DETERMINANTS OF GREEN ENERGY UTILIZATION AMONG SMALL AND MEDIUM-SIZED ENTERPRISES IN EKITI STATE, NIGERIA

Ayotunde Ola Kolawole[1,2], Sylvester Oluwadare Ojo[1], Samuel Adeyemi Igbatayo[1], Isaiah Oluwatobi Owolabi[3], Abimbola Moji Ezekiel[4], Kamal Adekunle Abdu-Raheem[2] and Moyinoluwa Folaranmi Adesakin[2]

[1]*College of Sciences, Department of Agricultural Sciences, Afe Babalola University, Ado-Ekiti Nigeria*

[2]*Department of Agricultural Economic & Extension Services, Ekiti State University, Ado-Ekiti Nigeria*

[3]*HACEY Health Initiatives, Lagos State, Nigeria*

[4]*Department of Agricultural Science and Technology, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, Nigeria*

ABSTRACT

The increasing need for sustainable energy options in Nigeria has highlighted the opportunities that green energy presents for enhancing environmental resilience and economic effectiveness, particularly for small and medium-sized enterprises (SMEs). This study investigated the determinants of green energy adoption among SMEs in Ekiti State, Nigeria. Primary data was obtained from 320 participants through a well-structured questionnaire. The data was analysed using descriptive and inferential statistics. The significant factors that influenced the utilization of solar energy by small business owners were the average monthly estimated power costs (-6.211E-005), the average cost of wiring a small firm's production environment (1.934E-005), and the BEDC service support rating (1.806). SMEs experienced an abnormally high rate of inaccurate billing (90%) from the power distribution company (BEDC) and unreliable power supply (89%) with less than 4 hours of energy each day. The t-test results indicate a significant difference in green energy investment between agricultural and non-agricultural SMEs.

This study suggests that the Ekiti State government should actively stimulate the growth of green energy among SMEs by fostering public-private partnerships. These findings contribute to the discourse on clean energy adoption and provide practical insights for policymakers aiming to scale green energy solutions in Nigeria's entrepreneurial landscape.

Keywords: Green Energy, Energy Use, Small and Medium Enterprises (SMEs) and Greenhouse Gas (GHG)

JEL classification: **????**

1. Introduction

Small and medium-sized enterprises (SMEs) in Nigeria are not operating at their optimal level due to the unstable power supply from the national grid and the high cost of alternative power provision from green energy sources and power generating sets (Adanlawo & Vezi-Magigaba, 2021; Anaba & Olubusoye, 2021; Peffley & Pearce, 2020). Infrequent**[Frequent?]** power outages have hindered the growth and development of existing SMEs and discouraged new entrants into business (Haleem et al., 2019).

Considering the economic activities of SMEs and road users, fossil fuel is a major source of power to drive their businesses for growth, profitability, and sustainability (Endris & Kassegn, 2022). Studies have revealed that most SMEs in developing economies rely on green energy from solar and non-renewable power from diesel and petrol generators due to erratic power supply (Saad et al., 2022).

Several SDG targets include climate action, responsible consumption and production, and achieving net-zero carbon emissions for sustainable development by 2060. These include goals for the environment, economic growth, climate change, sustainable cities, and inexpensive, clean energy. SMEs contribute significantly to the global economy, and their actions can significantly impact the environment. More GHG emissions from manufacturing, forestry, agriculture, transportation, and energy production have come from SMEs and cars that use fossil fuels for production and services (Tongwane & Moeletsi, 2018).

Even though the SMEs employed the most people, their liquidation suggests rising unemployment and declining government revenue. Those that were still in operation may have shifted to using diesel or gasoline-powered generators and green energy, such as solar or wind power. The activities of SMEs necessitate partial mitigation of the atmosphere, as the carbon emissions from generators contribute to global warming. For certain SMEs, particularly those in production and manufacturing that may require powerful machinery, the expense of using green energy as an abatement technique to protect the environment may be prohibitive.

The SMEs play a crucial role in fostering economic development and job creation in Nigeria; however, many still depend on fossil fuels and inconsistent grid power for their operations. Although green energy technologies and their associated environmental advantages are growing, SMEs in Ekiti State have shown limited adoption of these solutions. This lack of utilization stems from a complicated interplay of socioeconomic, financial, and institutional factors that existing policies and practices have not yet fully understood or effectively addressed. Without solid empirical data regarding the factors that promote or obstruct the adoption of green energy, efforts to facilitate the transition to clean energy in the SME sector may fall short. Consequently, this study aims to identify and examine the primary factors that affect the use of green energy among SMEs in Ekiti State to guide focused interventions and the development of sustainable energy policies.

Specifically, this study categorized the SMEs in the study area, described the socio-economic profile of SME operators, identified the recommended green energy technologies for reducing greenhouse emissions, determined the factors influencing SMEs' use of green energy, and ascertained the constraints to the use of electricity from the national grid and green energy. The study further hypothesized that agricultural SMEs' investments in green energy are significantly different from those of non-agricultural SMEs in the study area.

2. Methodology

The study focused on both agricultural and non-agricultural SMEs in Ekiti State, Nigeria. The sample size was dependent on the number of SMEs currently operating in Ekiti State, Nigeria. A multistage sampling procedure

was adopted. The first stage involved the purposive sampling of five (5) local government areas (LGAs): Ado LGA, Ikere LGA, Oye LGA, Ikole LGA, and Ijero LGA. This was due to the predominance of SMEs and institutional presence in these selected LGAs. The second stage involved the purposive sampling of SMEs engaged in production or services, such as transportation, that necessitate the use of fossil fuels. In the third stage, we stratified the sampling of SMEs into 10 enterprises (Table 1), randomly selecting 10 respondents from each enterprise in Ado LGA, as we anticipated a higher concentration of SMEs in the state capital than in other LGAs. We randomly sampled five (5) respondents from each of the remaining LGAs, in addition to ten (10) road users due to the widespread presence of motorists. The process resulted in the selection of 100 SMEs in Ado LGA and fifty-five (55) SMEs from each of the other LGAs. This led to the selection of three hundred and twenty (320) respondents.

Table 1: Samples of SMEs in the Study Area

Enterprises	Ado	Oye	Ikole	Ijero	Ikere
Agricultural Sector					
(1) Agricultural Production (Irrigation farming, animal production (poultry farm, fish farm and piggery))	10	5	5	5	5
(2) Agricultural Processing (Cassava processor, rice mills, oil palm processor, frozen food (meat, fish and broilers)	10	5	5	5	5
(3) Cafeteria/Bakery/Confectionary	10	5	5	5	5
Non-agricultural Sector					
(4) Road Users	10	10	10	10	10
(5) Service (IT, Telecommunication, Photography and Studio)	10	5	5	5	5
(6) Carpentry and furniture making	10	5	5	5	5
(7) Groceries and Supermarket	10	5	5	5	5
(8) Oil and gas sales outlet (filling station selling petrol, kerosene, diesel and gas)	10	5	5	5	5
(9) Fashion and boutique store	10	5	5	5	5
(10) Beauty and salon centre (barbing, hairdressing, pedicure, manicure and makeover, etc.).	10	5	5	5	5
Total	100	55	55	55	55

This research adopted quantitative methods to obtain both primary and secondary data. Primary data were collected using a well-structured

questionnaire. The questionnaires were distributed physically to the targeted SMEs in Ekiti State. The study employed both descriptive and inferential statistics to achieve its objectives. Descriptive statistics and a logit regression model were used to describe the socioeconomic profile of SMEs, their operations, and to determine the factors influencing SME operators' use of green energy. One sample t-test was used to test the hypothesis.

2.1 Logit Regression Model

Factors influencing the use of green energy (solar) utilization by SMEs was determined using a logit regression model stated in equation (1).

$$Y_i = \frac{1}{1+e^{-\beta 0+ \beta_1 X_1+ \beta_n X_{n+} e_i}} = \frac{1}{1+e^{-\beta 0+ \sum \beta_1 X_1}} \quad (1)$$

$Y_i = Solar\ Energy\ Utilization\ by\ SMEs\ (SEUS)\ Yes\ (1), No\ (0)$

$X_1 = Average\ Cost\ of\ Wiring\ of SMEs'\ Production\ Environment\ (Naira)$

$X_2 = Average\ hour\ of Power\ Availability\ per\ day$

$X_3 = Access\ to\ BEDC\ Electricity\ Facility\ (Yes = 1, No = 0)$

$X_4 = Average\ Connection\ Fee\ to\ BEDC\ Electricity\ (Naira)$

$X_5 = Average\ Estimated\ Electricity\ Bills\ Per\ Month\ (Naira)$

$X_6 = Average\ Cost\ of\ fuelling\ of\ Power\ Generator\ Per\ Month\ (Naira)$

$X_7 = BEDC\ Service\ Support\ Rating\ (Good = 1, Not\ Good = 0)$

$X_8 = BEDC\ Bill\ Collection\ Rating\ \ (Good = 1, Not\ Good = 0)$

$X_9 = Power\ Committee\ Cooperation\ in\ SMEs\ Environment\ (Good = 1, Not\ Good = 0)$

3. Results and Discussion

3.1 Categories of SMEs Operation

Figure 1 depicts the categories of small enterprises operating in the research area, along with pertinent information about their production needs and use of renewable energy. We examined more non-agricultural firms (72.2%) than agricultural enterprises (27.8%). Even though this is an agricultural region, some farmers may have looked for other forms of income in non-agricultural

sectors due to issues including low productivity, restricted access to technology, and fragmented land. In contrast to the very low number of power and heating enterprises (9.7%), these firms in the industry were actively providing services (55.3%). The fact that the majority of the study area's entrepreneurial enterprises are non-agricultural companies that offer services like transportation, trading, information technology, carpentry, furniture, fashion, and beauty parlours suggests that Ekiti State has not experienced much industrialization. This finding emphasizes how crucial non-agricultural sectors are becoming for generating revenue.

Agricultural enterprises may have difficulty implementing green energy due to high initial investment costs, reliance on outdated techniques, and fluctuating profitability in response to SMEs' green energy usage. The challenges of power inadequacy could have led non-agricultural firms to explore the potential of renewable energy sources like solar and biomass. Similarly, despite Ekiti State's agrarian nature, we expect non-agricultural firms to contribute more to carbon emissions due to their predominant sources of livelihood. This study corroborated the assertion, according to Hussain et al. (2019), that the share of non-agricultural SMEs in total greenhouse gas (GHG) emissions is much higher, as this sector is the third largest contributor. Their findings indicate that agricultural activities such as land use and tillage operations account for 20% of global anthropogenic GHG emissions.

Tongwane and Moeletsi (2018), however, opined that more GHG emissions from manufacturing, forestry, agriculture, transportation, and energy production have come from SMEs and motorists that use fossil fuels in the course of production and rendering services. Non-agricultural SMEs, on the other hand, may be more ready to invest in green energy as a result of improved financing, regulatory pressure, and customer demand for environmentally-friendly activities (Agrawal et al., 2023**[a or b?]**). Taghizadeh-Hesary and Yoshino (2020) also found that non-agricultural enterprises are more likely to embrace renewable energy technology, citing considerations such as energy cost reductions and corporate social responsibility as support for this finding.

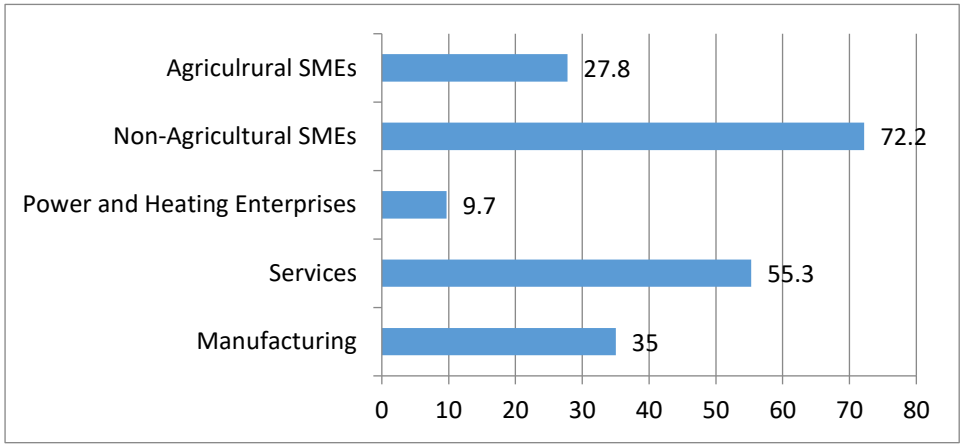

Figure 1: Categories of Small Medium Enterprises

3.2 Socio-economic profile of SME operators

Table 2 displays the respondents' socioeconomic profile. The average age of the SME operators was 33.4 years, making them younger**[quite/relatively young?]**. This suggests that more individuals in Ekiti State who are still within the working age bracket are becoming motivated to start their own businesses. The findings of this study are consistent with those of Eniola (2020) and Gumel (2017), which contend that the main impetus behind small enterprises in Southwest Nigeria is the youth. Numerous variables, such as the region's youthful population, high unemployment rates, and growing entrepreneurial spirit, could be responsible for this development. High rates of unemployment have long plagued the area, particularly among young people (Akanle & Omotayo, 2020; Fawole & Ozkan, 2019). Young people are finding that starting a small business is an appealing way to generate employment possibilities. The youth of Southwest Nigeria are developing an increasingly entrepreneurial mindset and culture. The idea of starting their own businesses and being their own bosses is attractive to many young individuals. Research by Maniu et al. (2021) reported that there is a direct relationship between the age of small business owners and their use of green energy solutions. This is possible because more senior owners have the means and expertise to engage in sustainable operations. In order to cut costs, small business owners are increasingly looking at renewable energy alternatives like solar power in countries with high energy bills, such as Nigeria. According to Qamar et al.

(2022), there is a significant positive correlation between SMEs' sustainable growth and their usage of renewable energy. This implies that using green energy can help ensure a company's long-term success.

The result also shows more male respondents (60%) than female respondents (40%) were active in small companies. Researchers have conducted numerous studies on the reactions of male and female small business owners to the variables influencing their adoption of green energy (Wang et al., 2022; Arroyo & Carrete, 2019). While internal considerations, such as environmental concerns, motivate both sexes, external pressures, such as government incentives, are more likely to influence women. Regardless of gender, small business owners must strike a balance between the need to preserve their financial viability and environmental concerns.

Even though 12.2% of SME owners did not have a formal education, there were still a lot of motivated and educated small business owners. About 53.7% of the respondents had completed secondary school, with the majority having OND/NCE (23.1%) and BSc/HND (20.6%) degrees. Research by Maniu et al. (2021) and Asante et al. (2021) reported a direct relationship between small business owners' adoption of green energy methods and their educational attainment. Higher-educated business owners were more likely to understand green energy environmental benefits and have the skills and resources to implement it. This implies that educational initiatives can help promote green and entrepreneurial attitudes and actions.

The study area's entrepreneurs had an average of 7.1 years of company experience. This displays the number of years since their companies have been operational. Among the respondents, 25% had less than five years of company experience. According to research by Hassen et al. (2018) and Ashton et al. (2017), more seasoned small business owners are generally more inclined to use green energy practices. Maniu et al. (2021) and Ashton et al. (2017) have demonstrated a favourable relationship between small business owners' adoption of green energy techniques and their level of business experience. Experienced owners are more likely to have the financial means and industry expertise to invest in green technologies, and they also tend to be better aware of the economic and environmental advantages of renewable energy. This may be due to better access to financial resources, a longer-term outlook on corporate operations, or improved knowledge of environmental issues.

Table 2: Descriptive Results of the Socio-economic Profile of Respondents

Socio-economic Variables	Agric. SMEs (N = 89) Freq. (%)	Non-Agric. SMEs (N = 231) Freq. (%)	Pooled (N = 320) Freq. (%)	Mean
Age (years)				
< 30	23(25.8)	82(35.5)	105(32.8)	
30 – 39	41(46.1)	115(49.8)	156(48.8)	33.4
40 – 49	15(16.9)	29(12.6)	44(13.8)	
> 49	10(11.2)	5(2.2)	15(4.7)	
Gender				
Male (1)	56(62.9)	136(58.9)	192(60.0)	
Female (0)	33(37.1)	95(41.1)	128(40.0)	
Business Experience (years)				
< 5	23(25.8)	57(24.9)	80(25.0)	
5 – 9	42(47.2)	135(58.4)	177(55.3)	7.1
10 – 14	10(11.2)	19(8.2)	29(9.1)	
15 – 19	7(7.9)	10(4.3)	17(5.3)	
> 19	7(7.9)	10(4.3)	17(5.3)	
Level of Education				
Non-formal Education (0)	9(10.1)	30(12.9)	39(12.2)	
Some Primary (1)	8(8.9)	12(5.2)	20(6.3)	
Primary (2)	9(10.1)	15(6.5)	24(7.5)	
Some Secondary (3)	4(4.5)	10(4.3)	14(4.4)	
Secondary (4)	15(16.9)	36(15.6)	51(15.9)	
OND/NCE (5)	20(22.5)	54(23.4)	74(23.1)	
BSc./HND (6)	16(17.9)	50(21.7)	66(20.6)	
MSC/MBA(7)	8(8.9)	24(10.4)	32(10.0)	
Number of Employees				
< 3	50(56.2)	154(66.8)	204(63.8)	2.5
3 – 5	15(16.9)	60(25.9)	75(23.4)	
6 – 8	11(12.4)	12(5.2)	23(7.2)	
9 – 11	5(5.6)	1(0.4)	6(1.9)	
> 11	8(8.9)	4(1.7)	12(3.8)	

Socio-economic Variables	Agric. SMEs (N = 89)	Non-Agric. SMEs (N = 231)	Pooled (N = 320)	Mean
	Freq. (%)	Freq. (%)	Freq. (%)	
Monthly Income (Naira)				
< 50,000	10(11.2)	38(16.5)	48(15.0)	
< 50,000 – 100,000	49(55.1)	100(43.3)	149(46.6)	92,206.30
100,001 – 150,000	5(65.6)	29(12.6)	34(10.6)	
150,001 – 200,000	6(6.7)	25(10.8)	31(9.7)	
200,001 – 250,000	8(8.9)	10(4.3)	18(5.6)	
250,001 – 300,000	3(3.4)	7(3.0)	10(3.1)	
> 300,000	8(8.9)	22(9.5)	30(9.4)	
Enterprise Competition				
Low (1)	10(11.2)	37(16.0)	47(14.7)	
Moderate (2)	14(15.7)	63(27.3)	77(24.1)	
Relatively High (3)	32(35.9)	70(30.3)	102(31.9)	
Very High (4)	25(28.1)	69(29.9)	94(29.4)	
Access to National Grid				
Yes (1)	80(89.9)	145(62.8)	225(70.3)	
No (0)	9(10.1)	86(37.2)	95(29.7)	
National Grid Monthly Bill (Naira)				
0	22(24.7)	75(32.5)	97(30.3)	
1 – 5,000	20(22.5)	70(30.3)	90(28.1)	
5,001 – 10,000	19(21.3)	72(31.2)	91(28.4)	6,316.40
10,001 – 15,000	16(18.0)	10(4.3)	26(8.1)	
> 15,000	12(13.5)	4(1.7)	16(5.0)	
Daily Fuel Consumption (Litre)				
0	22(24.7)	43(18.6)	65(20.3)	
1 – 7	50(56.2)	125(54.1)	175(54.7)	6.5
7.1 - 14	7(7.9)	39(16.9)	46(14.4)	
14.1 - 21	3(3.4)	14(6.1)	17(5.3)	
> 21	7(7.9)	10(4.3)	17(5.3)	

Source: Field Survey, 2024.

With a typical staff strength of 2.5, the majority of respondents (63.8%) who ran SMEs employed little more than three people. This is a sign of how SMEs operate, as the majority of their operations are similar to sole proprietorships or partnerships made up of a small number of people. The adoption of green energy presents particular difficulties for sole proprietorships, including limited access to money and technical competence. On the other hand, according to a study by Adepoju and Akinwale (2019), 72% of small and medium-sized businesses are keen to implement green energy solutions. This shows that small enterprises and sole proprietors are making a big move towards sustainability. Small business owners and suppliers of green energy might benefit from partnerships. Green energy providers can broaden their client base and increase market share, while small businesses can reap advantages such as reduced expenses, enhanced brand recognition, and easier access to knowledge. Studies by Maniu et al. (2021) and Adepoju and Akinwale (2019) indicate that there is a positive relationship between small enterprises' use of green energy and the number of employees they employ. Government incentives, cost reductions, and heightened awareness of environmental issues likely drive this trend. Businesses, particularly those with increased energy use because of a larger workforce, can save a lot of money by implementing green energy solutions like solar panels and energy-efficient appliances. Larger workforces within small enterprises may improve the likelihood of green energy adoption because of rising environmental consciousness and a desire to lessen carbon emissions.

With an estimated mean monthly income of ₦92,206.30, Table 2 reveals that the majority of respondents (46.6%) made between ₦50,000 and ₦100,000 per month. For SMEs with steady revenue streams, there may be a favourable attitude towards the use of green energy and carbon emission tax payments. According to Qamar et al. (2022) and Adepoju & Akinwale (2019), there is a positive correlation between small business owners' income levels and their use of green energy. Higher-income owners typically have more financial resources at their disposal, which makes it easier for them to invest in energy-efficient improvements and renewable energy technologies. Government subsidies and tax advantages enable small business owners to adopt green energy solutions. These incentives can partially offset the early expenses of renewable energy technology, thereby increasing its financial appeal.

Companies with larger revenue streams are more inclined to fund renewable energy and other sustainability-related projects, according to research by Sun et al. (2022) and Lin et al. (2022). This may be because they want to improve their brand image, have easier access to finance, or are more aware of environmental issues. Perceptions suggest that participants with higher salaries could be more inclined to pay for carbon offsets than those with lower incomes.

Since enterprise competition tends to be either very strong (29.4%) or reasonably high (31.9%), it serves as an indicator of market structure and polarization. This illustrates how SMEs in Ekiti State conduct business in a uniform manner. Although the relationship between competition and small businesses' adoption of green energy measures is complicated, some research indicates that heightened competitiveness may encourage companies to use green energy practices (Amankwah-Amoah, 2024; Anser et al., 2024). Companies might try to set themselves apart from rivals by providing eco-friendly goods or services or by lessening their environmental impact. Green energy can give small businesses a competitive edge by lowering energy expenses, enhancing their reputation, and drawing in eco-aware clients.

Furthermore, government policies and incentives can further encourage the use of green energy. The national grid provides electricity supply to the bulk of SME operators (70.3%). Sometimes, it is hard for small businesses to connect to the power grid, but it can make green energy solutions easier. Findings show that SMEs are most constrained by power shortages; they spend two to three times more on kerosene, diesel, and petrol than they do on grid-based electricity (Yetano Roche et al., 2020). Due to the failure of grid-based supply, over 80% of SMEs either own or use a generator, or self-generate (producing power on-site to make up for grid shortfalls or reduce purchases from the grid). Arguably, the segment of the Nigerian economy most disadvantaged by the mismatch between supply and demand for power is the small and medium enterprise (SME) sector (Anaba & Olubusoye, 2021). In Nigeria, SMEs contribute about 50% of the national GDP and account for 77% of employment. Youth ownership was also very high in this segment in 2012 (Kale, 2019**[Not in re list]**).

Connected businesses can use renewable energy sources like wind and solar electricity to reduce their dependence on fossil fuels and carbon footprints. Research by Igwe et al. (2018) and Hussain et al. (2022)

demonstrated that one important factor impacting entrepreneurship is the cost of electricity. Small**[With?]** the implementation of alternative energy sources such as solar power, small firms can lower their energy costs, thereby increasing their competitiveness and freeing up funds for additional investments. Small companies in places with limited grid access are increasingly turning to off-grid solutions like solar power systems and mini-grids. In the long run, these solutions may prove to be more economical and provide increased energy independence. In Nigeria, small enterprises are relying on off-grid solutions to power their operations due to the unreliability of grid connectivity. This pattern emphasizes how green energy can help businesses in underdeveloped nations.

We estimated that the average monthly charge for power supply from the national grid would be ₦6,316.40. Although there were discrepancies in payment of this bill, some SMEs viewed it as unjustifiable. About 30.3% of the respondents do not make any payments. The European Commission staff on European economic states conducted research that revealed the integral tariff is not sufficient to match the corresponding costs borne by electricity utilities (Linden et al., 2014). Similarly, the high electricity bills do not tally with the electricity supply in Nigeria, which has greatly affected SMEs. Most SMEs expressed dissatisfaction with charges by the Benin Electricity Distribution Company's (BEDC) monthly electricity service, deeming it excessive and unjustifiable due to the lack of regular electricity supply (Bala, 2019).

Small and medium enterprises that use off-grid alternative power sources, such as power plants or green energy, may fall into this category. Certain energy sources, such as solar panels, can result in considerable electricity bill savings, freeing up money that businesses can put to better use. Due to the scarcity of conventional energy sources like coal, oil, and gas, the cost of energy for the commercial and industrial sectors is gradually increasing annually. From a financial perspective, switching to renewable energy sources will eventually lead to cheaper energy costs. Compared to conventional fossil fuels, renewable energy sources like wind and solar electricity are frequently less expensive. In the long run, this can result in significant energy cost reductions for small enterprises. Businesses' dependency on the national grid and related costs may decline if more adopt green energy solutions like solar panels. On the other hand, the upfront costs associated with green energy

infrastructure may be high and have an immediate effect on bills. Renewable energy sources, such as solar energy, can eventually result in lower electricity costs in certain areas. However, small enterprises may find it difficult to afford the initial installation fees. Government incentives and financing options can help reduce these expenses.

About 20.3% of the respondents spent money on fossil fuels, and the average daily fuel consumption for SMEs was 6.5 litres. There is a complicated and multifaceted relationship between small business owners' use of green energy and fossil fuel consumption. While some small businesses are actively transitioning to renewable energy, others continue to rely on fossil fuels due to infrastructure limitations, financial constraints, or an insufficient understanding of renewable energy alternatives. Green energy use by SMEs might lower energy costs, boost profitability, guarantee regulatory compliance, lessen climate change, create jobs, expand the economy, and facilitate development (Okpokam 2021; Koirala 2019). Businesses that use more fuel may be less eager to pay because they feel that the tax is a bigger burden.

3.3 Recommended technologies for reducing greenhouse gas emissions

Figure 2 shows that solar energy is the most feasible and preferred method (71.9%) to mitigate the impact of greenhouse gases on the environment. Research has revealed that a significant number of SMEs in Lagos State, Nigeria, have explored solar energy as a substitute for traditional energy sources. Additionally, most SMEs have shown a preference for solar energy over electricity from the national grid (Anaba & Olubusoye, 2021). At the time of the study, the main things that stopped small businesses in Lagos State from switching from traditional energy sources to solar energy were the high cost of electricity from the national grid, the fact that distribution companies (DisCos) did not have good organizational practices and procedures, and the fact that the government did not provide support for solar energy.

Technologies that can harness solar, wind, and geothermal power offer significant advantages in reducing GHG footprints compared to traditional fossil fuels (Gherairi, 2023; Zakari et al., 2022). This reduction can also lead to other benefits; for example, the installation of solar panels or wind turbines on roofs or premises can act as a catalyst to generate electricity cleanly and

efficiently, lowering operating costs and reducing reliance on grid power (Blundel & Hampton, 2021; Li et al., 2023). These SMEs engage in eco-innovation, defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations" that reduce environmental impact, with or without intent. Small and medium enterprises are more likely to adopt "end-of-pipe technologies," which allow them to reduce their environmental impact ex-post without changing the processes that generate the impact (e.g., energy-efficient light bulbs), rather than "clean technologies," which eliminate the environmental impact of the production process itself. Understanding the entire energy conversion chain and the accompanying energy conversion losses is essential to promoting the most successful policies to improve the energy footprint of SMEs (Gennitsaris et al., 2023). The process of transforming energy from its raw form—the extraction and exploitation of natural energy resources, such as wind, solar, crude oil, and gas—to its final form—energy-consuming machinery, transportation, buildings, and other sectors—makes up a nation's or region's energy system.

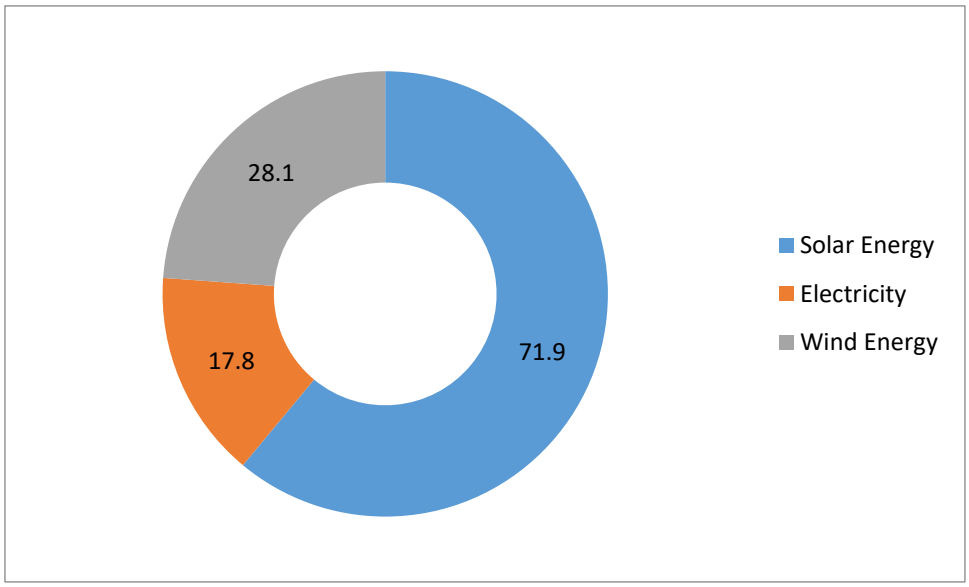

Figure 2: Preferred Technologies for Emission Reduction

3.4 Factors influencing SME operators' use of solar energy

Table 3 presents the logit regression estimates of the parameters that affect SMEs' solar energy utilization. The variable representing the average cost of wiring for SMEs showed a positive coefficient and was statistically significant at the 10% level. This suggests that increased wiring costs could result in a hesitancy to allocate resources towards the adoption of technologies aimed at lowering carbon emissions. The expense associated with solar installation is typically a small proportion of the total cost of a solar energy system. The amount of solar installation will depend on the power usage and capacity of appliances. We found statistical significance at the 5% level in the monthly average estimated electricity bills of SMEs per year. Furthermore, we observed a negative correlation between the usage of solar energy and these electricity bills. Therefore, SMEs with higher electricity bills are more inclined to choose solar energy as an alternative, and vice versa. Research has demonstrated that SMEs that utilize solar energy can achieve an average monthly cost savings of ₦8,896 on their electricity bills (Owusu-Sekyere et al., 2024). This translates to a significant reduction of 36.64% in their overall electricity expenditure. Our analysis revealed that the variable "BEDC service support rating" displayed a positive coefficient and was statistically significant at the 10% level. These findings suggest that SMEs are more inclined to adopt and utilize solar energy when they perceive their electricity source as lacking support and unreliable. This suggests that SMEs are more inclined to embrace solar energy when they believe they can rely on and receive prompt assistance from support services.

The inverse relationship between the average duration of power availability implies that as the availability of electricity from the national grid increases, the utilization of solar energy decreases. This will also lead to a reduction in fossil fuel burning, as SMEs will rely on electricity to operate their machinery during the production process. This, in turn, will result in a decrease in fuel consumption. Therefore, businesses that have consistent access to electricity are more inclined to endorse policies that encourage the use of renewable energy and decrease emissions. SMEs can benefit from a dependable power supply, which can lead to higher levels of production and profitability. As a result, SMEs may be more inclined to support carbon pricing schemes that provide financial rewards for adopting clean energy sources. The availability

of BEDC electricity facilities and the adoption of solar energy have a direct correlation. According to research, the availability of power and electricity infrastructure can influence the adoption of solar energy. SMEs that have improved access to these resources are more inclined to embrace environmentally-friendly technologies and promote the use of solar technology

The inverse correlation between the average connection charge for BEDC power by SMEs and the utilization of solar energy suggests that higher connection fees can incentivize the deployment of solar energy. Increased connection fees could potentially dissuade SMEs from embracing sustainable energy solutions, unless these solutions are in line with their environmental principles and long-term sustainability objectives.

Both variables, "average monthly estimated electricity bills and average monthly cost of fuelling a power generator," displayed a negative coefficient. This suggests that the utilization of solar energy may rise due to an escalation in electricity expenses, which in turn raises the cost of electricity for SMEs by increasing the price of fossil fuels used for generating power. This can result in increased electricity costs for businesses, which may affect their desire to comply with the tax.

Similarly, in Lagos State, Nigeria, SMEs are unable to function at their full potential because of the regular power outages that obstruct and limit their growth and operational performances. Due in part to the regular power outages from the national grid, these SMEs report enormous losses at the end of the year. Because they are unable to operate to their full potential due to frequent power interruptions, these SMEs are unable to compete on a global scale (Anaba & Olubusoye, 2021). Frequent power outages cost SMEs, on average, 15.6% of their yearly turnover (sales). Some SMEs in Lagos State, Nigeria, have allocated a significant portion of their capital to alternative energy sources to mitigate the adverse effects of frequent power outages.

Table 3: Logit Regression Parameter Estimates of Factors Influencing the Use of Solar Energy

Variables	Coefficient	Std. Error	Wald Chi-Square	df	Sig.
(Intercept)	6.723	25.6964	.068	1	.794
Average Cost of Solar Installation	1.934E-005	1.0734E-005	3.245	1	.072*
Average hour of Power Availability per day	-.147	.0968	2.293	1	.130
Access to BEDC Electricity Facility	.590	8.6411	.005	1	.946
Average Connection Fee to BEDC Electricity	-3.714E-007	2.1068E-005	.000	1	.986
Average Estimated Electricity Bills Per Month	-6.211E-005	3.1980E-005	3.772	1	.052**
Average Cost of fuelling of Power Generator Per Month	-7.809E-006	8.9218E-006	.766	1	.381
BEDC Service Support Rating	1.806	.9867	3.352	1	.067*
BEDC Bill Collection Rating	.932	12.0170	.006	1	.938
Power Committee Cooperation in SME Environment	.537	.4084	1.732	1	.188
Predicted probability	-20.258	7.2989	7.703	1	.006***
Predicted group	1.128	.5735	3.870	1	.049**
Predicted probability	-.644	81.7149	.000	1	.994
Predicted group	3.809	19.0247	.040	1	.841
(Scale)	1[a]				

***, ** and * represent significance at 1, 5 and 10% Levels respectively

Source: Field Survey, 2024

3.5 Constraints to national grid electricity and green energy utilization by SMEs

Figure 3 shows that SMEs experience an unusually high rate of incorrect billing (90%) from the power distribution company (BEDC) and inconsistent power supply (89%) with less than 4 hours of electricity each day. A significant proportion (45%) of individuals**[SME owners?]** frequently encounter cost limitations when accessing electricity from the national grid. Issues such as exorbitant energy expenses, restricted funds availability, and a lack of knowledge regarding energy-saving solutions contribute to this. Another issue

with the national grid is the exorbitant cost of wiring, which accounts for 45% of the problem**[was cited/mentioned by 45% of the respondents?]**. Additionally, there is a lack of cooperation within the host community, contributing to 40% of the problem**[as cited by 40% of respondents?]**. Factors such as the proximity to the power grid, the need for specialized equipment, and the associated labour costs, contribute to exorbitant expenses encountered **[that constitute?]** significant challenges in the form of financial constraints (90%) and a lack of awareness regarding market and non-market variables (85%) when it came to the utilization of green energy. They frequently encounter financial limitations when shifting to renewable energy sources. These challenges encompass substantial initial expenses for renewable energy technology, restricted availability of funding, and ambiguity on the enduring financial advantages. Insufficient knowledge of the several market and non-market factors that can impact the adoption of green energy may impede SMEs' capacity to make well-informed choices regarding investments in renewable energy. Market factors such as energy pricing and government subsidies can greatly influence the economic feasibility of green energy projects for SMEs. Gaining a comprehensive understanding of these forces is essential for making informed and prudent investment decisions. Non-market factors, such as public consciousness and environmental restrictions, can also influence the adoption of green energy among SMEs. Companies that are adaptable to these influences can acquire a competitive edge.

One issue that may prevent SME managers from switching from traditional fossil fuel sources to renewable energy sources is a lack of funding (Vand et al., 2019). Managers of SMEs may find it difficult to start green energy projects due to financial obstacles such as low fiscal incentives, insufficient energy market trading systems, and low priority for energy-saving issues (Agrawal et al., 2023). The adoption of green energy may face obstacles due to SMEs' ignorance of market and non-market forces. Managers of SMEs may find it more difficult to undertake green energy projects if they use outdated technologies. In an attempt to achieve growth and sustainable development, managers of SMEs may find it challenging to implement green products and drastically cut their daily operating expenses due to inefficient technology (Rahbauer et al., 2018). Green energy technology may face political obstacles from utility owners that rely on fossil fuels to generate electricity. Organizational leaders' ignorance of green energy may lead to a low degree of green electricity use.

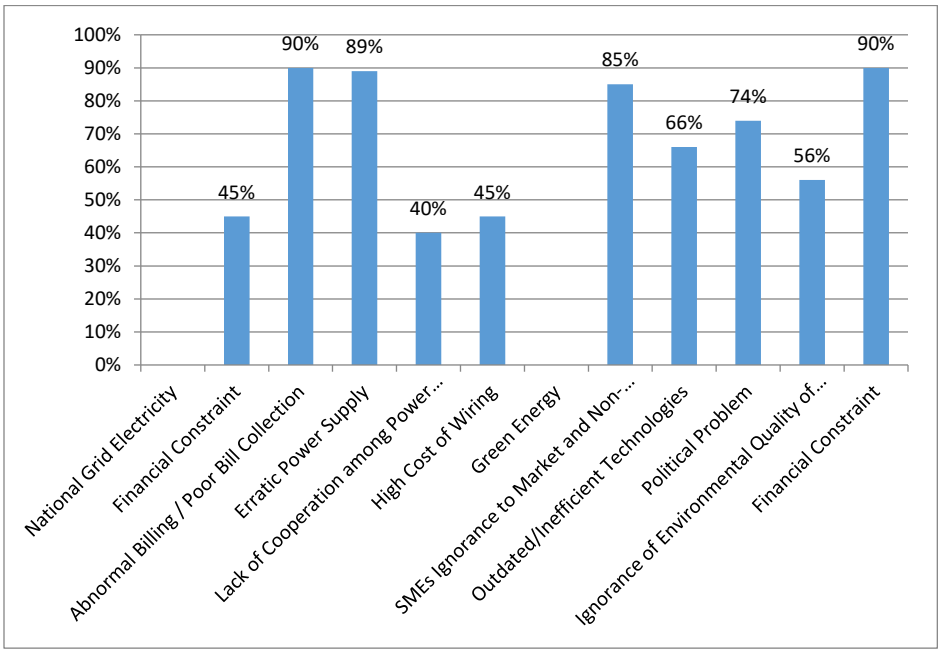

Figure 3: Problems of the Use of National Grid Electricity and Green Energy

3.6 Hypothesis testing

The result in Table 4 rejects the hypothesis that "investment of agricultural SMEs in green energy is significantly different from that of non-agricultural SMEs" due to significant differences at the 1% level. The agricultural industry's distinctive attributes, like its reliance on natural resources and susceptibility to climate change, account for this. As a result of their dependence on renewable energy sources and decreased energy use, agricultural SMEs typically exhibit reduced emissions. **[Sheri, line spacing]**

Table 4: Independent Sample T-Test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	**Sig.**	**T**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
Investment in Green Energy	Equal variances assumed	29.251	.000	3.266	318	.001***	43667.85836	13371.56238
	Equal variances not assumed			2.509	106.594	.014**	43667.85836	17407.58172

Notes: *** and ** represent significance at 1 and 5% Levels respectively
Source: Field Survey, 2024

4. Conclusion and Recommendation

Overall, there is a substantial presence of non-agricultural enterprises, primarily engaged in sectors such as transportation, trading, information technology, carpentry, furniture, and fashion and beauty services. Although the research area is mostly an agrarian one, the significance of non-agricultural SMEs in generating revenue is growing. Notwithstanding the difficulties posed by expensive initial investments, dependence on outmoded methods, and unpredictable profitability, some companies are investigating solar energy. Non-agricultural SMEs make a substantial contribution to the overall amount of greenhouse gas emissions. Nevertheless, their inclination to invest in green energy may increase as a result of improved funding, regulatory coercion, and customer insistence on eco-friendly practices.

Moreover, a significant proportion of SMEs in Ekiti State, Nigeria, are characterized by ~~their~~ youthfulness and strong drive to establish their own ventures.

Male entrepreneurs exhibit a higher propensity than female entrepreneurs to embrace green energy, despite the prevailing notion that women possess a stronger environmental consciousness. SMEs account for as much as 70% of worldwide pollution, with manufacturing small and medium-sized enterprises being accountable for 64% of air pollution. The government has the authority to exert influence on SMEs' transition towards environmentally-friendly practices, leading to the imposition of financial limitations on corporate green investments. Government assistance can enable businesses located in air-polluted areas with limited financial resources to take advantage of environmentally-friendly practices.

Solar energy has emerged as the foremost technique for mitigating the environmental consequences of carbon emissions. Nigerian SMEs are increasingly allocating resources to solar power because of its potential for cost reduction, environmental benefits, and energy efficiency. The cessation of fuel subsidies by the Federal Government of Nigeria has prompted a significant number of SMEs to see the necessity of seeking alternate energy sources. As a result, there has been a decline in creativity and limited financial gains, which may hinder SMEs' ability to allocate funds to environmentally-friendly technologies. Despite significant initial costs, limited financial availability, and

technical expertise, there is a growing inclination among SMEs to participate in**[adopt? invest in?]** solar power.

The key determinants impacting the adoption of green energy are the average expenses associated with wiring in the SMEs production environment, the average monthly predicted electricity bills, and inadequate assistance provided by the electricity supplier.

SMEs encountered substantial obstacles during the process of shifting to renewable energy sources. These factors consist of financial limitations, insufficient knowledge about market and non-market factors, significant upfront expenses for renewable energy technology, restricted finance options, and uncertainty about the long-term advantages. Market factors such as energy pricing and government subsidies significantly influence the economic viability of green energy technology. Additionally, non-market factors such as public awareness and environmental regulations can have an impact on the adoption of these technologies.

This study refutes the notion that there is a large variation in green energy investment between agricultural and non-agricultural SMEs.

However, this study recommends the following:

1. The Ekiti State government should proactively endorse public-private partnerships (PPPs) to stimulate the implementation of environmentally-friendly energy alternatives.
2. Governments and organizations should institute diverse programmes to assist SMEs in overcoming environmental and energy obstacles. These measures encompass the provision of financial aid for enhancing energy efficiency, the promotion of renewable energy sources, the provision of training on energy management practices, the allocation of grants for energy efficiency improvements, tax incentives for businesses that invest in low-carbon technologies, and support for the advancement of new low-carbon technologies.
3. Research institutes, business schools and other stakeholders should provide educational programmes that prioritize sustainability and green business practices of SMEs to equip them with the necessary knowledge and skills to implement green energy solutions.

5. Contribution to Knowledge

In contrast to earlier research that primarily examined technical or environmental awareness aspects, this study incorporates socioeconomic, financial, and institutional factors into its energy choice modelling, thereby enhancing the conceptual framework for analysing green energy behaviours in developing regions. The research highlights practical constraints and policy-relevant issues—including high initial costs, insufficient awareness, and limited governmental incentives—alongside enabling elements such as environmental awareness and the availability of financing. These insights provide actionable data to assist policymakers, donor organizations, and small and medium enterprise (SME) support initiatives. By pinpointing the categories of SMEs most inclined to adopt green energy solutions, the study formulates a decision-making resource for stakeholders—such as government entities, microfinance organizations, and renewable energy providers—to create focused outreach, subsidy initiatives, and educational programmes that promote the adoption of green energy.

In summary, these findings contribute to the discourse on clean energy adoption and provide practical insights for policymakers aiming to scale green energy solutions in Nigeria's entrepreneurial landscape.

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