrastructure attribute (i.e., a private benefit which is capitalized into property prices) rather than a pure public good (which is provided uniformly to all citizens) extends hedonic pricing theory (Rosen, 1974). Reliable power supply reduces uncertainty related to business continuity, decreases the risk of business interruptions, establishes stable service charges and improves environmental, social and governance (ESG) performance metrics. All these factors affect both net operating income (NOI) and capitalization rates (cap-rates), and consequently, the property valuation through income capitalization mechanisms.

However, despite the central role of reliable energy supply in business operations in Nigeria, the empirical quantification of the impacts of reliable energy supply on real estate value is relatively limited. Previous studies of the relationship between infrastructure and property have focused primarily on transportation networks, road accessibility and public amenities. Studies of the impact of electricity infrastructure on property prices have mainly focused on macroeconomic growth effects, productivity spillovers and the effects of electricity access on household welfare outcomes, rather than on direct asset price implications. Thus, there is a critical knowledge gap concerning how reliable energy supply is capitalized into property markets under conditions of infrastructure scarcity.

This study seeks to address this gap by providing an econometric analysis of energy infrastructure as a driver of real estate value in Nigeria. Using transactional level data from 2015 to 2024 for both residential and commercial segments, the study creates an Energy Reliability Index (ERI) based on three components: outage frequency, daily supply duration and the presence of embedded generation. The ERI is then incorporated into a log-linear hedonic pricing framework to quantify marginal effects on both capital values and rental rates. To provide confidence in the statistical validity of the study's estimates, the study conducts diagnostics including multicollinearity tests, heteroscedasticity tests and comparisons of alternative specifications.

In summary, the study contributes to the existing body of knowledge in four major ways:

1. **Conceptual Contribution:** It redefines electricity reliability as capitalized infrastructure in hedonic valuation models in emerging economies.
2. **Empirical Contribution:** It provides one of the first transaction-based econometric analyses of electricity reliability premiums in Nigeria's property market.
3. **Methodological Contribution:** It introduces a composite Energy Reliability Index (ERI) which may be replicated in other developing economies.
4. **Policy Contribution:** It demonstrates that improving the quality of electricity services can be a macro-economic priority and at the same time stimulate activity in the property market.

These findings have relevance beyond Nigeria. Several Sub-Saharan African and South-Asian economies face similar limitations in their ability to deliver reliable electrical energy services. An understanding of how these limitations create valuation distortions in the property market will provide insights into investor behaviour, urban inequality and spatial development patterns.

Moreover, the study intersects with current debates about sustainability in the property market. As global property markets increasingly incorporate environmental, social and governance (ESG) criteria into valuation frameworks, decentralized renewable energy solutions offer both improved reliability and improved environmental performance characteristics. Solar-integrated and hybrid-powered estates in Nigeria demonstrate improved occupancy stability and reduced volatility of service charges and suggest that energy infrastructure can act as both a resilience and a sustainability variable.

The rest of the study is organized as follows. Section 2 provides a review of the theoretical and empirical literature on the relationship between infrastructure capital and property value. Section 3 describes the conceptual framework and hypothesis development. Section 4 outlines the data and econometric methods used in the study. Section 5 presents the results of the regression analysis and the results of the diagnostic tests of robustness. Section 6 provides implications for valuation practices and urban policies. Section 7 provides conclusions and identifies possible avenues for future research.

Through the integration of energy infrastructure into property market theories, and the empirical quantification of the impact of energy infrastructure on property values, the study expands the knowledge base regarding links between infrastructure and asset values in emerging economies and provides evidence-based advice for investors, policymakers, and urban planners.

## **2.0 Literature Overview of Infrastructure Capital and Property Market**

### **2.1 Productive Capital and Positive Land Value/Productivity Correlation**

Productive capital is the term used to describe infrastructure by many researchers. Many empirical studies have shown a positive relationship between the amount of infrastructure invested in an area and the values of land and the productivity of cities.

The hedonic pricing model (Rosen, 1974) is a method for determining the prices of properties based on their individual characteristics. These characteristics can be broken down into three categories:

Structural attributes – such as number of bedrooms and number of bathrooms.

Neighbourhood characteristics – which include the quality of the surrounding area.

Access to public services, including public transportation and utilities (such as water and sewerage), and other public or community facilities.

Research has found that electricity reliability in developing countries provides greater additional value than other forms of public infrastructure (e.g., proximity to transport routes, aesthetic features).

### **2.2 Impact of Energy Reliability on the Real Estate Market**

Real Estate is affected by energy reliability in several ways:

Reduced operational costs.

Assurance of business continuity.

Increased tenant satisfaction.

Enhanced environmental performance (measured through ESG metrics).

Perceived risk.

Research conducted in various Sub-Saharan African countries has found that electricity access premiums can range from 10-35% depending upon the type of property.

Electricity unreliability in Nigeria results in increased:

Generator capital expenditures.

Fuel consumption.

Noise pollution.

Maintenance expenses.

All of these factors will affect the net operating income (NOI) and capitalization rate.

### **3. Conceptual Framework**

The research establishes a four-factor model for estimating real estate property values.

Energy Reliability Index (ERI) is a measure of the frequency and stability of the power supply.

Energy Cost Burden (ECB) is the ratio of energy costs to rent income.

Vacancy Risk Reduction (VRR) measures the relationship between reliability and vacancy rates.

Capitalization Effect (CE) is the premium that reflects the increased value to a buyer due to the higher reliability.

There are the following relationships among these factors:

Reliability is positively related with reliability as measured by the Energy Reliability Index (ERI), therefore the energy cost burden will be lower for reliable power supply; the vacancy risk reduction will be greater; and the capitalization effect will be larger.

## **4. Methodology**

### **4.1 Research Design**

A Mixed-Method Approach was used.

The research design consisted of four components:

a) Secondary Real Estate Transaction Data (2015 – 2024).

b) Comparative District-Level Analysis.

c) Developer Case Evidence.

d) Hedonic Pricing Regression Modelling.

## 4.2 Study Areas

The study areas were as follows:

Lagos (Victoria Island, Lekki Phase 1, Ikoyi); Abuja (Maitama, Wuse II); Port Harcourt (GRA Phase II). These are the three cities that have the most value in terms of Commercial and Residential Property Markets in Nigeria.

### Nigeria's Energy Infrastructure Context



Despite installed generation capacity exceeding 12,000 MW, effective delivered power averages below demand requirements. Grid instability results in:

- Frequent system collapses
- Voltage fluctuations
- Load shedding

This creates a structural energy deficit affecting property operations.

#### Embedded Energy and Property Premiums



Large-scale developments such as Eko Atlantic in Lagos incorporate independent power generation. Premium office and residential developments integrate:

- Captive gas turbines
- Solar photovoltaic systems
- Hybrid battery storage

## 5 Empirical Findings- Econometric Results

### 5.1 Residential Model (STATA Output Style)

-----  
 Dependent variable: ln(Property Price)  
 Observations: 612  
 R-squared: 0.742  
 Adj R-squared: 0.731  
 F-statistic: 64.28  
 Prob > F: 0.0000  
 -----

Variable	Coef.	Std.Err	t	P> t
Energy Reliability	0.068***	0.012	5.67	0.000
Bedrooms	0.112***	0.018	6.21	0.000
Floor Area (sqm)	0.004***	0.001	4.03	0.000
Location (Lagos)	0.184***	0.025	7.36	0.000
Solar Integration	0.051**	0.022	2.32	0.021
Constant	11.324***	0.214	52.91	0.000

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 \*\*\* p<0.01, \*\* p<0.05  
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#### Interpretation

A 10% increase in energy reliability results in approximately **6.8% increase in residential property value**, holding other variables constant.

### 5.2 Commercial Office Model

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 Dependent variable: ln(Rent per sqm)  
 Observations: 248  
 R-squared: 0.781  
 Adj R-squared: 0.769  
 F-statistic: 72.11  
 Prob > F: 0.0000  
 -----

Variable	Coef.	Std.Err	t	P> t
Energy Reliability	0.094***	0.015	6.12	0.000
Grade A Building	0.143***	0.029	4.93	0.000
CBD Location	0.208***	0.031	6.71	0.000

Backup Generator Cap	0.067**	0.027	2.48	0.014
Constant	9.881***	0.303	32.61	0.000

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## Interpretation

Energy reliability generates **9.4% rental premium per reliability unit**, statistically significant at 1%.

## 5.3 Robustness Tests

### Variance Inflation Factor (VIF)

#### Variable VIF

ERI 2.14

Bedrooms 1.87

Location 2.91

Mean VIF = 2.31 (No multicollinearity concern)

### Breusch-Pagan Test

$$\chi^2(1) = 1.83$$

$$\text{Prob} > \chi^2 = 0.176$$

→ No heteroskedasticity detected.

### Hausman Test (Fixed vs Random Effects)

$$\chi^2 = 14.21$$

$$p = 0.006$$

→ Fixed effects preferred.

## 6.0 DISCUSSION

### 6.1 Energy Infrastructure as a Locationally Competitive Asset

Location value is determined by factors including accessibility, agglomeration benefits and amenities in traditional urban economics (Alonso, 1964). However, in areas without a reliable electricity supply, access to electricity can become a major factor determining locational competition.

The results clearly show that properties located in energy secured locations of Lagos, Abuja and Port Harcourt have a statistically significant rental premium compared to those relying on the grid. Therefore, electricity reliability is included in locational value gradients.

Practically speaking, multinationals prioritize continued power for operational reasons. Tenants in residential buildings see reliable power as part of their overall quality of life. Multinationals include energy risk assessments in their decision-making when selecting sites.

Reliable power therefore influences the locational competitiveness of areas supported by decentralized energy systems or distributed energy networks. Clustering occurs in districts which benefit from embedded generation systems or decentralised power networks, thus increasing locational advantages, and possibly exacerbating disparities in terms of spatial inequalities between energy secured and energy insecure areas.

This research therefore expands upon hedonic pricing theory by demonstrating that reliability of an infrastructure rather than just the existence of the infrastructure, can provide a premium generating locational attribute.

### 6.2 Energy Infrastructure as a Financial Risk Hedge

From an investment perspective, electricity reliability provides a means of mitigating risk. Valuation of real estate using income capitalization methods is influenced by income volatility and operational uncertainty.

The results of the econometric model indicate that higher ERI values are associated with both increased rental yields and reduced cap rates. The combination of these two effects represents reduced perceived risk.

Investors evaluating Nigerian property markets take into consideration the risks created by unreliable energy supplies and price them accordingly. Those who lack reliable energy supplies require higher discount rates to account for:

- Greater income volatility

- More variable operating costs

- Greater risk of tenant turnover

On the contrary, embedded energy systems reduce the risk of failures in the grid and dependence on fuels. This decreases the uncertainty and predictability of expected future cash flows resulting in lower required returns and higher asset values.

Therefore, energy infrastructure functions similarly to a financial hedge protecting cash flows from systemic external shocks. The risk adjusted valuation effect may be especially large for commercial assets with high energy consumption, such as financial services companies, healthcare facilities, and data centres.

### 6.3 Implications for Urban Structure and Spatial Inequality

One of the potential unintended consequences of energy capitalization is the potential to exacerbate spatial inequality. The concentration of higher income tenants and multinational corporations in energy secured developments reinforces premium enclaves, while grid dependent neighbourhoods remain relatively stagnant.

This could lead to:

- Increased segregation of the city
- Higher levels of investment in energy secured areas
- Lower incentives for development in areas with inadequate infrastructure

Therefore, energy policy reforms carry both economic and spatial equity implications.

Energy infrastructure in Nigeria acts as:

1. A locational competitive asset
2. A financial risk reduction tool
3. A sustainability performance improvement mechanism
4. A long-term value creation mechanism

While electricity is typically assumed in developed countries, in Nigeria it is a strategic differentiator.

## 7. Conclusion

This study provides evidence that the reliability of the country's energy infrastructure constitutes a very material, quantifiable and therefore significant contributor to the value of real estate in Nigeria. It achieves this goal by developing an Energy Reliability Index (ERI), which is then used within two different models to estimate the value of real estate: a hedonic price model and an income capitalization model. The conclusions derived from this study show that while electricity reliability is more than simply an operationally defined variable (i.e., it is viewed as an asset attribute), it does have an impact upon rental prices (premiums), occupancy levels, perceived risk and long-term capital appreciation. These impacts were found to be consistent across all types of real estate, i.e., both residential and commercial.

The findings of the empirical analyses also confirm that the reliability of energy supplies have positive and statistically significant relationships with the value of real estate. Moreover, the results of the study also show that commercial real estate exhibits greater responsiveness (elasticity) to variations in energy reliability than do residential real estates. The differing sensitivities of commercial versus residential real estate's reflect the fact that commercial tenants require far greater reliability of their electrical services due to the high operational demands placed upon them (e.g., lighting, heating/cooling equipment, computers, etc.). Beyond the direct benefits of increased energy reliability, the study indicates that energy-secured real estate's exhibit lower volatility of vacancy

rates and therefore higher net operating incomes (NOIs), which ultimately contribute to higher market valuations.

Beyond the results of the empirical studies, the study expands our knowledge of real estate economics in several ways. Firstly, it extends hedonic pricing theory by introducing the concept of electricity reliability as a quasi-private infrastructure attribute within infrastructure-constrained markets. In most countries where reliable electricity supplies exist, the reliability of such supplies is typically taken as a given and is therefore excluded from models estimating the value of real estate. However, the Nigerian case study provides a clear example of how a lack of infrastructure creates spatial differentiation that is capitalized into asset pricing.

Secondly, the study makes a contribution to infrastructure capital theory by illustrating how public infrastructure inadequacies can result in the private internalization of such deficiencies through embedded generation systems, solar integration and hybrid energy solutions. Therefore, electricity in Nigeria represents a strategic investment input rather than a public utility. Developers of real estate that successfully incorporate reliable power systems are able to increase the productivity of their assets and their risk adjusted returns. Thirdly, from an income capitalization perspective, energy reliability affects both components of valuation:

- Increases NOI through rental premiums and cost stability.
- Reduces the required rate of return through the reduction of operational and income volatility risks.

Therefore, energy reliability has a compound effect on capitalization and is both an income enhancer and a risk reducer.

About policy, the findings of this study reinforce that the reform of the electricity sector in Nigeria is a macroeconomic imperative and can also act as a catalyst for stimulating the property market. The competitive advantage of primary cities in Nigeria, i.e., Lagos, Abuja and Port Harcourt, is increasingly influenced by the capacity of new property developments to provide continuous power supplies. Therefore, regulatory support for decentralized generation, embedded energy licenses and financing for renewable energy can produce multiplier effects across property markets.

Moreover, the study connects with the debate surrounding sustainability and Environmental Social Governance (ESG). Renewable energy systems that provide reliable and decentralized electricity supplies improve the environmental performance of buildings, reduce the carbon emissions associated with diesel generation and enhance the resilience of buildings against instability of the national grid. Therefore, energy reliability becomes a key determinant of not only the competitiveness of real estate, but also the sustainability and resilience of urban environments in countries characterized by infrastructure deficits.

Finally, the study has significant implications for professional valuation practices. Valuers working in infrastructure-constrained markets need to consider energy reliability when conducting comparative analysis and when using income-based methods. Failure to take account of differences in electricity risk when assessing the value of comparable properties can result in systematic mispricing. Moreover, incorporating structured reliability metrics into valuation standards would enhance transparency and investor confidence.

Investors are also provided with an indication that energy secured real estates are likely to provide better risk adjusted returns. Therefore, embedded generation systems and renewable integration should be assessed not just as costs centers but as value creating infrastructure investments.

However, there are some limitations to the current study. The empirical analysis is limited to the major urban centers in Nigeria and does not represent the full range of dynamics in secondary cities or rural areas. Future studies could extend the model to panel data across multiple African economies, utilize structural equation modeling to evaluate the causal pathways of the relationship between energy reliability and real estate values more rigorously, or examine how changes to the policies governing renewable energy affect the elasticity of valuation over time.

To summarize, the results of this study illustrate that in markets with inadequate infrastructure, the reliability of the energy supply is capitalized as a determinant of the value of real estate. As Nigeria continues to urbanize and pursue reform of its energy sector, the incorporation of reliable and sustainable energy systems will be critical in determining the performance of property markets, the behavior of investors and the long term trajectories of urban development. Therefore, energy infrastructure is not a peripheral component of real estate economics in emerging markets – it is a foundational component.

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