Energy Availability and Its Effect on Business Continuity and Environmental Sustainability of Small and Medium-Scale Enterprises in Rivers State

Njoku, Kelechukwu
Department of Economics,
Faculty of Social Sciences,
Rivers State University Nkpolu- Oroworukwu,
Port Harcourt, Nigeria
Kelechukwu.njoku@rsu.edu.ng 09169166127

Prof. D.B Ewubare
Department of Economics,
Faculty of Social Sciences,
Rivers State University Nkpolu- Oroworukwu,
Port Harcourt, Nigeria

Prof. C.G Nwikina
Department of Economics,
Faculty of Social Sciences,
Rivers State University, Nkpolu- Oroworukwu,
Port Harcourt, Nigeria

Prof. S.N Amadi
Department of Economics,
Faculty of Social Sciences,
Rivers State University Nkpolu- Oroworukwu,
Port Harcourt, Nigeria
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Abstract
This study investigates the effects of energy availability from different sources on business continuity and environmental sustainability of small and medium-scale enterprises in Rivers State. A population of 2,449 SMEs formed the study base, from which 400 respondents were selected using Cochran's sampling formula. The study employed a survey research design, while data were gathered using a structured self-designed questionnaire on a four-point Likert rating scale. Mean and standard deviation were used to analyse the research questions, while multiple regression, executed using SPSS (v.26), was used to test the hypotheses. The regression results showed that both fossil fuel generators and solar power have positive, statistically significant effects on business continuity and environmental sustainability, whereas grid power has a positive but statistically insignificant effect on both indicators. Energy cost, a major operational burden, demonstrated a positive, statistically significant relationship with business continuity but not with environmental sustainability. The study concludes that the adoption of solar power can materially

shape SME performance in Rivers State, particularly in relation to business continuity and environmental sustainability. It therefore recommends creating incentives to enhance solar power adoption among Small and medium-scale enterprises, as well as prioritizing grid expansion and modernization to reduce recurrent power failures and improve energy stability, thereby enhancing operational efficiency for SMEs in Rivers State.

Keywords: *Business Continuity, Environmental Sustainability, Energy stability, Energy cost*

1. Introduction

Small and medium-scale enterprises are widely acknowledged as the backbone of Nigeria's economy, driving economic growth, employment, and social development. In Nigeria, Small and medium-scale enterprises (SMEs) constitute about 96% of all businesses, contribute nearly 48–50% of the nation's Gross Domestic Product (GDP), and account for over 80% of total employment, highlighting their central role in economic stability and inclusion (Business Day, 2023; SMEDAN & NBS, 2021). These enterprises not only generate income and jobs but also support innovation, enhance local value chains, and foster rural–urban linkages across economic sectors. The sustainability of Small and medium-scale enterprises is defined as their ability to operate profitably over time while minimizing negative environmental and social impacts, and is increasingly important in contemporary economic planning. Sustainable Small and medium-scale enterprises can better withstand shocks, adapt to market changes, and meet environmental responsibilities, making them crucial players in advancing regional and national development goals. However, achieving sustainability requires reliable access to key productive resources, foremost among them stable and affordable energy (World Bank, 2022).

In many parts of Nigeria, including Rivers State, the national electricity supply remains erratic and unreliable. On average, grid-connected households and businesses in Nigeria experience frequent power outages, with firms reporting approximately 32.8 power interruptions per month, leading to significant production losses and reduced sales (Oyedepo et al., 2023). Furthermore, about 27% of Nigerian enterprises identify electricity reliability as their most severe business constraint, underscoring the depth of energy insecurity confronting the private sector (World Bank Enterprise Survey, 2023). The consequences of unreliable energy supply are felt acutely by SMEs. As a coping strategy, many businesses rely on self-generated power using petrol and diesel generators, with evidence showing that about 86% of Nigerian firms own or share generators to compensate for unstable grid electricity (Akinwale et al., 2022). This reliance substantially increases operating costs, with some studies estimating that SMEs may spend up to 40% of their total operational expenses on energy-related costs, particularly fuel and generator maintenance (Ecofin Agency, 2023). High energy expenditures erode profit margins, limit reinvestment opportunities, and weaken business competitiveness, thereby undermining both performance and long-term sustainability.

In Rivers State, where commercial activities coexist with industrial operations and energy-intensive enterprises, energy-related challenges are particularly pronounced. Empirical evidence indicates that energy availability, accessibility, and cost jointly account for about 50% of the variation in SME performance within the state. Frequent outages, rising fuel prices, and limited access to renewable energy technologies lead to production downtime, lost sales, and reduced operational efficiency. At the same time, growing environmental concerns and sustainability regulations pressure SMEs to adopt cleaner energy sources, despite limited institutional support and financing. Despite the critical importance of energy in shaping SME outcomes, empirical

studies that examine how different energy sources affect performance and sustainability at the sub-national level remain limited, particularly in Rivers State. Most existing research focuses on national energy supply or large-scale industries, overlooking the realities of localized SMEs in energy-constrained environments. This study, therefore, seeks to examine the effects of energy availability from different sources on the performance and sustainability of small and medium-scale enterprises in Rivers State, with an emphasis on business continuity and environmental sustainability.

Statement of Problem

Small and medium-scale enterprises constitute the backbone of Nigeria's economy, accounting for 96% of all businesses, contributing about 48–50% of national GDP, and providing over 80% of total employment (SMEDAN & NBS, 2021). Despite this critical role, the performance and sustainability of SMEs remain severely constrained by structural challenges, among which inadequate and unreliable energy supply is the most persistent. Energy is a fundamental input for production, service delivery, storage, and digital operations, yet Nigeria's power sector continues to underperform relative to the energy needs of its growing SME sector. Statistical evidence shows that Nigeria's average electricity generation fluctuates between 4,000 and 5,000 megawatts for a population exceeding 200 million people, resulting in one of the lowest per capita electricity consumption levels in Sub-Saharan Africa (World Bank, 2023). As a consequence, businesses experience frequent power outages, with firms reporting an average of 32.8 power interruptions per month, leading to production losses, idle labor hours, and reduced sales (Oyedepo et al., 2023). According to the World Bank Enterprise Survey (2023), 27% of Nigerian firms identify electricity as their biggest operational constraint, making energy insecurity a critical obstacle to business growth.

In Rivers State, where SMEs operate in energy-intensive commercial and industrial environments, the effects of unreliable electricity are particularly severe. To cope with power shortages, approximately 86% of Nigerian firms own or share petrol or diesel generators (Akinwale et al., 2022), and SMEs in Rivers State are no exception. The reliance on self-generated power has significant financial implications: studies indicate that Nigerian SMEs spend between 30% and 40% of their total operating costs on energy-related expenses, including fuel, generator maintenance, and repairs (Ecofin Agency, 2023). These high energy costs reduce profitability, limit reinvestment capacity, and weaken SMEs' competitiveness and survival chances. Beyond performance challenges, SMEs' sustainability is also threatened by their dependence on fossil-fuel-based energy sources. Diesel and petrol generators emit high levels of carbon dioxide, particulate matter, and noise pollution, contributing to environmental degradation and poor urban air quality. Nigeria is estimated to have over 22 million small generators in operation, collectively emitting more carbon annually than some small African countries (International Energy Agency, 2022). This environmental burden poses long-term risks to public health, regulatory compliance, and the sustainable operation of SMEs, especially in urbanized states such as Rivers State.

Despite the growing emphasis on renewable energy and sustainable business practices, access to clean energy solutions remains limited for SMEs. Less than 5% of Nigerian SMEs use renewable energy as their primary power source, largely due to high installation costs, lack of credit facilities, and weak policy incentives (REA, 2023). This creates a sustainability dilemma where SMEs are forced to prioritize short-term survival over long-term environmental responsibility. Although these challenges are well acknowledged at the national level, empirical studies examining how solar power affects business continuity and environmental sustainability at the state level,

particularly in Rivers State, remain scarce. The absence of localized evidence limits effective policymaking and weakens targeted interventions by government agencies, energy regulators, and SME support institutions. This gap underscores the need for a systematic investigation into the effect of energy available from different sources and its effect on the business continuity and environmental sustainability of small and medium-scale businesses in Rivers State, with a view to providing evidence-based recommendations that will promote sustainable energy adoption and support long-term economic development in Rivers State and Nigeria at large.

Objectives of the Study

The objective of this study is to examine the effect of energy availability on the performance of small and medium-sized enterprises in Rivers State. Specifically, the study seeks to:

i. Examine the role of energy availability on the business continuity of Small and Medium-scale Enterprises in Rivers State.

ii. Determine the contribution of energy availability to the environmental sustainability of Small and Medium-scale enterprises in Rivers State.

Research Questions

The following research questions are formulated to guide the study

i How does energy availability from different sources, such as grid, solar power, and fossil fuel generators, support the business continuity of Small and Medium-scale enterprises in Rivers State?

ii. Does energy availability from different sources support the environmental sustainability of Small and Medium-scale enterprises in Rivers State?

Research Hypotheses

The following hypotheses were formulated to guide the study in null form

H_{o1}: Energy availability does not support Business continuity for small and medium-sized enterprises in Rivers State.

H_{o2}: Energy availability does not significantly contribute to the environmental sustainability of Small and Medium Scale Enterprises in Rivers State.

2. Literature Review

Theoretical Literature

Early Economists view on Energy

Classical and neo-classical economists such as Smith (1776), Ricardo (1817), Say (1803), and Alfred Marshall (1890), known as the early economists, held that Land, Labour, and Capital are the primary factors of production. Energy was not considered an explicit factor of production capable of affecting the productivity of other factors of production, but rather, as the neo-classical economists conceived, is embedded in either land or capital as a secondary input. However, as industrialization deepened and economies became increasingly dependent on fossil fuels and electricity, critics argued that ignoring energy underestimated its central role in productivity, technological progress, and economic growth. For example, Cleveland et al. (1984) indicate that energy use in the United States of America accounts for much of the growth attributed to technological progress by Solow (1956) and Swan (1956). This position was echoed by Stern (2011) and Stresing et al. (2008), arguing that energy elasticity is significant and that omitting energy from the production function biases productivity estimates in neoclassical models.

Similarly, Kummel & Lindenberger (2020) expressed a strong view that the contributions of energy are understated in favour of technological progress.

These alternative positions were given further credence by the Oil shocks of 1970, which revealed that energy is not only important but also non-substitutable in the factors of production (Berndt & Wood, 1975). Some scholars, in a bid to make the neoclassical model more practical, have extended the Cobb-Douglas model into an energy–augmented model, incorporating energy as a primary factor of production (Ayres & Warr, 2005; Berndt & Wood, 1975).

This assertion has been tested by Lee et al. (2018) for Asian and African developing economies and found that energy consumption boosts firm productivity. This reaffirms that energy-augmented theory rather than the classical and neo-classical theories, is more relevant in developing economies like Nigeria, and especially for small and medium-scale enterprises, where unreliable energy supply disrupts operational efficiency of firms and impacts negatively on business continuity.

Energy as a Competitive Advantage

Following from the argument of energy-augmented theorists indicating that energy is not only an input but a master resource that enhances or limits the productivity of other factors of production, energy availability therefore introduces a dimension of competitive advantage for firms that have access to reliable, affordable and sustainable energy source. As introduced by Penrose (1959) and popularized by Birger Wernefelt (1984) and Jay Barney (1991), the Resource-Based View (RBV) theory posits that a company's competitive advantage depends on internal resources and capabilities rather than external conditions. RBV maintains that competitive advantage derives from the firm's tangible and intangible assets and can be achieved when firms have Valuable, Rare, Inimitable, and Non-substitutable assets or resources, otherwise known as the VRIN framework. These resources could be physical assets such as infrastructure, equipment or access to capital, or intangible assets such as patent rights, knowledge of a process, brand reputation or organizational culture or even capabilities that enables firms to integrate and deploy resources effectively; and that organizations that are able to leverage on these resources can not only gain competitive advantage but could outperform competitors on a sustained basis. This view is further supported by Peteraf (1993), Grant (1996), and Collins and Montgomery (1995). In this wise, firms with access to reliable energy sources such as uninterruptible power supply, steady generator power or solar power installations could bestow resilience and competitive advantages that others without such access could have.

Despite the criticisms of the RBV theory which include been too vague or difficult to measure empirically or a tautology problem where firms are successful because they hold unique assets or capabilities or that resources and capabilities are valuable because the firm is successful (Priem & Bulter, 2001a & b,), the theory is still relevant in analyzing energy availability on business continuity and environmental sustainability of SMEs in Rivers State, as it provides a framework for understanding how firms possessing the unique capability or superior combination of power supply can solve their electricity challenge, which has become a perennial problem in Nigeria; and in the same vein become a competitive edge, providing economic advantages and opportunities for business expansion, resilience, business continuity and environmental sustainability.

Conceptual Literature

Energy Sources

Energy sources represent the lifeblood of modern civilization, forming the foundation upon which economic activities, technological advancement, and human welfare depend. In its broadest sense, an energy source refers to any naturally occurring resource or physical process that can be harnessed and converted into usable power to drive production, transportation, communication, and household activities. As the world grapples with climate change, energy insecurity, and sustainable development challenges, the conceptualization of energy sources has evolved beyond mere fuel supply to encompass environmental responsibility, economic resilience, and intergenerational equity. According to the International Energy Agency (IEA, 2023), an energy source is defined as a primary resource available in nature that can be transformed into energy services through technological processes. This definition emphasizes the transformation role of technology in converting raw natural inputs into usable forms of energy for society. Similarly, Sovacool (2022) conceptualizes energy sources as the natural foundations of energy systems that shape economic growth, environmental quality, and social inclusion, highlighting their strategic importance in development planning. From an environmental economics perspective, Owusu and Asumadu-Sarkodie (2024) describe energy sources as natural endowments that provide power for human activities but differ in renewability, environmental impact, and long-term sustainability, stressing the trade-offs policymakers face when choosing among them. Furthermore, UN-Energy (2023) expands the concept by viewing energy sources as critical enablers of the Sustainable Development Goals, linking access to energy to poverty reduction, health improvement, industrialization, and climate action.

Within this framework, energy sources are not only physical resources but also economic inputs, environmental determinants, and instruments of social development. Their availability, affordability, and sustainability directly influence productivity, income generation, and quality of life, particularly in developing economies.

Small and Medium Scale Enterprises

Small and Medium Scale Enterprises (SMEs) remain a cornerstone of modern economic growth and development, particularly in emerging economies such as Nigeria, where they serve as engines of innovation, employment, and income generation. Scholars and institutions have defined Small and Medium Scale Enterprises in varying ways, reflecting differences in context, measurement, and developmental priorities. According to the Small and Medium Enterprises Development Agency of Nigeria (SMEDAN, 2022), Small and Medium Scale Enterprises (SMEs) are businesses with employment capacities ranging from 10 to 199 workers and asset bases (excluding land and buildings) ranging from ₦5 million to ₦500 million. Similarly, the Central Bank of Nigeria (CBN, 2021) defines Small and Medium Scale Enterprises (SMEs) by their scale of operations, with small enterprises categorized as firms employing between 10 and 49 staff with assets of ₦5 million to ₦50 million, while medium enterprises employ between 50 and 199 staff with assets of up to ₦500 million.

Empirical Literature

Boma-Orawari & Opuala-Charles (2025). The study conducted a cross-sectional survey of 70 information technology SMEs and assessed the relationship between renewable energy technology adoption and firm performance. Using quantitative survey instruments and regression analysis, they found strong positive associations between renewable energy adoption variables, attitudes,

perceived usefulness, and ease of use, and SME performance outcomes such as service delivery efficiency and profitability. Importantly, firm size was found to moderate these relationships, suggesting that larger SMEs were better positioned to benefit from renewable technologies. Although the study framed its scope broadly, in practice, it largely reflected solar photovoltaic (PV) adoption, as solar is the most accessible renewable option in the local SME context. This study thus provides preliminary but important evidence that renewable adoption can improve SME performance in Rivers State.

Owusu-Sekyere et al (2024) published in *Energy Policy*. The authors employed a large sample of 700 micro, small, and medium-sized enterprises (MSMEs) across Lagos, Kano, and Ondo states and applied propensity score matching (PSM) to estimate the treatment effects of solar adoption. The results showed that solar adoption increased MSME monthly earnings by approximately 23–27% while reducing energy expenditures by approximately 36.6%. These effects were consistent across nearest-neighbor, kernel, and radius matching methods, lending robustness to the findings. This study provides the strongest empirical evidence to date in Nigeria on the direct causal impact of solar adoption on SME financial outcomes. Although not based in Rivers State, the grid unreliability and diesel dependency in Lagos and Kano are highly comparable to those in Rivers, making the findings relevant.

Musa and Ibrahim (2023) assessed Solar electricity adoption and Small and Medium-scale Enterprises revenue generation in Kano State, where independent variables included cost of solar technology, government incentives, and awareness levels, while Small and Medium-scale Enterprises revenue generation was the dependent variable. The study employed survey questionnaires administered to 250 Small and medium-scale Enterprises and used regression analysis for interpretation. Findings revealed that firms with solar installations experienced higher sales revenue and longer operational hours, concluding that renewable electricity is a strategic tool for revenue maximization in Nigeria's Small and Medium-scale Enterprises sector.

Okafor and Bello (2023) investigated Number of solar panels and SME growth in Enugu State, with independent variables including panels installed, energy generation, and reliability, and dependent variable as business growth. Data were collected from 180 SMEs via structured questionnaires and analyzed using multiple regression. Results showed that increased panel installations facilitated expansion and improved operational efficiency, concluding that the number of solar panels is a strategic enabler of SME growth.

Chukwu and Ibrahim (2021) investigated Renewable electricity adoption and operational performance of SMEs in Abuja, with solar adoption, reliability, and cost-effectiveness as independent variables and operational performance as the dependent variable. Using survey data from 220 SMEs and analyzed through correlation and regression techniques, the study found that reliable solar electricity reduced downtime and improved customer satisfaction, leading to the conclusion that renewables enhance firm survival.

Eze and Adeyemi (2021) investigated the relationship between electricity generation and employment levels in SMEs in Abuja, using electricity generated, hours of supply, and reliability as independent variables and the number of employees as the dependent variable. Data were gathered from 180 SMEs using questionnaires and analyzed using regression analysis. Results revealed that increased electricity generation allowed firms to hire more staff and optimize labor utilization, concluding that electricity generation positively affects employment in SMEs.

Ogunleye and Okafor (2020) examined Solar-generated electricity and SME expansion in Northern Nigeria, using independent variables of kWh generated, system efficiency, and supply duration, while expansion rate was the dependent variable. Data were collected via structured

questionnaires from 200 SMEs and analyzed using structural equation modeling. Findings demonstrated that higher electricity output correlated with increased capacity to expand operations, concluding that generation capacity is a growth enabler for SMEs.

Olatunji and Adedoyin (2019) examined the broader impact of power supply on SME performance in Port Harcourt. Using a survey design, they regressed SME performance indicators, profitability, productivity, revenue, and losses in storage on power-supply variables, including public supply duration, electricity bills, and private generation costs. The results showed that lower public power duration significantly reduced profitability and productivity, while higher generator costs were strongly correlated with adverse performance outcomes. Although the study did not directly examine solar adoption, the evidence strongly implies that alternatives such as solar could offset these energy-related constraints. This aligns with the proposition that solar adoption offers SMEs cost savings, reliability, and enhanced productivity, thereby contributing to business sustainability in Rivers State.

Nwosu and Bello (2019) explored Electricity generation and business resilience among SMEs in Enugu, using generation capacity, supply stability, and energy storage as independent variables and business resilience as the dependent variable. Data were obtained from 170 SMEs through surveys and analyzed with panel regression. Findings indicated that SMEs with higher electricity generation experienced fewer disruptions during outages, concluding that electricity generation enhances operational stability.

Okoro and Musa (2018) assessed the role of solar panel quantity in SME expansion in Ogun State, using the number of panels installed, total kW capacity, and supply reliability as independent variables, and business expansion rate as the dependent variable. Structured questionnaires were administered to 210 SMEs and analyzed using multiple regression. Results showed that SMEs with higher panel installations were more likely to expand operations, concluding that panel quantity supports enterprise growth.

Ibrahim and Nwachukwu (2016) investigated the effect of solar electricity duration on small business output in Northern Nigeria, with independent variables of supply duration, peak hours, and reliability, and a dependent variable of output level. Data from 200 SMEs were analyzed using ordinary least squares regression. Results indicated a significant positive relationship between longer electricity duration and production output, concluding that supply duration drives SME performance.

Moyo's (2012) findings indicated that electricity supply has a negative and significant effect on manufacturing firms' productivity in Nigeria, especially for SMEs. Udoinyang & Daniel (2024) and Nkoro et al. (2019) conducted studies that found negative and significant effects of unreliable power sources on the productivity and profitability of small and medium-scale enterprises, even in Rivers State. Furthermore,

Gaps and Value Addition

Empirical studies in Nigeria and other developing economies have consistently demonstrated that energy availability and reliability are critical determinants of small and medium-scale enterprises performance and survival. Evidence by Moyo (2012) revealed that unreliable electricity supply has a negative and significant effect on the productivity of manufacturing firms, particularly SMEs, establishing energy as a fundamental production constraint. Similarly, Nkoro et al. (2019) and Udoinyang & Daniel (2024) found that unstable power supply significantly reduces SME productivity and profitability, even within Rivers State, reinforcing the centrality of energy reliability to enterprise performance. Building on this, a large body of literature has focused

predominantly on solar electricity adoption as a coping mechanism for unreliable grid power. For instance, Adebayo and Okoro (2015) and Ibrahim and Nwachukwu (2016) showed that longer duration and consistency of solar electricity supply significantly improve SME operational efficiency and output levels. Likewise, Okoro and Musa (2018), Ogunleye and Okafor (2020), and Okafor and Bello (2023) found that the number of solar panels installed and electricity generation capacity positively influence SME expansion and growth. These findings collectively confirm that solar-based electricity enhances SME productivity and operational scale.

More recent studies have extended the performance discourse to revenue and firm growth. Musa and Ibrahim (2023) demonstrated that solar electricity adoption increases sales revenue and operational hours among SMEs in Kano State, while Owusu-Sekyere, Cissé, and Achandi (2024), using robust propensity-score matching techniques, found that solar adoption raised MSME earnings by 23–27% and reduced energy expenditures by 36.6% across Lagos, Kano, and Ondo States. These results provide strong causal evidence of the financial benefits of renewable energy adoption. Similarly, Boma-Orawari and Opuala-Charles (2025), focusing on Rivers State, confirmed that the adoption of renewable (largely solar) energy significantly improves SME service delivery efficiency and profitability, particularly among larger firms.

However, despite the richness of this literature, three critical gaps remain unresolved. First, existing studies overwhelmingly concentrate on solar energy alone, treating renewable adoption as a single-energy solution, while neglecting the reality that most SMEs in Rivers State operate under mixed energy regimes. In practice, SMEs simultaneously rely on grid electricity, diesel or petrol generators, solar systems, and hybrid combinations, yet no study has systematically compared the relative and combined effects of these multiple energy sources on SME performance and sustainability outcomes. Second, the majority of studies conceptualize SME performance narrowly in terms of profitability, output, or expansion, with limited attention to business continuity, which is critical in energy-volatile environments such as Rivers State. Although Nwosu and Bello (2019) linked electricity generation to business resilience, their focus remained on generation capacity rather than energy-source composition. Thus, the literature lacks empirical evidence on how different energy sources influence SMEs' ability to sustain operations during outages, shocks, and energy disruptions.

Third, and most importantly, environmental sustainability remains largely absent from existing empirical studies. While the literature acknowledges the economic benefits of solar adoption, it rarely integrates environmental sustainability outcomes, such as emissions reductions, cleaner production, and energy efficiency. This omission is particularly striking in Rivers State, where diesel generators dominate SME energy use and contribute significantly to local pollution. Even studies conducted in Port Harcourt (e.g., Olatunji & Adedoyin, 2019) emphasized generator costs and productivity losses but did not assess environmental impacts or compare cleaner alternatives, such as solar or hybrid systems. Consequently, the empirical literature presents a fragmented understanding of energy–SME dynamics, focusing either on solar energy or short-term financial performance, while ignoring energy diversification, sustainability, and long-term business continuity, especially at the sub-national level. This study, therefore, fills a significant gap by simultaneously examining solar, generator, grid, and hybrid energy sources and linking them to business continuity, sales growth, and environmental sustainability among SMEs in Rivers State. By doing so, it extends existing knowledge beyond single-energy analysis and short-term performance, offering a holistic and context-specific framework for understanding how energy choices shape SME performance and sustainability in Nigeria's energy-constrained economy.

3. Methodology

The study focused on the three senatorial zones of Rivers State and adopted a survey research method to capture the qualitative experiences of SME owners and Managers. The survey method is appropriate when results are expected to be measurable, comparable, and generalizable (Creswell & Plano, 2018). The motivation for the study was to examine the specific effect of energy availability on business continuity and environmental sustainability among SME operators in Rivers State. The study adopted a survey research design, and data was collected from representative SMEs from the selected local governments of the senatorial zones.

Population of Study

The population of this paper comprises all SMEs operating in Rivers State, both registered and unregistered, that have been in existence for at least 12 months and use electricity in their core operations. This list was compiled from the Small and Medium Enterprises Development Association (SMEDAN), Rivers State; the Rivers State chapter of the Manufacturers Association of Nigeria (MAN); and Market and Cluster Associations. The accessible population for the study, however, was determined by SMEs contacted during the data-collection window, selected from three local governments in each of the identified senatorial zones, giving a sample frame of nine (9) Local Governments. Selected local governments included Port Harcourt City, Obio-Akpor, and Okirika in the Rivers East senatorial zone; Ogba/Egbema/Ndoni, Abua-Odual, and Degema in the Rivers West senatorial zone; and Gokanna, Andoni, and Eleme in the Rivers Southeast senatorial zone.

Sampling Technique and Sample Size

The sampling technique adopted for this study was multi-stage sampling, in which samples were drawn from three local governments in each of the three senatorial zones of Rivers East, Rivers West, and Rivers Southeast. The focus within the selected local governments was on SMEs operating in energy-intensive sectors such as Manufacturing, Agro-processing, Hospitality, ICT, Trading/Retail, and Services. A total of 400 owners and managers of SMEs were selected using Cochran's (1977) method in proportion to the registered SMEs (SMEDAN/NBS, 2022) within the Local Governments.

Sources of Data

The study gathered data through a self-designed questionnaire developed around the study variables, which was administered on a four-point Likert scale to allow respondents to express varying levels of agreement or disagreement in a measurable form, thereby enhancing the accuracy and comparability of responses. Respondents were from the selected local governments of Port Harcourt City, Obio-Akpor, Okirika, Ogba/Egbema/Ndoni, Abua-Odual, Degema, Gokanna, Andoni, and Eleme.

Data Analysis Method

The gathered information was subjected to descriptive and analytical methods. Analysis was conducted using the mean and standard deviation to answer the various research questions, while multiple regression was used to test the hypotheses in the Statistical Package for Social Sciences (SPSS 26) at the 0.05 level of significance.

The aggregate mean score from responses of the multiple Likert-scale questionnaire measuring the same construct was used to generate the composite scores suitable for regression analysis (Carifio

& Perla, 2008; Hair et al., 2019) after a reliability test using Cronbach's alpha (Nunnally & Bernstein, 1994) confirmed a Cronbach's alpha score of 0.8.

Model Specification

SMEs performance =f (Energy sources)

Where Performance is measured by (Business Continuity and Environmental Sustainability). And energy sources are indicated (Grid, Generator, Solar); using ENR and ECS as control variables.

Model 1: Business Continuity Model

$BCN = f(GRD, GEN, SOL, ENR, ECS)$

$BCN = f\,\Theta o + \Theta 1\ GRD + \Theta 2,\ GEN + \Theta 3\ SOL + \Theta 4\ ENR + \Theta 5\ ECS_i + \varepsilon_i$

Where;

BCN = Business Continuity, **GRD** = Grid, **GEN** = Generator, **SOL** = Solar, **ENR** = Energy Reliability, **ECS** = Energy Cost, Θ 1 -5 = measurable elasticities/propensities of the variables and εi = *Error term*

Model 2: Environmental Sustainability (ES) Model

$ENS = f(GRD, GEN, SOL, ENR, ECS)$

$ENS = f\,¥o + ¥1\ GRD + ¥2,\ GEN + ¥3\ SOL + ¥4\ ENR + ¥5\ ECS_i + \varepsilon_i$

Where;

ENS = Environmental Sustainability, **GRD** = Grid, **GEN** = Generator, **SOL** = Solar, **ENR** = Energy Reliability

ECS = Energy Cost, ¥1 -5 = measurable elasticities/propensities of the variables and εi = *Error term*

Research Hypotheses

Research hypotheses formulated in the null are given by:

Ho_1: Energy availability do not significantly affect business continuity of SMEs in Rivers State.

Ho_2: Energy availability does not significantly affect the environmental sustainability of SMEs in Rivers State.

Data Presentation Analysis and Discussion of Findings

To address the objectives of the study, the study used aggregate mean scores and standard deviations to answer the research questions, and Statistical Package for Social Sciences (SPSS V.26) was used to test the hypotheses. Data analysis was conducted using tables, descriptive statistics, and multiple regression analysis.

Questionnaire response rate

The questionnaire response rate refers to the number of questionnaires retrieved from respondents divided by the total number of questionnaires distributed. This was expressed in the form of a percentage. Out of the total 400 questionnaires distributed, 339 were retrieved (85%) while 61(25%) were not returned. Therefore, the response rate in this study was considered good for the purpose of the study as shown in table 1. Other demographic data such as gender, age etc are represented in the tables below:

Table 1: Response Rate of Respondents

Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Returned	339	80.7	84.7	84.7
Not Returned	61	19.3	15.3	100.0
Total	400	100.0	100.0	

Source: Field survey, 2025

Table 2: Gender Distribution

Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Male	181	53.4	53.4	53.4
Female	158	46.6	46.6	100.0
Total	339	100.0	100.0	

Source: Field Survey, 2025

Table 3: Age Bracket

Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Below 25 Years	23	6.8	6.8	6.8
26-35 Years	118	34.8	34.8	41.6
36-45 Years	123	36.3	36.3	77.9
46-55 Years	55	16.2	16.2	94.1
56 & Above	20	5.9	5.9	100.0
Total	339	100.0	100.0	

Source: Field Survey, 2025

Table 4: Educational Qualification

Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Primary	17	5.0	5.0	5.0
Secondary	104	30.7	30.7	35.7
Graduate	183	54.0	54.0	89.7
Post Graduate	35	10.3	10.3	100.0
Total	339	100.0	100.0	

Source: Field Survey, 2025

Table 5: Nature of Business

Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Manufacturing	46	13.6	13.6	13.6
Trading/Retail	108	31.9	31.9	45.4
Service	107	31.6	31.6	77.0
Hospitality	56	16.5	16.5	93.5
Agro-Processing	22	6.5	6.5	100.0
Total	339	100.0	100.0	

Source: Field Survey, 2025

Table 6: Number of Employees

Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
11-49 Employees	303	89.4	89.4	89.4
50-199 Employees	23	6.8	6.8	96.2
Not Applicable	13	3.8	3.8	100.0
Total	339	100.0	100.0	

Source: Field Survey, 2025

Table 7: Responses from selected Local Governments

Category	Frequency	Percentage (%)	Valid Percentage (%)	Cumulative Percentage (%)
Port Harcourt	70	20.6	20.6	20.6
Obio/Akpor	54	15.9	15.9	36.6
Okrika	33	9.7	9.7	46.3
Degema	24	7.1	7.1	53.4
Abua	33	9.7	9.7	63.1
Gokana	21	6.2	6.2	69.3
Andoni	39	11.5	11.5	80.8
Ogba/Ngbema/Ndoni	65	19.2	19.2	100.0
Total	339	100.0	100.0	

Source: Field Survey, 2025

Table 8: Research Questions

S/N	Research questions	Aggregate Mean score	Standard deviation	Remark
1	Does the energy source *(Grid, Generator, Solar)* support the business continuity of Small and Medium-scale enterprises in Rivers State?	2.9	0.9	Agreed
2	To what extent do energy sources (Grid, Generator, Solar, hybrid) contribute to environmental sustainability for Small and Medium-scale enterprises in Rivers State?	3.2	0.7	Agreed

Criterion Mean: ≥ 2.5; STD ≤ 1.0
Source: Author's computation, 2025.

The analysis of respondents' perceptions underscores the importance of energy availability in influencing business continuity and environmental sustainability of SMEs in Rivers State. The aggregate mean scores of 2.9 and 3.2 for business continuity and environmental sustainability, respectively, exceeded the benchmark mean criterion of 2.5 and STD of 1, indicating that energy availability and diversified energy sources - whether grid, generator, solar, or hybrid—play a decisive role in ensuring uninterrupted business operations. This finding underscores the economic reality that consistent energy availability reduces operational disruptions, mitigates production downtime, and enhances resilience. Similarly, energy available and its sources also, is widely recognized as a crucial determinant of eco-friendly business operations. This finding provides a key economic insight that sustainable energy access not only reduces operational inefficiencies but also aligns business growth with environmental stewardship, ultimately supporting the long-term economic resilience of SMEs in Rivers State.

Hypotheses Testing

The hypothesis of this study which hinges on the effect of energy availability on business continuity and environmental sustainability, was tested using SPSS V.26. The decision to accept or reject the null hypothesis was based on calculated test statistics and significance levels. The result provided empirical evidence that supported or contradicted the assumptions underlying the study.

Hypothesis 1: Test result on the multiple regression between energy availability and business continuity of SMEs in Rivers State.

Variable	Unstandardized Coefficient (B)	Std. Error	Unstandardized Beta (B)	t-Statistics	Sig (P-value)
(Constant)	786	.158		4.963	.000
GRD	.091	.156	.068	.588	.557
GEN	.526	.139	.396	3.792	.000
SOL	.491	.116	.432	4.236	.000
ENR	-.149	.230	-.114	-.647	.518
ECS	.563	.225	.089	2.506	.013
Adj R^2 0.71, F-Stat 172.180 (0.000)					

Dependent Variable = Business Contiguity

The regression results unveil an insightful economic perspective on how energy availability shape the business continuity of Small and Medium Scale Enterprises in Rivers State. With an Adjusted R^2 of 0.71, the model shows that 71% of the variation in business continuity is explained by the nature and quality of energy sources available to enterprises, indicating that access to reliable energy is one of the strongest determinants of long-term business survival. The F-statistic of 172.180 and a p-value of 0.000 further affirms that the model is highly significant and economically compelling, indicating that energy availability from different sources collectively exerts a powerful influence on whether businesses remain operational and resilient over time.

However, continuity depends on the energy mix a business relies on. Grid electricity for example, is positive, yet not statistically meaningful lending the credence to the fact that although public power supply has the potential to enhance continuity, irregular distribution, instability and high downtimes weaken its ability to sustain operations. This suggests that while the grid remains a desirable option, its reliability gap prevents it from being a strong economic pillar of business survival.

Fossil fuel Generator on the other-hand, tells a different story. With a significant positive coefficient of 0.526, generator energy appears to play a stabilizing role in business operations. Despite being a costly substitute for public power, the ability to generate electricity on demand seems to safeguard productivity, minimize downtime, and keep businesses active even during blackouts. Economically, generator access functions as a coping mechanism — firms that power themselves remain operational while those without power are forced to halt production.

Solar power energy emerges as a powerful driver of continuity, showing a coefficient of 0.491 with high statistical significance. This indicates that renewable energy adoption is rapidly becoming a survival strategy for modern SMEs. Solar power reduces dependence on unstable grid supply, eliminates fuel scarcity shocks, lowers long-run energy costs and ensures steady operational flow. The result reflects a structural transition — firms integrating renewable energy systems are better positioned to remain productive, competitive and sustainable.

Energy cost also shows a significant positive effect at 0.563, suggesting that as energy costs rise, businesses may actively adopt smarter consumption patterns, reduce waste, improve energy efficiency or invest in alternative energy sources. While higher costs typically discourage productivity, here it appears to stimulate innovation and adaptive resilience, enabling continuity rather than weakening it.

Energy reliability, however, presents a negative but insignificant coefficient, showing that fluctuations in reliability do not strongly predict continuity within this sample. This may suggest that firms have already adapted to instability by diversifying energy sources, particularly through generators and emerging solar systems, reducing the sensitivity of continuity to reliability alone.

Hypothesis 2: Test result on the multiple regression between energy availability and environmental sustainability of SMEs in Rivers State.

Variable	Unstandardized Coefficient (B)	Std. Error	Unstandardized Beta (B)	t-Statistics	Sig (P-value)
(Constant)	.318S	.092		.465	.002
GRD	.145	.091	.136	1.594	.112
GEN	.492	.081	.466	6.075	.000
SOL	.409	.068	.454	6.058	.000
ENR	-.117	.134	-.113	-.875	.382
ECS	.004	.131	.004	.031	.975
Adj R^2 0.85, F-Stat 375.8-2 (0.000)					

Dependent Variable = Environmental Sustainability

The regression results provide a striking economic insight into how energy sources shape environmental sustainability among Small and Medium-Scale Enterprises in Rivers State. With an Adjusted R^2 of 0.85, the model explains a remarkable 85% of the variation in environmental sustainability, revealing that the type, quality and pattern of energy consumption have a profound influence on how environmentally friendly business operations become. The F-statistic, significant at 0.000, confirms the robustness of the model, meaning that the selected energy variables jointly have the power to determine whether SMEs operate sustainably or contribute to environmental degradation.

Grid power carries a positive but statistically insignificant coefficient, suggesting that access to public electricity can support environmentally friendly operations but has not yet translated into tangible ecological outcomes. This may be due to inefficiencies in grid supply, reliance on fossil fuels, or unstable voltage patterns, which mean that grid electricity does not currently offer SMEs a strong platform for cleaner production.

Generator usage tells a different story — with a significant coefficient of 0.492, generators appear to influence sustainability, even though they are known to rely on fossil fuels. This may signal that firms using generators adopt emission-moderating practices, energy-efficient equipment, or improved waste management to cushion the environmental burden. In economic terms, generator-dependent SMEs may respond to cost pressures by optimizing energy use, reducing waste, and improving fuel efficiency, thereby indirectly enhancing sustainability.

Solar energy emerges as a clear leader, showing a significant coefficient of 0.409, suggesting that renewable energy provides a more environmentally responsible pathway for SMEs. Solar adoption reduces carbon emission intensity, minimizes atmospheric pollution, and promotes cleaner long-run production cycles. The result signals that renewables are becoming a transformative force for eco-friendly business growth, helping firms decouple productivity from environmental harm.

Energy reliability, however, presents a negative and insignificant coefficient, indicating that fluctuations in supply reliability do not strongly determine sustainability outcomes. This may reflect a shift in which SMEs have learned to adapt through hybrid systems, reducing reliance on reliability alone as a sustainability driver. Energy cost also shows no meaningful effect, implying that high or low energy expenses do not directly determine environmental behaviour in this model. Firms may focus more on survival and production efficiency than on ecological performance when responding to cost changes.

Discussion of Findings

The findings of this study provide robust empirical evidence of the profound influence of energy availability and its sources on the performance of small and medium-scale enterprises in terms of business continuity and environmental sustainability in Rivers State. The analysis across multiple dimensions demonstrates that energy availability, type, reliability, and cost are not merely operational factors but critical economic levers shaping SMEs' overall efficiency, resilience, and growth potential.

Energy sources, whether grid, generators, solar power installations, or their hybrids, play a pivotal role in business continuity. With an Adjusted R^2 of 0.71, the regression results indicate that 71% of the variation in business continuity is explained by energy access and energy type. Firms equipped with generators and solar systems demonstrate enhanced resilience, maintaining production cycles even amidst grid unreliability. Economically, this positions energy as a form of operational insurance, enabling SMEs with alternative energy sources to withstand supply shocks, minimize downtime, and safeguard market position. The positive influence of energy costs on business continuity suggests that financial pressures from higher energy expenses can stimulate adaptive strategies, such as investing in efficient equipment or adopting hybrid systems, ultimately sustaining operations in a competitive environment.

Similarly, energy sources are shown to have a transformative effect on environmental sustainability. With an Adjusted R^2 of 0.85. Solar energy, in particular, emerges as a statistically significant and environmentally advantageous energy source, reducing carbon intensity and promoting cleaner production cycles. While generator use is traditionally a high-emission energy option, the positive sustainability coefficient suggests that SMEs may adopt complementary measures—such as energy-efficient equipment or optimized fuel use to mitigate environmental impact. Grid electricity, energy reliability, and energy cost demonstrate limited or insignificant effects, highlighting the need for targeted policies to align energy consumption with sustainable practices.

The findings of this study further corroborate those of Boma-Oruwari & Opuala Charles (2025), Musa & Ibrahim (2023), and Olatunji & Adedoyin (2019) on the importance of energy availability and business continuity across different geographies.

5. Conclusion and Recommendation

Conclusion

The study concludes that energy availability significantly determines SMEs' performance trajectory, especially in business continuity and environmental sustainability, in Rivers State. Enterprises that depend solely on the national grid experience frequent operational disruptions, whereas those that rely on fossil-fuel generators or adopt solar power achieve greater business continuity and environmental sustainability. Solar power, therefore, becomes an instrument for SMEs to demonstrate environmental stewardship while enhancing operational resilience.

Recommendations

i. Port Harcourt Electricity Distribution Company (PHED) should implement scheduled supply patterns, faster fault response systems, and transparent billing structures to restore business confidence.

ii. Rivers State Ministry of Commerce and Industry should introduce incentives such as tax rebates for SMEs transitioning to renewable energy sources.

iii. Rivers State Microfinance Agency (RIMA) should offer low-interest energy-transition loans enabling firms to acquire solar, hybrid, and storage systems without financial strain.

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