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Effect of innovations in electricity infrastructure on sustainability of small businesses (SBs) in Ogun State Nigeria

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Abstract
The broad objective of this is to shed light on the effect of innovations in electricity infrastructure on sustainability of small businesses (SBs). The study adopted a descriptive survey research design and the population for this study was drawn from SMEDAN (2022). The study population consists of 2,394 SBs owners or representative. Simple random sampling was adopted, while Yamane sampling techniques was adopted to determine sample size of 342.. The primary data was collected through the administration of questionnaires and descriptive statistics was adopted for analysis of demographic data and research questions, while linear regression were adopted to test the hypotheses. The result shows that innovation in electricity infrastructure does have a significant effect on ecological sustainability of SBs in Ogun State Nigeria. Furthermore, innovation in electricity infrastructure does have a significant effect economic sustainability of SBs in Ogun State Nigeria. Also, innovation in electricity infrastructure does have a significant impact on social

sustainability of SBs in Ogun State Nigeria. The study concluded that there is significant effect innovations in electricity infrastructure significantly and positively affect sustainability of SBs. The study recommended that SBs need to make provision backup power system for production/service provision due to epileptic nature of electricity; government needs to finance transmission and distribution in order to digitalise and provide smart grid to boost energy to industrial sector; and renewable energy solution should be encouraged and accepted to inculcate green sustainability by the nation.

Keywords: Electricity, Infrastructure, Innovation, Small Businesses, Sustainability

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I. Introduction

Innovation in electricity infrastructure is essential in order to combat climate change and improve power production, transmission, and distribution's efficiency, dependability, and sustainability (Onyenandu *et al.*, 2025). Due to rising reliance on non-renewable energy sources like coal, oil, and natural gas brought on by population growth, urbanization, and economic development, the world's energy demand has increased, harming the environment and contributing to climate change (Ejiyi *et al.* 2025). The energy sector in developing nations is confronted with structural inefficiencies, unstable grid infrastructure, and an excessive dependence on fossil fuels (Nelson *et al.*, 2025). Although hydroelectric power gained popularity by the middle of the 20th century, nonindustrial countries continued to rely heavily on traditional resources like biomass (Rajendran *et al.*, 2025).

Governments and businesses have made large investments in electricity infrastructure expansion with an emphasis on sustainability and service quality, making it a top priority for economic, social, and ecological growth (Meeks & Mahadevan, 2025). The need to decarbonize output has rekindled interest in hydro power, a vital energy system, on a global scale. However, funding for alternative renewable energy sources may be diverted when small hydroelectric plants are built in underdeveloped nations. Shortfalls in energy production due to low reservoir water levels have rendered hydropower facilities unusable. This emphasizes the necessity of energy transitions that are sustainable (Sasges & Ziegler, 2024).

Despite significant infrastructure investments, electrification initiatives continue to encounter obstacles such as low cost recovery, inconsistent and subpar electricity supply, and unpredictable demand patterns (Meeks & Mahadevan, 2025). Nigeria's electricity industry suffers from inadequate generation capacity, ineffective distribution networks, and inefficiency. Even with reforms, problems like corruption still exist. Businesses and small enterprises are affected by the crisis, which is made worse by the aging grid system and insufficient investment in renewable energy (Onyenandu *et al.,* 2025). With national economic regulation guaranteeing social benefits and electricity networks acting as a mediator between resource endowments and governance structures, the shift to a greener energy system poses challenges for the infrastructure supporting the transmission and distribution of electricity (De Laurentis, 2023).

Nigerian businesses, including SBs rely on generators as a backup, but growing fuel expenses, such as shortages of diesel and inflation, can have a big effect on earnings (Akaeze & Akaeze, 2025). The majority of business owners use gasoline generators extensively, which has negative health effects, such as headaches, coughs, respiratory and cardiovascular infections, and ecological and noise-related issues (Abu Fares *et al.*, 2024). Additionally, high investment costs, restricted access, socioeconomic problems, interoperability problems, cyber security, connectivity, and stringent system security requirements are obstacles that smart grids must overcome, especially in developing nations (Kabeyi & Olanrewaju, 2023). In developing countries, renewable energy technologies are gradually gaining traction, but their adoption is constrained by their high capital costs and erratic availability. These technologies have the potential to change ecosystems, which could result in the development or extinction of species (Farghal *et al.,* 2023).

High costs, infrastructure risks, technology volatility, and substantial institutional and policy requirements are just a few of the many obstacles that must be overcome in order to adopt and transform sustainable practices (Kabeyi & Olanrewaju, 2023). Additionally, Durrani et al. (2024) reveal that SBs' awareness and adoption of sustainable practices are hampered by a lack of funding, education, and government support. Temitope et al. (2025) further support this economic perspective by stating that SBs frequently fail to be sustainable because of challenges like a lack of investing, budgeting, credit management, and accounting skills, which results in poor financial awareness and insufficient resources. Nigeria and the rest of the world have high unemployment rates as a result.

There are numerous studies on the sustainability of SBs and electricity infrastructure, both independently and in tandem. However, there are few studies on the sustainability of SBs and innovations in electricity infrastructure in Ogun State, Nigeria; however, Onyenandu et al. (2025) conducted a study in Lagos State. The research aims to provide general insight into innovations in electricity infrastructure and small enterprise sustainability in the developing world, such as Nigeria, specifically in Ogun State, given the paucity of studies that have been conducted on the same topic in Nigeria.

II. Literature Review

The movement of charged particles, particularly electrons, produces a type of energy known as electricity. Electricity is considered a secondary energy source because it is generated through the conversion of primary energy sources such as coal, natural gas, wind, solar, and nuclear energy (Blume, 2025). It is vital to modern life since it is a versatile energy transporter that can change into various forms like heat, light, or motion (Mekuye *et al.,* 2024). It is possible to generate power from a wide variety of resources. Certain electricity sources are categorized as renewable energy because they refill faster than they are consumed. Non-renewable energy sources, on the other hand, run out faster than they can naturally be supplied. However, there is a cost associated with using any kind of electricity (Al Mubarak *et al.*, 2024).

The electricity system consists of distribution, transmission, and generation. The three factors used to assess a country's performance are energy security, energy equity, and sustainability. Energy security evaluates a country's ability to meet its energy needs while preserving ecological sustainability, while equity guarantees that everyone has access to reliable energy (Nguyen *et al.*, 2024). Access to electricity can lead to positive outcomes including employment, education, and health, but the extent of these benefits relies on a number of factors, such as infrastructure, income, the quality of the electricity, and the duration of access (Meeks & Mahadevan, 2025).

Hydrocarbon power infrastructure has been the main source of electricity and its security, notwithstanding environmental challenges (Kabeyi & Olanrewaju, 2023). Because electricity contributes to both environmental degradation and human well-being, decarbonization and changes to generation and consumption are required (Lockwood, 2023). The energy transition involves moving from fossil fuels to low-carbon, renewable sources in order to combat climate change and achieve sustainability goals. The transition cocktail, which consists of gas and electricity, is influenced by historical legacy, cost, availability, and environmental impact (Bompard *et al.,* 2024).

In emerging nations like Nigeria, SBs make up 40% of national income and 90% of all firms, making them the foundation of the economy. They are essential to both economic expansion and societal well-being (Kannan & Gambetta, 2025). Despite these benefits, SBs contribute significantly to national economies through fostering innovation, job creation, and local economic development. They are vital employers, fostering skill development and entrepreneurship while also improving industry dynamics. Despite challenges including budgetary constraints and regulatory concerns, SBs promote resilience, social equity, and economic diversity because to their sustainability and adaptability (Zhao, 2024).

Sustainability means meeting stakeholder needs without compromising a business's ability to fulfill future demands. It means increasing value beyond the needs of stakeholders while improving the dividends for owners and society. According to Martins et al. (2022), businesses must adapt to new market and societal forces and be "good citizens" in order to ensure sustainability. Sustainability in business refers to incorporating social, environmental, and economic aspects into business strategies. Elkington's Triple Bottom Line (TBL) concept, which prioritizes people, earth, and business, has had a big impact on sustainability conversations.Businesses are increasingly implementing TBL as a balanced approach to economic objectives, environmental stewardship, and social equality. SBs face unique opportunities and problems in sustainability initiatives, however how this paradigm is utilized differs based on the type of business (Asbullah & Tarigan, 2024).

Hypotheses Formulation

This study examines the effect of power infrastructure improvements on the sustainability of small businesses in Ogun State, Nigeria, as well as the sustainability metrics of ecological, economic, and social sustainability. Backup power systems, smart grid integration, and renewable energy solutions are used to measure innovation in electricity infrastructure, underscoring the significance of taking everything into account.

The authors connected the independent variables of innovation in energy infrastructure with the dependent variable of sustainability in order to conceptualize this study.

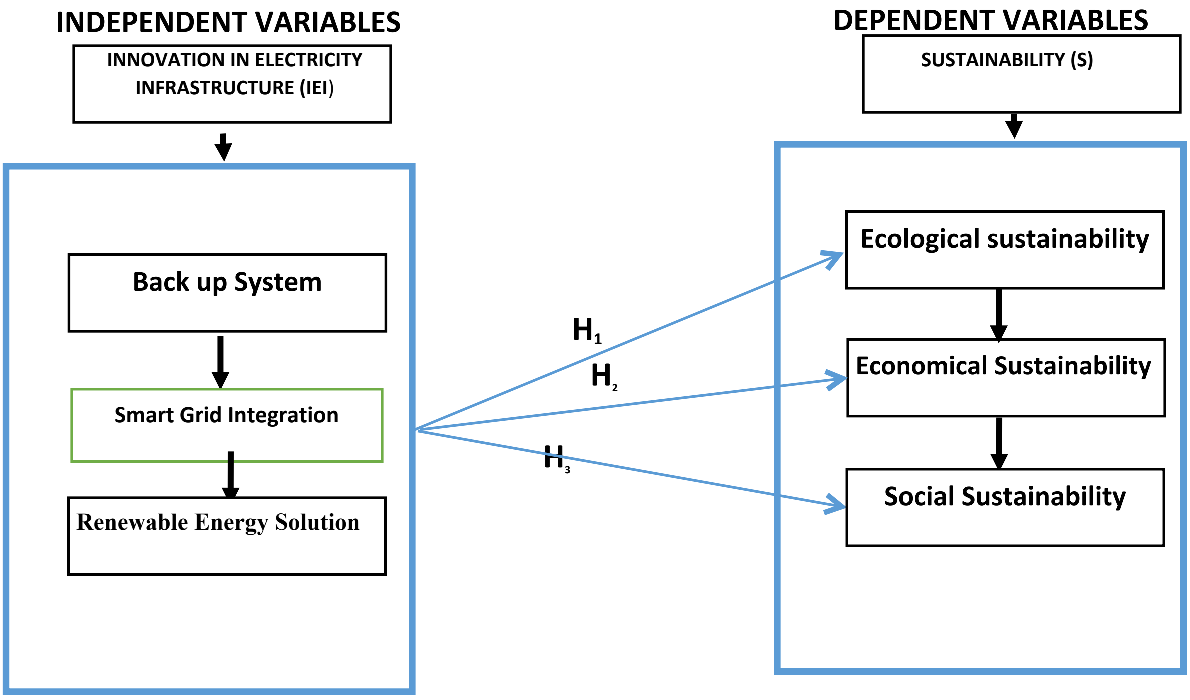

Figure 1: Conceptual Model of Innovations in Electricity Infrastructure and Sustainability Of SBs in Ogun State Nigeria.

Source: Researchers' Conceptualization (2026).

Innovations in electricity infrastructure: Back Up System

Backup energy solutions that provide power during a blackout include solar battery storage, standby generators, and uninterrupted power supplies (UPS) (Hasibi & Adiprasetya, 2025). Nigeria's electricity issue, exacerbated by antiquated grid infrastructure and a lack of investments in renewable energy, affects businesses that rely on dependable power. Using alternate energy sources could mitigate these issues (Onyenandu *et al.*, 2025). A UPS provides electricity devices with clean power, whereas generators burn fuel. Battery systems store energy from the grid or solar panels for backup power (Blume, 2025).

The inadequacies of Nigeria's electricity sector have been widely documented. The energy problem, which is exacerbated by reliance on an antiquated grid system and inadequate investment in renewable energy sources, directly affects businesses that rely on dependable power. The possibility of alternative energy solutions to assist SBs with their electricity issues (Onyenandu *et al.*, 2025). Effective power backup systems depend on rechargeable batteries because they provide a stable and seamless transition during blackouts. Because they boost output, reduce losses, and enhance quality of life, they are a sustainable energy storage solution (Kostenko, 2025).

Due to its inadequate coverage and frequent outages, Nigeria's national grid offers off-grid limitless energy systems. However, these systems' high costs, limited availability, and lack of technical assistance hinder their scalability and sustainability (Ajeigbe & Abiola, 2025). They ensure ongoing operations and activities by providing power during grid failures and being charged when electricity is available (Osagie *et al.*, 2024). Rechargeable batteries are crucial for off-grid regions because they provide an independent, self-sufficient power source, reduce dependency on the grid, and promote energy independence, sustainability, and resilience in the event of a power outage (Njema *et al.*, 2024).Because they may be charged when electricity is available and provide power in the event of a grid failure, they ensure ongoing operations and activities (Osagie *et al.*, 2024).

Hypothesis (H_O1): There is no significant relationship between Innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) and ecological sustainability of SBs in Ogun State Nigeria.

Innovations in electricity infrastructure: Smart Grid Integration

The smart grid is not a simple system with several layers. It consists of the Computer Layer, which enhances processing capabilities, the Energy and Power Layer, which regulates the flow of electricity, and the Communication Layer, which connects components. This integration improves the grid's resilience, efficiency, and adaptability by including renewable resources and reacting to changing energy demands (Rajendran *et al.*, 2025). Before the smart grid period, there were conventional and micro grids (Etukudoh & Igunma, 2025; Mlambo *et al.*, 2025; Ojo *et al.,* 2025).

The conventional power grid enables the long-distance transmission of electricity from centralized places to multiple facilities, industry, and residential consumers (Esmaio & Rahmah, 2025). It is composed of interconnected parts including distribution lines, transformers, and generating facilities to guarantee reliable delivery and balance supply and demand across areas for energy supply stability (Adeniji *et al.,* 2025). Consequences of traditional grids lead to innovative grids, such as micro and smart grids (Oprea & Bâra, 2025). Microgrids focus on improving renewable energy source control, protection, operation, and planning techniques. These systems provide energy independence and a constant power supply by combining distributed energy resources (Ariyo *et al.*, 2025).Due to their renewable technology and declining costs, MGs are gaining popularity as solutions for both urban and rural energy issues (Nelson *et al.*, 2025).

Hypothesis (H_o2): There is no significant relationship between Innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) and economical sustainability of SBs in Ogun State Nigeria.

Innovations in electricity infrastructure: Renewable Energy Solutions

Renewable energy sources are a vital tool in the battle against climate change since they replenish quickly and produce fewer greenhouse gases (Obiorah *et al.*, 2025). It is energy generated by renewable natural resources like sunshine, wind, water, tidal waves, geothermal heat, and plant biomass. Sustainable sources convert these resources into electricity that can be used (Gan *et al.*, 2023). Wind energy is a promising renewable resource, especially in Nigeria's northern and coastal regions where wind speeds are considerable (Enikanselu *et al.*, 2025). It offers a clean, sustainable alternative to fossil fuels and may be applied to both small-scale and large-scale systems. Small-scale wind turbines are most appropriate for rural areas, while large-scale wind farms promote energy security and meet growing demand (Charamba *et al.*, 2025).

Solar energy has the potential to address Nigeria's energy issues, especially with regard to energy poverty. Because it may be implemented at many scales, from large utility farms to small off-grid systems, it is adaptable and crucial for reaching remote places without reliable national grid infrastructure (John *et al.*, 2025; Yusuf, 2025). Mini-grids, water pumps, and solar household systems are examples of solar solutions that provide rural communities with clean, reliable electricity for economic activity, communication, lighting, health care, and education (Ukoba *et al.*, 2024).The solar energy sector boosts local economies and underprivileged areas by generating jobs in the manufacturing, installation, and maintenance of solar panels (Agupugo *et al.*, 2024). Solar energy reduces the financial burden on homes and companies that use diesel generators because it is dependent on abundant sunlight and has reduced running expenses (Yusuf, 2025).

Nigeria's extensive river systems, including the Niger and Benue, offer significant potential for hydropower production (Yusufu *et al.*, 2025). Despite significant projects like the Kainji, Shiroro, and Jebba Dams, Nigeria still has untapped potential for mini- and micro-hydropower systems. Mini-hydropower systems, which produce less than 100 kW and reduce energy poverty while promoting rural development, are very beneficial to SBs and off-grid populations (Abdulkadir *et al.,* 2023). Nigeria's underutilized agricultural and urban trash can be sustainably replaced by biomass energy derived from organic materials (Odejobi *et al.*, 2024). Nigeria's agriculture sector produces large volumes of biomass, which can be converted into biogas, biofuels, or electricity for the creation of clean, renewable energy using technologies like bioethanol and biomass power plants (Adekanye, 2025).

Hypothesis (H_o3): There is no significant relationship between Innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) and social sustainability of SBs in Ogun State Nigeria.

Theoretical Review

The Resource-Based View (RBV) was developed by Jay Barney in 1991 (Mushtaq *et al.*, 2025; Onyenandu *et al.*, 2025). It was based on the works of Penrose in 1959 and Birger Wernerfelt in 1984 and laid the groundwork (Nebo & Ndukwe, 2025; Wokocha & Madukasi, 2025). According to Parojčić et al. (2025), the fundamental tenet of this approach is that an organization's internal resources, which it possesses and effectively utilizes, are the source of its long-term competitive advantage rather than external factors. According to the principle, businesses should make use of special resources (Nebo & Ndukwe, 2025). In order to formulate strategy and achieve growth, RBV reoriented the strategic focus from external market conditions to enterprises' own capabilities and resources (Wokocha & Madukasi, 2025). According to the resource-based view (RBV) paradigm, an organization's capacity to obtain and successfully utilize resources that are valuable, rare, unique, and non-substitutable (VRIN) is what gives it a sustainable competitive edge. By increasing operational effectiveness, fostering creative decision-making, and bolstering sustainability credibility, innovative power infrastructure is an example of a strategic resource (Onyenandu *et al.*, 2025). RBV illustrates how technical and managerial changes are assimilated through a firm's strategic resources, demonstrating its relevance in sustainability, supply chain networks, and digital transformation (Mushtaq *et al*., 2025).

In addition, RBV theory emphasizes the critical interaction between resources and capabilities, implying that businesses may struggle to combine complementary resources. A thorough understanding of resource management is essential for overcoming these constraints, emphasizing the strategic value of resources. This framework highlights the importance of businesses adapting and scaling their resources in response to changing environmental conditions (Agrawal *et al.*, 2025). The Resource-Based View (RBV) emphasizes SBs' ability to effectively compete with larger organizations by leveraging their unique resources. This viewpoint sheds light on how SBs can leverage their unique resource setups to achieve success (Arief *et al.*, 2023).

Resources in this sense include both material and immaterial assets, such as renewable energy sources, smart grid integration, and backup power systems. The evaluation of resource heterogeneity, which is crucial for comprehending the variety and unpredictability of available resources, is at the heart of RBV analysis. Heterogeneous resources, like backup power systems, show differences in quantity, quality, and accessibility compared to homogeneous resources (Salmi *et al*., 2025). The necessity for creative backup power solutions for vital substation activities is highlighted by the rising frequency of power outages. While newer battery solutions are constrained by high capital costs, traditional diesel generators must contend with issues such fuel supply dependence, high costs, and pollution. This calls for the investigation of substitute alternatives that strike a balance between environmental sustainability, economic viability, and technical feasibility (Kostenko, 2025).

To increase the effectiveness, dependability, and sustainability of contemporary electricity infrastructure grids, smart grid technology integration is crucial (Etukudoh & Igunma, 2025). A "smart grid" is essentially an improved electricity grid that makes use of automation, computers, sensors, and communication to improve the system's dependability, efficiency, and safety. While depending on energy sources for the best possible system performance, it gives customers the ability to choose how much electricity they use, which lowers costs (Ohanu *et al.*, 2024). This is depending on energy sources for optimal system performance, it gives users the ability to control their electricity usage, which lowers costs (Rajendran *et al.,* 2025).

Smart meters, sophisticated communication systems, energy management systems, and Internet of Things devices which allows for real-time observation, data analytics, as well as predictive maintenance, are essential components of a smart grid. Data collection is improved by automation and communication technologies, which promotes efficiency and sustainable energy practices using renewable energy (Qays *et al.*, 2023). These resources include stakeholder relationships, institutional knowledge, human capital, and technology assets in the field of renewable energy. The importance of intangible resources, particularly in emerging economies and the weather energy industry, where strategic resource allocation is essential in the face of infrastructure and regulatory obstacles. This demonstrates how RBV relates to business-level innovation initiatives (Kurniawan & Triandi, 2025).

The success of the organization in accomplishing strategic objectives, satisfying stakeholder needs, and guaranteeing long-term sustainability in a dynamic environment is measured by the outcome of organizational functioning (Parojčić *et al.*, 2025). Eco-friendly power is a strategic resource that is essential for better corporate performance, especially in competitive marketplaces, and is supported by RBV theory. It suggests that a combination of competencies leads to sustainable performance. Green electricity infrastructure is also recognized as an innovative resource that can improve environmental and operational results. According to de Andrade et al. (2025), this suggests that it can be a significant asset for SBs, promoting sustainable performance while meeting economic, social, and environmental goals.By investing in their own resource bundles, firms can take advantage of opportunities thanks to RBV's emphasis on improving strategic resources associated with historical trajectories. Analyzing how resources and capabilities affect competitive advantage and sustainable performance is made easier by integrating different resources inside the RBV framework (El Nemar *et al.*, 2025).

Despite its extensive application, RBT has been critiques by academics who point out difficulties in fundamental ideas such as resource value, rareness, inimitability, and non-substitutability. Additionally, critics claim that it is inadequate in terms of environmental reforms, lacks dynamism, and is overly focused on businesses. Alternative theories including resource orchestration, knowledge-based view, and dynamic capabilities have emerged as a result of these problems. However, RBT is seen as a developed theory, which has led to proposals for its expansion and incorporation with various viewpoints (Iliyas, & Barca, 2025). In contrast to responses motivated by external uncertainties and concentrating on internal capabilities, RBV theory provides a fundamental viewpoint for SBs to use strategic resource management to improve sustainability (Adamu & Sundararajan, 2025).

Empirical Review

Onyenandu et al. (2025) examined how electricity infrastructure innovations affect the sustainability of small enterprises in Lagos State, Nigeria, using a survey design with both primary and secondary data. From a population of 42,067 small enterprises, a sample of 331 was selected using the Taro Yamane formula. Data were gathered through face-to-face questionnaires. The analysis, conducted using regression analysis and Pearson's correlation, showed positive and significant relationships between various dimensions of electricity infrastructure and the sustainability of these enterprises.

Ohiri et al. (2025) examined the integration of smart grid technology in developing countries, particularly Nigeria. The study highlighted challenges such as infrastructure limitations and regulatory hurdles, while also identifying opportunities like improved energy efficiency, reduced power theft, and the integration of renewable energy sources. A mixed-method approach, including literature reviews, stakeholder interviews, and case study analyses, was used to uncover these insights.

Azebi and Lubo (2025) investigated the effects of renewable energy investment on Nigeria's long-term economic development. The growth rate of gross domestic product was used to quantify sustainable economic development, while solar, wind, and biomass were used as proxy for renewable energy. Data on these variables from 1990 to 2023 were analyzed using the Augmented Dickey-Fuller unit root test, Johansen Cointegration test, and Error Correction Model approach. The unit root test results show that all of the variables (solar, wing, and biomass) became stationary at first difference. The Johansen Cointegration test shows a long-term relationship among the variables. Econometric estimates indicate that investment in solar energy positively impacts Nigeria's GDP growth significantly, while wind energy investment has an insignificant positive impact. Additionally, biomass investment also significantly boosts Nigeria's GDP growth.

III. Methodological Procedure

Research Design

The study's methodology is quantitative. In order to better comprehend the study objectives and give uniform data for precise measurement, a descriptive research strategy was used. 2,394 SBs that are registered with the Small and Medium Development Agency of Nigeria (SMEDAN) 2022 comprise the study's population (Taiwo & Kayode, 2025). A sample size of 342 was established using the Yamane sampling techniques. To ensure that all respondents, who are Ogun State small business owners, had an equal chance to participate, the study used basic random sampling. A questionnaire was utilized as the study tool to collect primary data. The questionnaire's items were modified from earlier research. While the detail for sustainability were adapted from the studies of Kuusalu et al. (2024) for economic sustainability (ES), Nogueira et al. (2024) for social sustainability (SS), and Adesua-Lincoln (2025) for environmental sustainability (EcS), the components of innovations in electricity infrastructure (backup system (BS), smart grid system (SGS), and renewable energy solution (RES)) were adopted from the studies of Onyenandu et al. (2025). Strongly agree, agree, uncertain, disagree, and strongly disagree were the four points on the scale used to rate the issues.In order to determine the contribution of each implemented component of innovations in electricity infrastructure to resolving the sustainability issue among SBs in Ogun State, multiple regression was used. Therefore, the model to accomplish the study's goals was developed as follows:

$ES = \beta_0 + \beta_1 BS_i + \beta_2 SGS_2 + \beta_3 RES_3 + \mu_i$---------- eqn (i)

$SS = \beta_0 + \beta_1 BS_i + \beta_2 SGS_2 + \beta_3 RES_3 + \mu_i$---------- eqn (ii)

$EcS = \beta_0 + \beta_1 BS_i + \beta_2 SGS_2 + \beta_3 RES_3 + \mu_i$---------- eqn (iii)

Reliability and Validity Test for the Study

The pilot study involved 34 SB' owners from Ogun State, representing 10% of the sample size, and the results are detailed in the accompanying table.

Table 1: Pilot Study Result

S/N	Variables	Reliability (Cronbach Alpha)	Validity (KMOs)	No of Items
1	Backup System	0.847	0.689	4
2	Smart Grid System	0.828	0.752	4
3	Renewable Energy Solution	0.758	0.793	4
4	Economic Sustainability	0.787	0.784	4
5	Social Sustainability	0.870	0.709	4
6	Environmental Sustainability	0.813	0.715	4

(*Source*: Researcher's Computation, 2026)

The reliability test was calculated using Cronbach Alpha, and the validity of the study instrument was tested using Kaiser Meyer Olkin. The developed hypotheses, the reliability test was conducted based on the variables used in the study.

The table displays all of the reliability test results for the study's variables which are tested in accordance with the variables used in the study, served as the basis for the reliability test. All of the reliability test findings for the variables used in the study are displayed in the table. With four items, reliability values for backup systems, smart grid systems, renewable energy solutions, economical sustainability, social sustainability, and ecological sustainability were 0.847, 0.828, 0.758, 0.787, 0.870, and 0.813, respectively, while validity values for the variables were 0.689, 0.752, 0.793, 0.784, 0.709, and 0.715, respectively.The validity values were over 0.60, and those reliability results that are greater than 0.70, indicating that every item for every variable is dependable to accomplish the study's goals. According to Syakuro et al. (2024), the following standards are to be supported and applied when evaluating an internal consistency reliability coefficient: Cronbach's Alpha was used to measure internal consistency, with the interpretations of excellent (> 0.9), good is (> 0.8), acceptable is (> 0.7), questionable is (> 0.6), the poor (> 0.5), and the unacceptable (< 0.5). Upadhyaya and Malek (2024) support the idea that a validity value above 0.50 is good for further analysis.

IV. Data Analysis And Interpretation

A pre-estimation of the data test results was carried out to ensure that the assumptions were not broken. The test of linearity, the normality, and the multi-collinearity were performed. The following pre-estimation was carried out in order to accomplish the above goals, and the test's findings are shown below:

Table 2: Pre-Estimation Results of the Data

Variables	Skewness	Kurtosis	VIF	Backup Power	Smart Grid Integration	Renewable Energy Solution
Backup Power	0.270	0.293	3.199	1		
AuSmart Grid Integration	0.247	0.330	2.485	0.678(0.000)	1	
Renewable Energy Solution	0.213	0.316	2.644	0.455(0.000)	0.622(0.000)	1

(*Source:* Researcher's Field Survey, 2026)

The pre-estimation diagnostic results for the variables Backup Power, Smart Grid Integration, and Renewable Energy Solution are shown in the above table, with an emphasis on skewness, kurtosis, multicollinearity (VIF), and bivariate correlation (with p-values). All of the variables' skewness and kurtosis values, which range from 0.213 to 0.270 for skewness and 0.293 to 0.330 for kurtosis, show that the data are roughly regularly distributed. According to Gawali (2023), skewness is essentially a frequently used metric in descriptive statistics that reflects the asymmetry of a data distribution, whereas kurtosis specifies the heaviness of the distribution tails. This is relevant to the normality test of latent variables.The normality of data distributions is assessed using the skewness and kurtosis values. All variables were tested for normalcy using skewness and kurtosis. A basically normal distribution should have skewness and kurtosis between 0 and 1. The results of the normality test are shown here (Hair *et al.*, 2022). As a result, the data set's distribution is considered appropriate for additional parametric analyses like regression.

The independent variables, Backup Power (3.199), Smart Grid Integration (2.485), and Renewable Energy Solution (2.644), all have Variance Inflation Factor (VIF) values below the widely recognized threshold of 5.0, suggesting that multicollinearity is not an issue in the model. This is consistent with Kyriazos and Poga's (2023) assertion that collinearity is severe when it is less than 0.1, tolerance should be 0.1, and VIF should not be greater than 5.00. Multicollinearity is indicated by VIF scores more than 10 (Bhandari, 2023). The p-values in parenthesis show that all of the correlation coefficients between the variables are statistically important at the 1% level ($p < 0.01$). Specifically, there is a considerable correlation between Backup Power and Smart Grid Integration ($r = 0.678$), and there is a significant relationship between Renewable Energy Solution and both Backup Power ($r = 0.455$) and Smart Grid Integration ($r = 0.622$). These noteworthy and favorable correlations imply that innovation in electricity infrastructure tends to be interconnected and reinforces one another to influence the performance of SBs.

Test of Hypotheses

$H0_1$: Innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) have no significant effect on ecological sustainability of SBs in Ogun State Nigeria.

Model	Independent Variable	Coefficients	Std. Error	T-Statistic	P-Value
	(Constant)	11.524	1.630	7.072	.000
	Backup_ Power_ Systems	.634	.136	4.664	.000
	Smart_Grid_ Integration	.445	.093	4.787	.000

	Renewable_Energy_Solution	.399	.113	3.533	.001
	R-Square	0.498		F-Statistic	35.785
	Adjusted R-Squared	0.463		F-Statistic (P-value)	.000
	Dependent Variable: Ecological_Sustainability				

(*Source:* Researcher's Field Survey, 2026)

The above table shows the regression result between innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) and ecological sustainability of SBs in Ogun State Nigeria. It is discovered that 46.3% (0.463) of the changes that occur in the ecological sustainability of SBs are accountable to innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution). It showed that backup power system has a positive and significant effect on ecological sustainability (β=4.664; p=.000). Smart grid integration has a positive and significant effect on ecological sustainability (β=4.787; p=.000), and renewable energy solution has a positive and significant effect on ecological sustainability (β=3.533; p=.001). The f-statistic has a value of 35.785 with p=value 0.000 this proofed that the model is fit for study. Thus, the null hypothesis that innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) have no significant effect on ecological sustainability of SBs in Ogun State Nigeria is rejected.

H0$_2$: Innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) have no significant effect on economical sustainability of SBs in Ogun State Nigeria.

Model	Independent Variable	Coefficients	Std. Error	T-Statistic	P-Value
	(Constant)	19.639	3.843	5.113	.000
	Backup_ Power_ Systems	.865	.274	3.162	.000
	Smart_Grid_ Integration	.477	.128	3.729	.011
	Renewable_Energy_Solution	.680	.192	3.543	.000
	R-Square	0.487		F-Statistic	25.233
	Adjusted R-Squared	0.452		F-Statistic (P-value)	.002
	Dependent Variable: Economical_Sustainability				

(*Source:* Researcher's Field Survey, 2026)

The above table displayed the regression result between innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) and economical sustainability of SBs in Ogun State Nigeria. The study discovered that 45.2% (0.452) of the relation that occur in the economical sustainability of SBs are accountable to innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution). It showed that backup power system positively and significantly have effect on economical sustainability (β=3.162; p=.000). Smart grid integration has an affirmative and significant effect on ecological sustainability (β=3.729; p=.011), and renewable energy solution has a positive and significant effect on ecological sustainability (β=3.543; p=.000). The f-statistic has a value of 25.233 with p=value 0.000, this proofed that the model is fit for study. Thus, the null hypothesis that innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) have no significant effect on economic sustainability of SBs in Ogun State Nigeria is rejected.

H0$_3$: Innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) have no significant effect on and social sustainability of SBs in Ogun State Nigeria.

Model	Independent Variable	Coefficients	Std. Error	T-Statistic	P-Value
	(Constant)	17.417	2.621	6.647	.000
	Backup_ Power_ Systems	.745	.358	2.083	.002
	Smart_Grid_ Integration	.289	.098	2.950	.000
	Renewable_Energy_Solution	.139	.109	1.277	.000
	R-Square	0.498		F-Statistic	32.637
	Adjusted R-Squared	0.463		F-Statistic (P-value)	.000
	Dependent Variable: Social_Sustainability				

(*Source:* Researcher's Field Survey, 2026)

The above table shows the regression result between innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) and social sustainability of SBs in Ogun State Nigeria. It is affirmed that 46.3% (0.463) of the effect that occur in the social sustainability of SBs in Ogun State Nigeria are accountable to innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution). It signaled that backup power system has a supportive and significant effect on social sustainability (β=2.083; p=.002). Smart grid integration has an affirmative and significant effect on social sustainability (β=2.950; p=.000), and renewable energy solution has a positive and significant effect on social sustainability (β=1.277; p=.000). The f-statistic has a value of 32.637 with p=value

0.000, this means that the model is appropriate for study. Thus, the null hypothesis that innovations in electricity infrastructure (backup power systems, smart grid integration, and renewable energy solution) have no significant effect on social sustainability is rejected.

V. Conclusions

The study's objective is to probe how innovations in electricity infrastructure could influence the sustainability of SBs in Ogun State, and this has been achieved by asserting that backup power system, smart grid integration, and renewable energy solution as dimensions for innovations in electricity infrastructure has contributed to the ecological, economical as well as social sustainability of SBs in Ogun State. It is discovered that innovations in electricity infrastructure (backup power system, smart grid integration, and renewable energy solution) is one of the key resources needed that influences sustainability of SBs in Ogun State that are captured in this study. It concluded that innovations in electricity infrastructure is a determinant element in achieving desirable sustainability of SBs in Ogun State.

The study recommended that:

i. Due to epileptic nature of electricity, SB' owners in Ogun State should continue to display more and need to make provision backup power system for production/service.
ii. Government needs to finance transmission and distribution in order to digitalise and provide smart grid to boost energy to SB owners and industrial sector.
iii. The renewable energy solution should be encouraged and accepted to inculcate green sustainability by the nation to small business owners and others.

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