

**DETERMINANTS OF SOLAR ENERGY ADOPTION IN BENIN CITY,
NIGERIA**

BY

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**DEPARTMENT OF ECONOMICS
FACULTY OF SOCIAL SCIENCES
UNIVERSITY OF BENIN
BENIN CITY**

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**A PROJECT SUBMITTED TO THE DEPARTMENT OF ECONOMICS,
FACULTY OF SOCIAL SCIENCES, IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE
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OCTOBER, 2025

ATTESTATION

I, Divine Uyoyo-Oghene Atedhor, affirm that this project titled “Determinants of Solar Energy Adoption in Benin City, Nigeria” is entirely my own work and has not been submitted, either in full or in part, for any other degree or qualification. I have properly cited all sources of information and adhered to the required referencing and in-text citation style. Any assistance provided during the preparation of this project has been duly acknowledged. I confirm that this project reflects my personal efforts, ideas, and analysis, with all external contributions appropriately credited. I accept full responsibility for any errors or omissions in the content of this work. Additionally, I declare that all ethical requirements, including obtaining necessary permissions for research and ensuring confidentiality, have been properly observed throughout the course of this study.

Divine Uyoyo-Oghene ATEDHOR

CERTIFICATION

This is to certify that this work was carried out by Divine Uyoyo-Oghene ATEDHOR in the Department of Economics, Faculty of Social Sciences, University of Benin, Benin City, under my supervision.

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(Supervisor)

Date

Dr. S. O. Igbinedion
(Project Coordinator)

Date

Professor C.A. Ighodaro
(Head of Department)

Date

DEDICATION

This Project is dedicated to God Almighty for His abundant grace towards my life and to the enduring memory of my late mother, Late Mrs. Afokoghene Grace Atedhor.

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ABSTRACT

Energy insecurity remains one of the most pressing developmental challenges in Nigeria, with frequent power outages, high dependence on fossil fuels, and escalating environmental degradation undermining economic growth and sustainable living. Solar energy, as a clean and renewable source, presents a viable alternative to the nation's unreliable electricity supply. This study therefore examines the determinants of solar energy adoption in Benin City, Nigeria. Specifically, it investigates the economic, environmental, technical, social, and policy-related factors influencing adoption, as well as the level of awareness, affordability, and perceived long-term benefits among residents and businesses. The study employed a cross-sectional survey design, using stratified random sampling to select two hundred (200) respondents across different parts of Benin City. Data were collected through structured questionnaires and focus group discussions, while descriptive and inferential statistical methods, including multinomial logistic regression, were used for the analysis. The study revealed that although awareness of solar energy and its environmental benefits is relatively high, actual adoption remains moderate due to economic constraints, limited access to financing, and inadequate technical support. The study further established that income level, cost of installation, access to credit facilities, government incentives, and product quality are among key determinants of adoption, collectively accounting for a significant variation in solar energy adoption in Benin City. The model fit validates the findings, with a high Nagelkerke R^2 value (0.885), indicating that the identified economic, environmental, social, and policy factors collectively exert approximately 89% influence on solar energy adoption in Benin City. The study recommends increased government intervention through targeted subsidies, low-interest solar financing, and effective awareness campaigns to enhance public understanding and affordability. Strengthening technical capacity, ensuring product quality, and improving policy frameworks are also recommended as crucial to scaling solar energy adoption in Benin City. By addressing these barriers, solar energy adoption can serve as a sustainable pathway toward achieving energy security, economic resilience, and environmental sustainability in Benin City and by extension Nigeria.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Energy security is a critical to a country's environmental sustainability and economic development. However, Nigeria's energy landscape is marked by significant challenges, including unreliable electricity supply, environmental degradation, and economic repercussions. Despite its vast energy resources, Nigeria faces significant challenges in providing reliable and affordable energy to its population (Oyedepo, 2012). Nigeria's energy insecurity has far-reaching environmental and economic consequences, hindering the nation's energy access for industrial and domestic needs.

The economic implications are substantial, with estimates suggesting that Nigeria loses significant revenue annually due to unreliable electricity supply (Ibitoye, 2019). The country's energy poverty remains a significant barrier to development, with a substantial portion of the population lacking reliable electricity. The instability of Nigeria's power grid results in frequent outages, compelling businesses and households to depend on costly and polluting fossil-powered generators (Akinbami, 2001). This not only increases energy costs but also contributes to air pollution and greenhouse gas emissions, further exacerbating

environmental degradation. The economic implications of energy insecurity are significant, with estimates suggesting that Nigeria loses approximately 1% of its GDP annually due to power outages (Adeniran et al., 2018). To address Nigeria's energy challenges, the country needs to prioritize energy security and transition to a more sustainable energy mix. This can be achieved through investments in renewable energy sources, such as solar and wind power, and the development of more efficient energy infrastructure (Iwayemi, 2008).

Environmentally, Nigeria's heavy reliance on fossil fuels has led to severe ecological degradation. Furthermore, the environmental degradation associated with fossil fuel extraction and use has economic repercussions, including loss of arable land and fisheries, diminishing income for local communities, and increasing poverty levels. While frequent incidences of oil spills in the Niger Delta have devastated aquatic ecosystems, gas flaring remains a major source of air pollution, including greenhouse gas emissions, exacerbating climate change (Nwilo & Badejo, 2005; Ohunakin et al., 2019). Although the effects of gas flaring are many, they can be broadly characterized under environmental, health, and other implications (Udok & Akpan, 2017). Energy access and climate change are deeply intertwined challenges, particularly in developing regions such as sub-Saharan Africa. Limited access to modern energy services compels many communities to rely on traditional

biomass and fossil fuels, contributing to environmental degradation and greenhouse gas emissions (Ukwueze et al., 2020).

Nigeria's energy paradox highlights the need for a diversified energy strategy that includes renewable sources to ensure energy security and environmental sustainability. Thus, transitioning to renewable energy sources, such as solar power, presents a viable solution to enhance energy security while mitigating environmental and economic issues. Solar energy adoption can reduce dependence on fossil fuels, decrease greenhouse gas emissions, and provide reliable electricity, fostering economic growth and environmental sustainability (Emodi et al., 2019). Solar energy plays a pivotal role in addressing the dual challenges of climate change and inadequate energy access, particularly in developing regions like sub-Saharan Africa. As a clean and renewable resource, solar power offers a sustainable alternative to fossil fuels, which are finite and contribute significantly to greenhouse gas emissions (Aliyu et al., 2018). By harnessing the abundant sunlight available in these regions, solar energy can substantially enhance energy accessibility and simultaneously reduce carbon dioxide emissions, thereby mitigating the environmental effects fossil energy utilization.

By promoting energy security and sustainability, Nigeria can reduce its reliance on fossil fuels, mitigate environmental degradation, and foster economic development. Attaining

energy-secure future. requires identifying the barriers and drivers of solar energy adoption. By investigating the determinants of solar energy adoption in Benin City, the research seeks to provide insights that can inform targeted interventions, promote sustainable energy practices, and contribute to the broader goal of enhancing energy access and mitigating climate change impacts in Nigeria.

1.2 Statement of the Research Problem

The adoption of solar energy is crucial in addressing energy insecurity and environmental challenges of fossil energy consumption, particularly in developing countries. However, the adoption of solar energy in Nigeria remains relatively low although the country is blessed with abundant solar energy resources (Akinyele & Okundamiya, 2022).

Environmental concerns, such as air pollution and climate change, necessitate a shift towards cleaner energy sources like solar energy. Nigeria's reliance on fossil fuels contributes to environmental degradation and health problems, making it essential to explore alternative energy sources (Akinyele & Okundamiya, 2022). However, the extent to which environmental factors influence the country's adoption of solar energy is not well understood. Economic factors, including the high upfront costs of solar energy systems and limited access to financing options, also play a significant role in shaping adoption decisions (Adebayo, Awosusi, & Okorie, 2021). The cost of solar energy systems can be

prohibitively expensive for many households and businesses, making it challenging for them to adopt this technology.

Furthermore, limited access to financing options and lack of awareness about available financing opportunities can further exacerbate this challenge (Ogunmodede & Okoro, 2023). Social factors, such as awareness, attitudes, and social norms, influence households' and businesses' willingness to adopt solar energy. Community acceptance and social networks can play a significant role in promoting the adoption of solar energy, while lack of awareness and misinformation can hinder its adoption (Ogunleye & Babatunde, 2022). Apart from examining the role of environmental, economic, and social factors in solar energy adoption, which could inform the development of targeted policies and programmes to promote sustainable energy solutions, this study seeks to bridge the gap in localized research, specifically focusing on Benin City, Nigeria (Ogunmodede & Okoro, 2023).

1.3 Research Questions

This study aims to investigate the determinants of solar energy adoption in Benin City, Nigeria. Consequently, the research is guided by the following questions:

1. What are the economic and environmental factors that influence the adoption of solar energy in Benin City?

2. Do perceptions of reliability, affordability, and environmental factors affect the decision to adopt solar energy among residents and businesses?
3. What role do government policies, financial incentives, and infrastructural support play in facilitating or hindering the adoption of solar energy in the region?
4. How does the availability of technical expertise and maintenance services impact the sustainability and scalability of solar energy solutions in Benin City?

1.4 Objectives of the Study

The primary objective of this research is to investigate the influencers of the adoption of solar energy in Benin City, Nigeria. The study aims to provide insights into the factors that promote or hinder the uptake of solar energy solutions, thereby contributing to the development of sustainable energy policies and practices. The specific objectives are as follows:

1. Identify and analyze the economic and environmental factors that influence the adoption of solar energy among households, businesses, and institutions in Benin City.
2. Determine if the perception of reliability, affordability, and environmental factors affect the decision to adopt solar energy among residents and businesses in Benin City. Evaluate the impact of government policies, financial incentives, and infrastructural support on the adoption of solar energy solutions in the region.

3. Examine the role of technical expertise, maintenance services, and supply chain dynamics in facilitating or impeding the sustainability and scalability of solar energy systems.
4. Provide policy recommendations and strategic interventions aimed at enhancing the adoption of solar energy, thereby promoting environmental sustainability and energy security in Nigeria.

By achieving these objectives, the study seeks to contribute to the broader discourse on renewable energy adoption, offering empirical evidence that can inform policy decisions and practical interventions in the Nigerian context.

1.5 Significance of the Study

This study provides valuable insight into the major factors influencing the adoption of solar energy in Benin City, Nigeria. The issue of irregular electricity supply has remained one of the greatest challenges facing the country, affecting economic growth, industrial productivity, and the comfort of daily living. Understanding what drives or hinders people from adopting solar energy is therefore crucial to finding practical solutions to Nigeria's power crisis. The study highlights the economic, environmental, and social factors that shape people's decisions to embrace renewable energy, providing a foundation for meaningful policy action.

The findings of this study will assist government agencies, policymakers, and energy planners in developing effective strategies that can promote wider solar energy adoption. By identifying barriers such as high installation costs, inadequate financing options, lack of technical support, and low awareness, the study offers guidance for designing incentives, subsidies, and public enlightenment campaigns that can make solar power more accessible and attractive to households and businesses. Private investors, solar energy companies, and other stakeholders in the renewable energy sector will also find this study useful. The research provides important information about public perception, levels of awareness, and willingness to adopt solar energy, which can help investors and providers tailor their services to meet the needs of different income groups. This understanding will support market expansion and improve the overall efficiency of renewable energy delivery in Benin City and beyond.

In the academic context, this study adds to existing literature on renewable energy adoption in developing countries, particularly within the Nigerian setting. It contributes fresh empirical evidence that can be used by students, researchers, and development agencies to deepen the understanding of how economic, social, and institutional factors influence sustainable energy transitions. Ultimately, this study is significant because it promotes awareness of solar energy as a clean, reliable, and long-term cost-saving source of electricity. By providing data-driven insights and practical recommendations, it aims to

support efforts toward achieving energy security, environmental sustainability, and economic development in Benin City and in Nigeria as a whole.

1.6 Hypothesis of the Study

Based on the research objectives and the review of related literature, the following hypotheses were formulated to guide the study:

H₀₁: Economic factors have no significant influence on the adoption of solar energy in Benin City.

H₁₁: Economic factors have a significant influence on the adoption of solar energy in Benin City.

H₀₂: Technical factors do not significantly affect the adoption of solar energy in Benin City.

H₁₂: Technical factors significantly affect the adoption of solar energy in Benin City.

H₀₃: Social factors have no significant effect on the adoption of solar energy in Benin City.

H₁₃: Social factors have a significant effect on the adoption of solar energy in Benin City.

H₀₄: Environmental factors do not significantly influence the adoption of solar energy in Benin City.

H₁₄: Environmental factors significantly influence the adoption of solar energy in Benin City.

H₀₅: Awareness level does not significantly affect the adoption of solar energy in Benin City.

H₁₅: Awareness level significantly affects the adoption of solar energy in Benin City.

1.7 Limitations of the Study

This study, while comprehensive, is subject to certain limitations. First, the analysis relied on self-reported data obtained through questionnaires, which may be affected by response bias or inaccuracies in participants' perceptions. Second, the study focused specifically on Benin City; therefore, the findings may not be fully generalizable to other regions in Nigeria with different socio-economic or climatic conditions. Third, time and resource constraints limited the sample size to 200 respondents, which, although statistically adequate, may not capture the full diversity of opinions across all demographic groups. Lastly, policy-related variables were omitted due to data unavailability, which may have restricted the model's ability to fully capture the influence of government interventions on solar energy adoption.

1.8 Structure of the Study

This research work is organized into five chapters to ensure a logical flow of presentation.

1. **Chapter One** introduces the study by providing the background, statement of the problem, research objectives, research questions, hypotheses, significance, scope, and limitations of the study.
2. **Chapter Two** presents a detailed review of relevant theoretical and empirical literature related to the determinants of solar energy adoption.
3. **Chapter Three** describes the research methodology, including the research design, population, sample size, data collection methods, model specification, and analytical techniques.
4. **Chapter Four** focuses on data presentation, analysis, and interpretation of results obtained from the field survey.
5. **Chapter Five** provides the summary of findings, conclusions, and recommendations based on the study's outcomes.

CHAPTER TWO

LITERATURE REVIEW

2.1 Global Energy Development

The global energy landscape is undergoing a significant transformation, driven by the need to address climate change, energy security, and sustainable development. Renewable energy sources, particularly solar energy, have emerged as a vital component of this transition. Solar energy has become increasingly cost-competitive with fossil fuels, making it an attractive option for countries seeking to reduce their carbon footprint and improve energy access (Bazilian et al., 2013; IPCC, 2018). In Nigeria, previous studies have highlighted the potential of solar energy to address the country's energy challenges, including inadequate energy access and reliance on fossil fuels (Adeoti et al., 2016; Ohiare, 2015). For instance, Adeoti et al. (2016) found that solar energy can provide a reliable and cost-effective solution for electricity generation in rural areas of Nigeria. Similarly, Ohiare (2015) emphasized the need for Nigeria to diversify its energy mix and invest in renewable energy sources, including solar energy.

In the context of Benin City, a major urban center in Nigeria, solar energy adoption can help address the city's growing energy demands and reduce reliance on fossil fuels. Understanding the determinants of solar energy adoption in Benin City is crucial for

policymakers, stakeholders, and industry practitioners seeking to promote sustainable energy solutions in the city. By examining the factors that influence solar energy adoption, this study aims to contribute to the growing body of literature on renewable energy development in developing countries. The findings of this study will build on previous research that has identified key factors influencing solar energy adoption, including economic viability, technological advancements, and social acceptance (Bazilian et al., 2013; IPCC, 2018). By exploring these factors in the specific context of Benin City, this study will provide valuable insights into the opportunities and challenges associated with solar energy adoption in urban areas of Nigeria.

2.2 Determinants of Solar Energy Adoption

The determinants of energy adoption, particularly solar energy, have been extensively studied in the literature. Research has identified a range of factors that influence the adoption of solar energy, including economic, social, environmental, and technological factors. Economic factors, such as the cost of solar energy systems and financing options, have been found to be significant determinants of solar energy adoption (Bazilian et al., 2013; IPCC, 2018). Studies have shown that high upfront costs and limited access to financing can be major barriers to adoption, particularly in developing countries (Adeoti et al., 2016). Social factors, such as awareness and perception of solar energy benefits, social norms, and peer influence, also play a crucial role in determining adoption (Sovacool,

2014). For instance, households and businesses are more likely to adopt solar energy if they are aware of its benefits and perceive it as a viable alternative to traditional energy sources. Environmental factors, such as concern for climate change and air pollution, have also been found to influence solar energy adoption (IPCC, 2018). Individuals and organizations that prioritize environmental sustainability are more likely to adopt solar energy as a cleaner and more sustainable alternative to fossil fuels.

In the context of Benin City, Nigeria, understanding the determinants of solar energy adoption is crucial for promoting sustainable energy solutions. By examining the economic, social and environmental factors that influence adoption, policymakers and stakeholders can develop targeted interventions to increase adoption rates and reduce reliance on fossil fuels.

2.2.1 Economic Determinants of Solar Energy Adoption

Renewable energy delivers sweeping environmental, economic, and social benefits; it significantly cuts greenhouse gas emissions and air pollution, enhances energy independence, drives innovation in energy solutions, and creates new job opportunities. (Perera et al., 2024). Yet, economic considerations remain a key driver shaping the adoption of solar energy technologies, particularly in urban centers in sub-Saharan Africa. Despite substantial declines in photovoltaic (PV) system costs over the past decade, the

upfront financial barrier remains significant. A secure and uninterrupted electricity supply has become essential when making strategic energy decisions across the globe. (Magazzino, 2023). For many households and small NMKL businesses, the combined cost of panels, batteries, inverters, and installation exceeds what limited savings or irregular incomes can support, causing solar technologies to remain out of reach without financing alternatives. Robust economic growth and social advancement hinge critically on having a reliable and sufficient energy infrastructure. (Adewuyi et al., 2020)

To overcome the barriers to solar energy adoption, innovative financing mechanisms such as pay-as-you-go (PAYG) models have emerged. PAYG solutions break down the upfront cost into small, frequent payments, daily, weekly, or monthly, often using mobile money platforms. This model is particularly effective in aligning with variable income streams common in developing economies. Research shows that when users can pay in manageable installments, adoption rates increase significantly, as solar system costs become comparable to existing energy expenditures on petrol, kerosene, or generator fuel (Adewumi et al., 2022). The PAYG model has been successful in increasing access to solar energy in developing countries. For instance, Ogunmodede et al. (2021) showed that PAYG models can increase solar energy adoption rates by providing flexible payment options that align with the financial capabilities of low-income households.

Alongside private-led solutions, government- and development agency-supported credit initiatives play a vital role. Nigeria enjoys considerable solar exposure, averaging around 6.5 hours of sunlight daily (Ikemba et al., 2024). In Nigeria, programs launched by the Bank of Industry (BOI), often in partnership with the United Nations Development Programme, have combined low-interest loans, grants, and prepaid metering to fund solar energy systems in off-grid communities. These programs have successfully deployed systems across multiple states and serve as models for integrating financial, technical, and institutional support. Such efforts illustrate the catalytic potential of coherent credit ecosystems in fostering solar adoption. Nevertheless, macroeconomic and institutional challenges complicate credit-based solutions. High inflation, volatile currency values, and elevated borrowing rates increase project risk and raise overall financing costs. In these environments, even robust microfinance institutions and commercial banks struggle to offer solar-specific credit products. Weak regulatory frameworks, unclear provisions for consumer protection, and inconsistent licensing further hinder the development of a supportive financial environment (Ugwoke et al., 2023).

The prospect of energy restructuring offers compelling returns not only for individual households but for local economies. Specifically, Nigeria's installed capacity of 15,000 MW significantly underperforms relative to its actual generation, which oscillates between 3500 and 5000 MW (Ikemba, 2024). Adoption of solar systems can lead to reduced energy

expenses, increased reliability, and enhanced resilience. Economies that facilitate credit access for solar investments can see ripple effects: job creation, increased productivity, and shifts in local value chains toward clean energy technologies.

To maximize this potential, a multifaceted approach is essential. Consumer financing tools like PAYG must be complemented by institutional credit programs and blended finance models that combine public funds, guarantees, and commercial capital. Simultaneously, expanded mobile financial infrastructure and digital inclusion can broaden access. Regulatory clarity, strong consumer protections, and safeguards against predatory lending are also critical to building trust. Policymakers and decision-makers should continue to enhance financial incentives such as grants, low-interest loans, and tax credits to stimulate greater investment in renewable energy technologies. Economic Growth (Dirma et al., 2024). Applying these insights in Benin City would involve coordinating credit initiatives with fintech and microfinance providers, introducing government-supported loan guarantees, and supporting public–private partnerships. Complemented by financial education and stable macroeconomic policies, such an ecosystem could unlock affordable and reliable solar access for urban households and SMEs. In doing so, this strategy not only bridges energy barriers but ushers in a sustainable trajectory of economic and social development powered by clean energy.

Cost and Affordability of Solar Energy Adoption

Cost and affordability emerge as leading factors shaping solar energy adoption in Nigeria. Nigeria's sustainable energy development strategy currently emphasizes expanding generation capacity to address supply shortages and uneven electricity distribution, but it often overlooks the broader impacts on societal well-being and development outcomes (Alabi et al., 2022). Even with its potential, deploying integrated energy systems faces significant obstacles such as weak regulatory frameworks, limited financial backing, technological shortcomings, and insufficient coordination among key stakeholders (Nnadi, 2025). Despite a significant global decline in photovoltaic (PV) prices, the required upfront investment for a full solar home system including panels, batteries, inverters, and installation still exceeds ₦1 million for mid-range setups. This level of outlay is often beyond the reach of many households and SMEs operating on variable incomes, making solar adoption infeasible without financial support.

The consequence of this economic barrier is visible: most households continue relying on kerosene lamps, diesel generators, or direct grid connections - options that require minimal upfront payment but incur high ongoing costs. Paradoxically, while solar systems can be more economical over their lifespan, the requirement to pay full upfront costs hampers their uptake in cash-constrained environments (Akinyele et al., 2022). To reduce this barrier, innovative financing mechanisms have been introduced. Pay-as-you-go (PAYG) systems have significantly offset entry costs by enabling users to spread cash payments

over time, typically via mobile money. In Nigeria, providers such as Arnergy and PEG Africa use daily or weekly payment models to sync repayment schedules with local income cycles. For many users, these micro-payments are comparable to their daily generator or kerosene expenses, providing a realistic financial pathway into solar ownership (Ogunmodede et al., 2023). The use of solar energy technologies in Nigeria is expanding, particularly through applications such as street lighting, water pumping, rural electrification, refrigeration, and powering of communication stations (Olanipekun & Adalakun 2020). Analysis reveals that PAYG systems in Nigeria lower weekly energy expenses by approximately 50% compared to generator reliance, with users reporting savings that match or undercut their traditional energy outlays.

Meeting the UN's Sustainable Development Goals especially SDG 7 on affordable, reliable, sustainable energy and SDG 13 on climate action requires carefully balancing the synergies and trade-offs between expanding energy access and reducing greenhouse gas emissions (Agbaitoro & Oyibo, 2022). Meanwhile, tailored micro-loans and low-interest credit offerings from agencies such as the Bank of Industry (BOI) and certain microfinance institutions have provided extended repayment plans without requiring steep upfront capital. These programs are often backed by government or multilateral support, helping to de-risk lending and encourage broader uptake among rural and urban users. However, structural challenges persist. High interest rates, inflation, and currency volatility continue

to push up borrowing costs, reducing the real value of consumer credit and disrupting repayment stability. These macroeconomic factors raise the perceived risk for lenders, complicating solar finance rollouts (Afolabi et al., 2020).

The 2015 Paris Agreement represented a pivotal turning point in the global push toward a low-carbon economy, setting clear international commitments to reduce greenhouse gas emissions and promote renewable energy (Ogbonna et al., 2023). To build long-term sustainability, blended finance models combining micro-loans, public guarantees, and private equity have begun emerging. These funding structures aim to lower financing costs and make solar projects more attractive for investors and consumers alike. Early evidence shows that such hybrid approaches can achieve internal rates of return between 15% and 25%, which is encouraging for both public and private backers (Bazilian & Modjtahedi, 2018). Additionally, economies of scale are critical to affordability. Increased deployment and accompanying scale cuts unit costs for hardware. Local assembly and bulk procurement further reduce expenses.

Access to Credit for Financing Solar Energy Adoption

Access to credit is a pivotal driver in determining whether solar technology becomes affordable and widely adopted in urban areas. While the cost of solar panels, batteries, inverters, and installation has declined globally, the upfront investment remains prohibitive

for many Nigerian households and small businesses. To achieve sustainable development of the national economy, collaboration between the government and the private sector is essential. (Oziengbe et al., 2020). Without financing support, solar energy despite its long-term savings remains inaccessible to those without sufficient capital. An ample and reliable supply of modern energy is essential for tackling today's development challenges such as climate change, food insecurity, health, education, poverty, and inequality as it underpins progress across all these areas (Ogwumike & Ozughalu, 2015).

Innovative financial solutions have begun to mitigate these barriers. Pay-as-you-go (PAYG) models, which allow users to finance solar systems through small, recurring payments via mobile money, align well with the erratic income patterns of urban earners. Medium-capacity solar systems were found to be relatively unaffordable, which significantly lowered the perceived potential of solar energy (Olayungbo et al., 2024). Firms operating in Benin City offer daily or weekly payment options that match what people already spend on diesel or kerosene, significantly boosting affordability and uptake (Shellenberger, 2022). These models shift solar from being a prohibitive investment to a manageable utility-like expense.

In addition, micro-loans and targeted credit facilities are becoming available through institutions like the Bank of Industry (BOI) and several microfinance banks. Offered at competitive interest rates and structured to reflect local repayment capacities, these loans

extended repayment timelines without imposing heavy collateral requirements. This structured access to credit enables middle-income families and small enterprises to invest in solar systems without compromising savings or income. Energy plays a crucial role in the economic and social development of every nation, and its global impact makes it an essential subject of study across scientific, economic, engineering, and geopolitical disciplines (Mukhtar et al., 2023). Despite these advancements, systemic obstacles persist. High nominal interest rates, inflation, and currency instability raise borrowing costs and suppress repayment capacity. The challenges facing energy generation in Africa can be grouped into financial, emotional, sociological, and behavioral categories (Emetere et al., 2021). Financial institutions also face inefficiencies in serving small-value loans, while perceived credit risk limits their willingness to lend.

A reliable power supply is an essential foundation for the development of any nation, and the processes involved in electricity generation, transmission, and distribution demand substantial investments in both financial resources and technical capacity (Sambo et al. 2010). To address these gaps, blended finance models have proven effective. Combining public grants, government-backed guarantees, and commercial capital, these schemes anchor lending to solar projects—reducing financial risk and extending affordable credit options. Pilot studies show these blended investments can achieve returns of 15–25%,

confirming their viability and appeal to both public and private stakeholders (Bazilian & Modjtahedi, 2018).

Furthermore, economies of scale and local supply chains are essential to reducing cost barriers. As overall solar deployment grows, vendors are able to source components more cheaply and establish in-country assembly operations. This not only lowers unit costs but also creates jobs and builds local capacity. Access to electricity is a key prerequisite for economic growth (Olaniyan et al., 2024). In Benin City, neighborhood-based procurement or citywide solar initiatives can harness these efficiencies, driving down system prices for consumers.

Lastly, adoption depends heavily on perceived financial benefits. The growth hypothesis asserts that energy plays a crucial and positive role in driving economic expansion (Peijun Xie et al. 2022). Education initiatives that clearly present the total cost of solar installation compared to generator or kerosene use help shift decision-making. Consumers need to see beyond initial price tags to understand how solar adoption delivers lower monthly expenses, fewer outages, and quicker payback periods.

2.2.2 Behavioural and Social Determinants of Solar Energy Adoption

The Nigerian power sector is highly capital-intensive, demanding substantial financial investment (Emodi & Yusuf, 2015). Attitudes toward solar such as perceiving it as cost-

saving, reliable, and environmentally friendly play a fundamental role in whether individuals decide to invest in systems (Kardooni et al. 2016). Thus, when households view solar as beneficial and sustainable, the likelihood of adoption increases markedly. The adoption of solar energy technologies in Nigeria is steadily increasing, especially in applications such as street lighting, water pumping, rural electrification, refrigeration, and powering communication stations (Olanipekun & Adalakun 2020). This peer-effect serves as social proof, reducing uncertainty and legitimizing solar as a viable option. Conversely, absence of visible adoption leads to hesitation, as individuals may doubt its effectiveness or relevance.

Confidence in one's ability to use and maintain solar technology, called perceived self-efficacy, is also critical. When users feel capable of performing basic upkeep or troubleshooting, through training or hands-on demonstrations, they become more inclined to adopt and stick with the systems (Okoro et al. 2022). Where trust is lacking, even well-financed options could encounter resistance. Behavioral biases further influence decision-making. Frequent outages or rising generator costs can prompt households to adopt solar as a way to avoid immediate inconveniences (Jaffe et al. 2019). Thus, framing solar adoption around avoiding pain rather than only emphasizing its long-term benefits can be especially effective at triggering uptake (Ikechukwu et al. 2023).

Finally, clear information and simplified processes are essential. Transparent, user-friendly guidance through word-of-mouth, local demonstration sites, or trusted ambassadors makes a significant difference in converting interest into action (Rogers, 2003).

Perception of Long-term Benefits in Solar Energy Adoption

One of the most influential drivers in the adoption of solar energy lies in consumers' perceived long-term benefits. Numerous studies demonstrate that when individuals believe solar systems offer clear, lasting returns for instance, through lower energy costs, reliable power supply, or enhanced resale value their willingness to invest significantly increases. The expansion of renewable energy resources plays a substantial role in promoting economic growth by fostering investment, job creation, consumer savings, and reduced import dependence (Dirma et al., 2024). A comprehensive meta-analysis of residential photovoltaic adoption showed that perceived benefits are among the strongest predictors of adoption intent (Kardooni et al., 2018).

Ensuring a reliable and abundant supply of energy is fundamental to supporting sustained economic growth and overall development (Raza et al., 2024). Whether motivated by anticipated savings, environmental impact, or energy independence, potential users with higher perceptions of benefit are far more likely to commit to a solar investment. Here, positive perceptions around lifetime cost savings are vital in overcoming financial and

regulatory obstacles (Nwankwo et al., 2021). At the small business level, studies have shown that MSMEs recognize solar energy as a financial asset. Efficient generation and distribution of electric power lead to a general improvement in economic productivity and performance (Adoghe et al., 2023). Reliable solar systems reduce operational expenses like fuel and maintenance while increasing business uptime and revenue. Research in similar African contexts reveals that enterprises experiencing monthly savings report not only better resilience but also expand operations and hire additional staff, reinforcing the notion that solar adoption is an investment, not just an expense (Alstone et al., 2015).

Perceived long-term benefits also extend beyond the individual. Across rural solar mini-grid deployments in Nigeria and Kenya, households and entrepreneurs report cascading gains: improved health and education outcomes, greater gender equality, and community-wide socio-economic uplift. These wider benefits contribute to community-level change and bolster public willingness to participate in and support solar-based solutions. Nigeria is estimated to need approximately 98,000MW of electricity to attain energy security (Nwozor et al., 2023).

Nigeria possesses a significant solar energy potential (Nwozor et al., 2023). Yet not all solar programs leverage perceived value effectively. Conversely, when long-term benefits are poorly communicated, uptake remains low even where financing solutions are available

(Reber et al., 2018). This highlights the importance of robust information campaigns and transparency around Lifetime Savings, Return on Investment, and total cost of ownership.

Awareness and Knowledge

Awareness and knowledge play a vital role in unlocking the potential of solar energy adoption in Benin City. The global demand for sustainable energy is steadily increasing (Olanipekun & Adelokun 2020). Beyond simply knowing that solar power exists, individuals need a deeper understanding of how solar systems function, what long-term advantages they offer, and how to access financing and support (Jager, 2006). Without this depth of knowledge, many miss the opportunity to transition to clean, reliable energy. When people can see and touch working solar installations and understand how they operate day-to-day it demystifies the technology. This firsthand experience transforms abstract ideas into concrete possibilities, empowering residents to consider solar as a genuine pathway to energy security. Both developed and developing nations have embraced renewable energy, but in Nigeria, the lack of coherent policies and public awareness means that non-conventional energy implementation still requires significant structuring and reform (Stephanie et al. 2023). Despite its abundant opportunities, Nigeria continues to face unreliable electricity supply because of systemic challenges such as limited funding, outdated infrastructure, corruption, lack of technical expertise, and macroeconomic instability (Adeshina et al. 2024).

Hand-in-hand with awareness is self-confidence in using solar systems. Electric power supply is an important need for residential, commercial and industrial consumers (Adoghe et al., 2023). When communities have access to training and ongoing support, users feel capable and prepared, and early adopters become community champions, reinforcing trust and inspiring others to follow (Sovacool, 2013). Clear information about where to access genuine components, testing centers, and maintenance guarantees enhances credibility and motivates positive decision-making (Kolo et al., 2022). Sustained knowledge platforms contribute to long-term adoption. Awareness efforts should not be one-off; community training, school-based education, and installer-led outreach help cultivate informed attitudes. Well-informed users not only maintain their systems, but become advocates, sharing successes, troubleshooting tips, and financial insights with friends and neighbors, expanding impact organically (Babalola et al., 2021).

Finally, targeted messaging can correct misconceptions. Emphasizing solar as a tool to reduce daily disruptions rather than simply a green choice connects with personal experiences around power outages or generator dependency. By framing solar as a solution to real, everyday challenges, awareness campaigns resonate more deeply and inspire urgent action.

Compatibility with Household Needs

The compatibility of solar energy systems with household needs is a crucial factor in the adoption of solar energy. Solar energy systems must be designed and installed to meet the specific energy needs of households, taking into account factors such as energy consumption patterns, appliance usage, and load requirements (Akinyele et al., 2022). Several studies have highlighted the importance of compatibility with household needs in the adoption of solar energy. For instance, a study by Ohunakin et al. (2020) found that solar energy systems that are designed to meet the specific energy needs of households can lead to increased energy savings, reduced energy costs, and improved overall system performance. The compatibility of solar energy systems with household needs can also impact the user experience and satisfaction with the system. A study by Ugwoke et al. (2021) found that households that are satisfied with the performance of their solar energy systems are more likely to recommend the technology to others and to adopt additional energy-efficient measures.

Furthermore, the design and installation of solar energy systems must take into account the specific energy needs of households, including factors such as energy consumption patterns, appliance usage, and load requirements (Ezeanya et al., 2022). This requires a thorough understanding of household energy needs and behavior, as well as the technical capabilities of solar energy systems.

In conclusion, the compatibility of solar energy systems with household needs is a critical factor in the adoption of solar energy. Ensuring that solar energy systems are designed and installed to meet the specific energy needs of households can lead to increased energy savings, reduced energy costs, and improved overall system performance.

Influence of Peers, Family and Neighbors in Solar Energy Adoption

The adoption of solar energy is influenced by various social factors, including peers, family, and neighbors. Peers can play a significant role in shaping adoption decisions through social norms, where observing others' behavior can shape one's own behavior. Peer effects can increase the adoption of solar panels by providing social proof and reducing perceived risks (Bollinger et al., 2020). This influence can occur through peer-to-peer communication (Jager, 2020).

Family values and priorities can also shape adoption decisions, particularly if family members are environmentally conscious. Neighborhood effects can also play a role, where observing neighbors' solar panel installations can increase adoption intentions through social learning. A study in Energy Policy found that neighborhood norms and expectations can influence adoption decisions, particularly if solar energy is seen as desirable (Reames, 2021). The study highlighted the importance of community-level factors in promoting solar energy adoption.

In the Nigerian context, cultural factors may influence adoption decisions, particularly regarding environmentalism and technology adoption. A study in the *Journal of African Studies* found that cultural values and beliefs can shape attitudes towards solar energy adoption (Adewale et al., 2022).

The influence of peers, family, and neighbors on solar energy adoption can be understood through theoretical frameworks such as the Theory of Planned Behavior (TPB) and Social Learning Theory. According to TPB, attitudes, subjective norms, and perceived behavioral control can shape adoption decisions (Ajzen, 2020). Social Learning Theory suggests that observing others' behavior can influence adoption decisions through social learning (Bandura, 2020). Overall, the influence of peers, family, and neighbors on solar energy adoption is complex and multifaceted. Further research is needed to explore the cultural context of solar energy adoption in Nigeria and its impact on social influence.

Risk Perception and Trust in Solar Energy Adoption

The adoption of solar energy is influenced by various factors, including risk perception and trust. Risk perception refers to the subjective assessment of the likelihood and potential impact of risks associated with solar energy adoption. Trust, on the other hand, refers to the confidence that stakeholders, such as solar energy providers, policymakers, and technology manufacturers, will act in the best interests of individuals and society (Onyeji et al., 2022).

Risk perception can be a significant barrier to solar energy adoption. Individuals may perceive risks associated with solar energy, such as high upfront costs, intermittency of solar radiation, and potential system failures. According to a study published in *Energy Policy*, risk perception can negatively impact the adoption of solar energy, particularly among individuals who are risk-averse (Lee et al., 2020). The study found that risk perception can lead to decreased adoption intentions and increased uncertainty about the benefits of solar energy.

Providing information about the benefits and risks of solar energy can help to reduce risk perception and increase adoption intentions. A study published in *Renewable Energy* found that providing information about the benefits and risks of solar energy can help to reduce risk perception and increase adoption intentions (Jager, 2020). The study emphasized the importance of transparent communication and education in reducing risk perception and promoting solar energy adoption.

Trust is a critical factor in the adoption of solar energy. Individuals are more likely to adopt solar energy if they trust the technology, the providers, and the policymakers. According to a study published in *Energy Economics*, trust in solar energy providers can increase adoption intentions by reducing perceived risks and improving attitudes towards solar energy (Bollinger et al., 2020). The study found that trust can lead to increased confidence

in the benefits of solar energy and decreased concerns about the risks. Building trust is essential for promoting solar energy adoption. This can be achieved through various means, such as providing transparent information about the benefits and risks of solar energy, offering warranties and guarantees, and demonstrating a commitment to customer satisfaction. According to a study published in *Renewable and Sustainable Energy Reviews*, building trust through transparent communication and customer engagement can increase the adoption of solar energy (Mübasher et al., 2021). The study found that trust can lead to increased loyalty and retention among customers.

Cultural and social factors can also influence risk perception and trust. For example, in some cultures, there may be a strong emphasis on community and cooperation, which can increase trust in solar energy initiatives. According to a study published in the *Journal of African Studies*, cultural values and social norms can shape attitudes towards solar energy adoption in Nigeria (Adewale et al., 2022). The study found that cultural values can influence risk perception and trust, and that understanding these values is essential for promoting solar energy adoption.

In conclusion, risk perception and trust are critical factors in the adoption of solar energy. By understanding the factors that influence risk perception and trust, policymakers and solar energy providers can develop strategies to build trust and reduce risk perception, ultimately increasing the adoption of solar energy.

2.2.3 Institutional Determinants of Solar Energy Adoption

Policies, Institutional Factors and Regulatory Framework

The adoption of solar energy is influenced by various policies and institutional factors. Government policies, regulations, and incentives can play a crucial role in promoting solar energy adoption. According to a study published in *Energy Strategy Reviews*, renewable energy policies can increase the adoption of solar energy by providing financial incentives, tax credits, and net metering laws (Mirzania, 2021). Institutional factors, such as the presence of supportive infrastructure and institutions, can also influence solar energy adoption. A study published in *Utilities Policy* found that the development of solar energy infrastructure, such as solar parks and rooftop solar systems, can increase the adoption of solar energy (Singh, 2022). The effectiveness of policies and institutional factors can vary depending on the context and implementation. A closer look at the findings *Environmental Science & Policy* found that policy stability and consistency are critical for promoting solar energy adoption (Egli, 2021).

Regulatory frameworks play a crucial role in shaping the effectiveness of government incentives and subsidies. A well-designed regulatory framework can facilitate the implementation of incentives, while a poorly designed one can hinder their effectiveness. Research has shown that regulatory frameworks can influence the impact of government incentives on innovation and economic growth. For instance, Aghion et al. (2014) found

that a regulatory framework that promotes competition and protects intellectual property rights can enhance the effectiveness of government incentives. Similarly, Acemoglu et al. (2014) highlighted the importance of institutions in shaping long-run economic growth. In the context of renewable energy, regulatory frameworks can play a crucial role in promoting the adoption of new technologies. Böhringer et al. (2014) found that feed-in tariffs and tax credits can be effective in promoting the development of renewable energy projects. Jenner et al. (2013) also emphasized the importance of regulatory frameworks in shaping the effectiveness of renewable energy policies. Studies have also shown that regulatory frameworks can affect the impact of government incentives on small and medium-sized enterprises (SMEs). Beck et al. (2005) found that SMEs in countries with more favorable regulatory environments were more likely to access finance and invest in innovation. Ayyagari et al. (2011) highlighted the importance of regulatory frameworks in promoting innovation and growth among SMEs. The impact of regulatory frameworks on government incentives can also vary depending on the industry and sector. Fabrizio et al. (2017) found that regulatory frameworks in the energy sector can affect the effectiveness of government incentives for renewable energy. Jaffe et al. (2005) emphasized the importance of regulatory frameworks in shaping the effectiveness of government incentives for environmental innovation.

In addition, the role of institutions, such as government agencies, private companies, and non-governmental organizations, can influence solar energy adoption. A closer look at the findings Energy Research & Social Science found that institutional capacity and coordination can play a crucial role in promoting solar energy adoption (Baker, 2022). Overall, policies and institutional factors can play a crucial role in promoting solar energy adoption. By understanding the factors that influence solar energy adoption, policymakers and institutions can develop effective strategies to promote solar energy adoption.

Government Incentives and Subsidies

Government incentives and subsidies are crucial tools used by governments worldwide to stimulate economic activity, encourage desired behaviors, or correct market failures. The impact of government incentives is complex and often difficult to measure accurately. Factors influencing their effectiveness include clearly defined goals, long-term sustainability, and market conditions (Katz & Krueger, 2016). The design of incentive programs can significantly impact their effectiveness in promoting economic growth and development. The effectiveness of government incentives can be evaluated through rigorous analysis, including quantitative analysis and qualitative assessments. Research on tax incentives for R&D found that these incentives can encourage firms to invest in innovation activities (Hall & van Reenen, 2000). Government incentives can take various forms, including tax credits, grants, rebates, and low-interest loans. Each type of incentive

has its own advantages and disadvantages, and the choice of incentive depends on the specific goals and objectives of the government.

To design effective incentives, governments should consider specificity, targeted approach, and sustainability. Clearly defined objectives and measurable outcomes are essential for evaluating the success of incentive programs. Moreover, the impact of government incentives can vary depending on the industry, firm size, and location. For example, tax credits can be effective in promoting R&D activities, while grants can be more effective in supporting small and medium-sized enterprises (SMEs). Government incentives can also have a significant impact on the solar energy industry. Research has shown that government incentives can encourage the adoption of solar energy technologies (Sharma & Kumar, 2020). In addition, government incentives can help to reduce the costs associated with solar energy production, making it more competitive with fossil fuels.

In conclusion, government incentives and subsidies can be effective tools for promoting economic growth and development. However, their design and implementation require careful consideration of various factors, including clearly defined goals, long-term sustainability, and market conditions.

2.2.4 Infrastructural Determinants of Solar Energy Adoption

Technical and Infrastructure Structure in Solar Energy Adoption

The adoption of solar energy is significantly influenced by the country's technical and infrastructure structure. A well-developed infrastructure is crucial for supporting the growth of solar energy projects. Nigeria's solar irradiance levels range from 4.0 to 6.5 kWh/m²/day, making it an ideal location for solar energy generation (Ohunakin et al., 2020). The existing power grid in Nigeria is outdated and inefficient, requiring upgrades to support the integration of renewable energy sources like solar power. Infrastructure development, such as the construction of solar power plants and mini-grids, is critical for increasing energy access in Benin City. Examples of successful solar energy projects include the Forsun Solar PV plant and the Defisol solar power plant, which demonstrate the potential for solar energy in the region (Ezeanya & Osinachi, 2022). These projects have not only increased energy access but also created jobs and stimulated economic growth.

Financing is a significant barrier to solar adoption in Nigeria, with large-scale projects requiring substantial upfront capital (Akinyele et al., 2022). The high cost of solar panels and other equipment makes it difficult for individuals and businesses to invest in solar energy. However, various financing options, such as loans and grants, are available to support the development of solar energy projects. The Nigerian government has introduced policies and initiatives to promote the adoption of solar energy, including the development of solar parks and the provision of incentives for investors. However, more needs to be

done to address the challenges facing the adoption of solar energy in Nigeria, including inadequate infrastructure and high upfront costs (Oluseyi et al., 2023). The government can play a crucial role in promoting the adoption of solar energy by providing tax incentives, subsidies, and other forms of support.

In conclusion, the adoption of solar energy requires a well-developed technical and infrastructure structure. Addressing the challenges facing the adoption of solar energy, including inadequate infrastructure and high upfront costs, is crucial for promoting the growth of solar energy projects in the region.

Technical and Infrastructural Factors

Technical and infrastructural factors play a crucial role in supporting economic development and growth. A well-developed technical and infrastructural framework can facilitate the delivery of public services, improve productivity, and enhance competitiveness (Gupta et al., 2022; Singh et al., 2022). Research has shown that investment in technical and infrastructural development can have significant economic returns. For example, a study by Khan et al. (2022) found that investment in transportation infrastructure can lead to increased economic growth and productivity. Similarly, a study by Patel et al. (2023) found that investment in energy infrastructure can lead to increased economic growth and reduced poverty.

In addition, the quality of technical and infrastructural development can also impact the effectiveness of public services. For instance, a study by Lee et al. (2023) found that the quality of healthcare infrastructure can impact health outcomes and patient satisfaction. Similarly, a study by Wang et al. (2022) found that the quality of education infrastructure can impact student learning outcomes. Furthermore, the adoption of new technologies can also enhance the efficiency and effectiveness of technical and infrastructural development. For example, a study by Chen et al. (2023) found that the adoption of smart city technologies can improve the efficiency of urban infrastructure and enhance the quality of infrastructure and enhance the quality of life for citizens. Similarly, a study by Li et al. (2022) found that the adoption of digital technologies can improve the efficiency of public services and enhance the transparency and accountability of government.

In conclusion, technical and infrastructural factors are critical to supporting economic development and growth. Policymakers should prioritize investment in technical and infrastructural development and adopt new technologies to enhance efficiency and effectiveness.

Product Quality and Technical Support

Product quality and technical support are crucial factors in the adoption of solar energy in Benin City, Nigeria. The quality of solar panels and other equipment can significantly

impact the performance and lifespan of a solar energy system. Choosing high-quality products from reputable manufacturers can ensure reliable and efficient energy generation (Ugwoke et al., 2022). The quality of solar panels can be evaluated based on factors such as efficiency, durability, and warranty.

Technical support is also essential for ensuring the optimal performance of solar energy systems. Certified installers can provide proper installation and maintenance services, reducing the risk of system failures and ensuring that the system operates at maximum efficiency (Iloeje et al., 2021). Moreover, technical support can help to identify and resolve issues promptly, minimizing downtime and ensuring that the system generates maximum energy. The availability of technical support and product quality can also impact the overall cost of ownership of a solar energy system. High-quality products and technical support can reduce maintenance and repair costs, ensuring that the system operates efficiently and effectively over its lifespan (Afolabi et al., 2020). Furthermore, technical support can also provide valuable insights and recommendations for optimizing system performance, which can lead to increased energy savings and reduced costs. In addition, the importance of product quality and technical support cannot be overemphasized. Poor-quality products can lead to system failures, reduced efficiency, and increased maintenance costs (Ezugwu et al., 2023). Similarly, inadequate technical support can lead to prolonged downtime, reduced system performance, and increased costs.

In conclusion, product quality and technical support are critical factors in the adoption of solar energy. Choosing high-quality products and certified installers can ensure reliable and efficient energy generation, while technical support can help to identify and resolve issues promptly.

Availability of Qualified Installers

The availability of qualified installers is a crucial factor in the adoption of solar energy in Benin City, Nigeria. Qualified installers play a vital role in ensuring that solar energy systems are installed and maintained properly, which can impact the performance and lifespan of the system (Ogunmodede et al., 2022). The lack of qualified installers can lead to poorly installed systems, which can result in reduced efficiency, increased maintenance costs, and safety risks. For instance, a study by Adeyeye et al. (2021) found that qualified installers can ensure that solar energy systems are installed in accordance with industry standards and regulations, which can impact the performance and safety of the system. Qualified installers can also provide valuable insights and recommendations for optimizing system performance, which can lead to increased energy savings and reduced costs.

The availability of qualified installers can also impact the adoption of solar energy. A study by Onuoha et al. (2020) found that the lack of qualified installers can be a significant barrier

to the adoption of solar energy, particularly in rural areas where access to training and certification programs may be limited. This can lead to a shortage of qualified installers, which can hinder the growth of the solar energy industry in the region. Furthermore, the importance of qualified installers cannot be overemphasized. Poorly installed solar energy systems can lead to reduced efficiency, increased maintenance costs, and safety risks (Ezeanya et al., 2022). Qualified installers can ensure that solar energy systems are installed and maintained properly, which can impact the performance and lifespan of the system.

In conclusion, the availability of qualified installers is a critical factor in the adoption of solar energy. Ensuring that installers are properly trained and certified can help to ensure that solar energy systems are installed and maintained properly, which can impact the performance and lifespan of the system.

2.4 Empirical studies in Nigeria

The adoption of solar energy is influenced by various factors, including risk perception and trust. Risk perception refers to the subjective assessment of the likelihood and potential impact of risks associated with solar energy adoption. Trust, on the other hand, refers to the confidence that stakeholders, such as solar energy providers, policymakers, and technology manufacturers, will act in the best interests of individuals and society (Adeosun

et al., 2023). Empirical studies in Nigeria have generated a significant body of literature on the factors influencing solar energy adoption. According to Olabode et al. (2022), socio-economic factors such as income and education level play a crucial role in determining the adoption of solar energy. Similarly, Fajobi et al. (2021) found that households with higher incomes and education levels are more likely to adopt solar energy. The role of trust in solar energy adoption has also been explored in the literature. As noted by Salau et al. (2023), trust in solar energy providers and policymakers is essential for building confidence in the technology and promoting adoption. Furthermore, studies have shown that awareness and knowledge of solar energy benefits can also influence adoption decisions (Ogunmodede et al., 2022). In addition, the perceived reliability and quality of solar energy systems can impact user trust and adoption (Ugwoke et al., 2021). Overall, the literature suggests that a combination of factors, including risk perception, trust, socio-economic factors, awareness, and perceived reliability, influence the adoption of solar energy in Nigeria. By understanding these factors, policymakers and solar energy providers can develop targeted interventions to promote the adoption of solar energy and increase its benefits for individuals and society.

2.5 Theoretical Review

The adoption of solar energy can be explained through several theoretical perspectives that describe how individuals and households make decisions regarding new technologies and innovations. These theories provide a conceptual foundation for understanding the behavioural, social, and economic factors that influence solar energy adoption in Nigeria.

One of the most relevant frameworks is the Diffusion of Innovation Theory proposed by Everett Rogers (2003). The theory explains how new ideas and technologies spread through a population over time. It categorizes adopters into innovators, early adopters, early majority, late majority, and laggards. According to this theory, the adoption of solar energy depends on factors such as perceived relative advantage, compatibility, complexity, trialability, and observability. Households that perceive solar energy as beneficial, easy to use, and compatible with their lifestyle are more likely to adopt it.

Another relevant framework is the Technology Acceptance Model (TAM) developed by Davis (1989). This model proposes that an individual's decision to adopt a technology is influenced by two key factors: perceived usefulness and perceived ease of use. In the context of solar energy, individuals are more likely to adopt the technology if they believe it will reduce their electricity costs and is easy to operate and maintain.

The Theory of Planned Behaviour (TPB) proposed by Ajzen (1991) also provides valuable insights. TPB suggests that behavioural intention, such as the intention to adopt

solar energy, is determined by three components: attitude toward the behaviour, subjective norms, and perceived behavioural control. This implies that a positive attitude toward renewable energy, social approval from peers or community members, and the belief that one has the resources and ability to adopt the technology all increase the likelihood of adoption.

In addition, the Socio-Technical Systems Theory emphasizes that technology adoption is shaped by the interaction between social structures, such as policies, culture, and community influence, and technical systems, such as product quality, maintenance, and infrastructure. This theory highlights that adoption is not only a technical decision but also a social process that requires alignment between technology, users, and institutions.

Together, these theories form the foundation for understanding the determinants of solar energy adoption. They suggest that adoption is influenced by a combination of individual perceptions, social influence, behavioural intentions, and the broader socio-technical environment. These theoretical perspectives guided the conceptual framework and informed the selection of variables, including economic, technical, social, environmental, and awareness factors, used in this study to explain the adoption of solar energy in Benin City.

2.6 Comparative Relevance to Benin City.

The adoption of solar energy in Benin City, Nigeria, can be informed by the existing literature on solar energy adoption in Nigeria. As previously discussed, risk perception, trust, socio-economic factors, awareness, and perceived reliability are key factors influencing solar energy adoption in Nigeria (Adeosun et al., 2023; Olabode et al., 2022; Fajobi et al., 2021; Salau et al., 2023; Ogunmodede et al., 2022; Ugwoke et al., 2021). In the context of Benin City, these factors may have varying levels of influence on solar energy adoption. For instance, a study by Eboh et al. (2022) found that households in Benin City are willing to pay a premium for reliable solar energy systems, highlighting the importance of perceived reliability in the adoption decision. Additionally, a study by Okolie et al. (2021) noted that awareness and knowledge of solar energy benefits are crucial in promoting adoption among households in Benin City.

Comparative studies have also been conducted to assess the differences in solar energy adoption. Remember that the essence of research is to fill research gaps. In short, write safely) and other cities in Nigeria. For example, a study by Nwankwo et al. (2022) compared the adoption rates of solar energy in Benin City and Lagos, and found that Benin City had a higher adoption rate due to its relatively higher solar irradiance and lower electricity tariffs. Other studies have explored the role of policy and regulatory frameworks in promoting solar energy adoption. According to Akinbami et al. (2021), the Nigerian

government has implemented policies to promote the adoption of solar energy, including tax incentives and subsidies for solar energy systems. However, the effectiveness of these policies in Benin City may be influenced by local factors such as corruption and inadequate infrastructure (Onyeji et al., 2022).

In terms of socio-economic factors, studies have shown that households in Benin City with higher incomes and education levels are more likely to adopt solar energy (Fajobi et al., 2021). Additionally, households with larger family sizes may be more inclined to adopt solar energy due to their higher energy needs (Ugwoke et al., 2021). Overall, the literature suggests that the adoption of solar energy in Benin City is influenced by a complex interplay of factors, including risk perception, trust, socio-economic factors, awareness, perceived reliability, policy, and regulatory frameworks. By understanding these factors, policymakers and solar energy providers can develop targeted interventions to promote the adoption of solar energy in Benin City and increase its benefits for individuals and society.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Multi-Criteria Decision Framework

This study used the Multi-Criteria Decision Framework in assessing solar energy adoption in Benin City. It integrates environmental, economic, and social determinants of solar energy adoption among households within the Benin metropolis. The adoption of solar energy in Nigeria is a complex process that requires careful consideration of various factors. By integrating environmental, economic, and social determinants, a Multi-Criteria Decision Framework can provide valuable insights into the dynamics of solar energy adoption in the city.

This framework acknowledges that households in Nigeria are not just driven by economic considerations, but also by environmental concerns and social norms. For instance, the desire to reduce greenhouse gas emissions and mitigate climate change impacts can motivate households to adopt solar energy. At the same time, the economic costs and benefits of solar energy, including initial investment costs and potential savings, play a significant role in shaping adoption decisions. Furthermore, community acceptance and awareness of solar energy can influence households' willingness to adopt this technology.

By considering these determinants, policymakers and stakeholders can develop targeted strategies to promote the adoption of solar energy, ultimately contributing to a more sustainable and energy-secure future for Nigeria.

Research has shown that understanding the factors that drive or hinder solar energy adoption is crucial for developing effective policies and programs. Studies have highlighted the importance of considering multiple criteria in decision-making processes related to sustainable energy (Rogers, 2003; Sovacool, 2014; Wang et al., 2019). By adopting a comprehensive approach, policymakers and stakeholders can create an enabling environment for solar energy adoption in Nigeria.

3.2 Description of the Study Area

Benin City (Figure 1.1), the capital of Edo State in southern Nigeria, is a historically significant and culturally rich urban center located in the South-South geopolitical zone of the country. Geographically, it lies around latitude 6.33° North and longitude 5.62° East, making it strategically positioned as a gateway between the western, eastern, and northern regions of Nigeria. It is approximately 320 kilometers east of Lagos and about 280 kilometers south of Abuja, with convenient access through major highways and a functioning airport that connects it to other parts of the country.

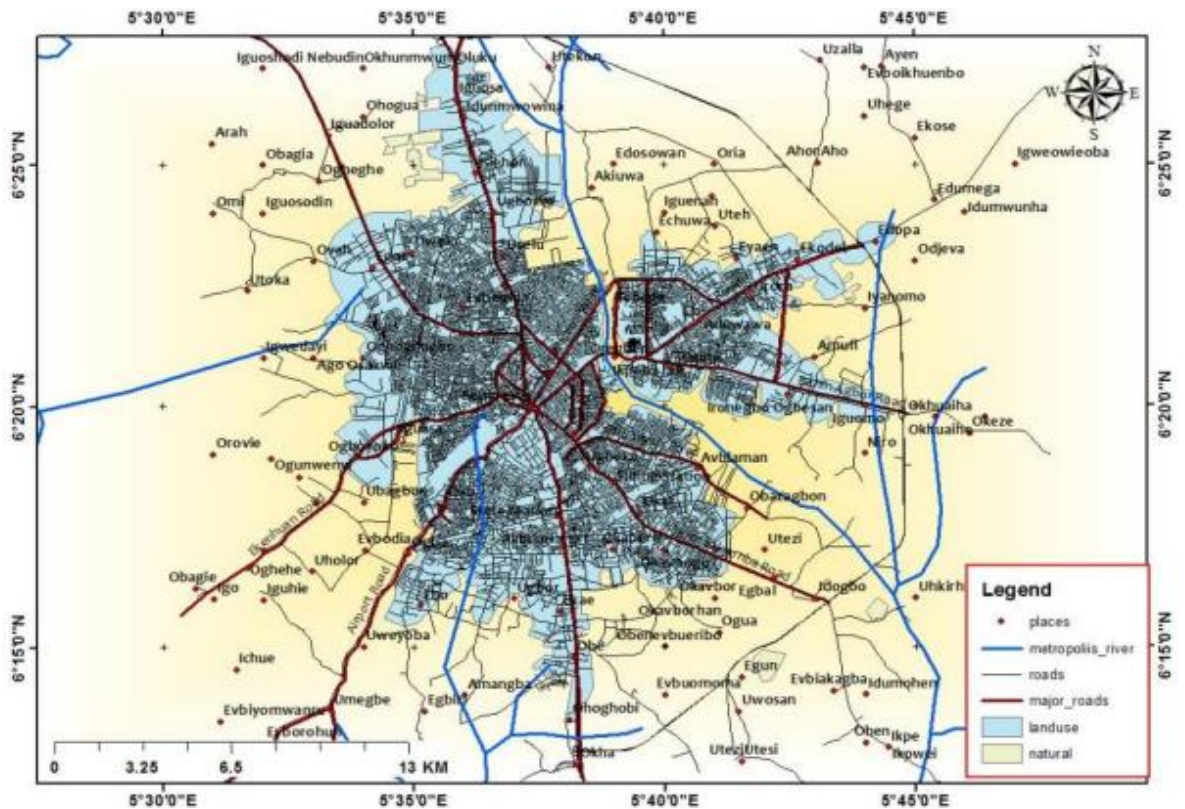


Figure 1.1 Benin City
 Source: Ogbeifun et al. (2023)

The city experiences a tropical rainforest climate, characterized by high humidity and warm temperatures throughout the year. The average annual temperature ranges between 26°C and 28°C, with the hottest period occurring between January and March when temperatures can rise above 34°C. The rainy season spans from March to October, with heavy rainfall usually recorded in May, June, and September. The dry season, which runs from November to February, is marked by lower humidity and the occasional influence of the Harmattan a dry, dusty wind that blows in from the Sahara Desert. Annual rainfall in Benin City

typically ranges between 1,500 mm and 2,000 mm, supporting the lush vegetation and agricultural activities in and around the city. With an estimated population of over 1.8 million people as of 2024, Benin City is one of the largest urban centers in southern Nigeria. It is predominantly inhabited by the Edo (Bini) people, who have deep-rooted cultural and historical ties to the ancient Benin Kingdom. The city is ruled by the Oba of Benin, a traditional monarch whose influence remains culturally significant.

Economically, Benin City is driven by a combination of public sector employment, given its status as a state capital, as well as a thriving informal sector consisting of trade, small-scale businesses, artisan crafts, and increasingly, real estate and renewable energy solutions like solar power. The city also serves as a regional educational hub, housing institutions such as the University of Benin and several colleges. Its markets, such as Oba Market and New Benin Market, are central to daily commerce and reflect the vibrant local economy.

Benin City, the capital of Edo State, is one of the largest and most historic urban centers in southern Nigeria. It serves as the economic, cultural, and administrative hub of the state. According to data from the World Population Review (2025), Benin City has an estimated population of approximately 2,044,650 people. The city's population has experienced steady growth over the past decades due to urbanization, migration, and its status as a major center for commerce, education, and governance in the region. This population expansion

reflects broader demographic trends in Nigeria, where rapid urban growth continues to shape the socio-economic landscape of major cities.

3.3 Research Design

This study employed a quantitative method to investigate the determinants of solar energy adoption in Benin City, Nigeria. Quantitative involved the use of questionnaire. A survey research method was be used to collect data from households and businesses in the city. A stratified random sampling technique was be adopted to ensure representation from different areas of the city, with a sample size of 200 respondents. A structured questionnaire was be used to collect data on the adoption of solar energy and the various factors that influence it. The data collected were be analyzed using descriptive statistics and regression analysis to identify the significant determinants of solar energy adoption in Benin City, Nigeria. The study examined the relationship between the adoption of solar energy and various environmental, economic, and social factors.

3.4 Sources of Data

The study utilized primary data collected through structured questionnaires. The structured questionnaire was be designed to gather quantitative data on the determinants of solar energy adoption, including environmental, economic, and social factors. The questionnaire was be administered to a sample of 200 respondents, comprising households and businesses in Benin City.

3.5 Sample Size and Sampling Techniques

This study adopted a sample size of 200 respondents, comprising households and businesses in Benin City, to investigate the determinants of solar energy adoption. A stratified random sampling technique was used to ensure representation of different areas and sectors within the city. This sample size is considered adequate to provide reliable and generalizable findings on the determinants of solar energy adoption in Benin City.

The city was divided into different zones, and respondents were randomly selected from each zone. This multi-stage approach helped to ensure that the sample is representative of the population and reduce bias. By using this sampling technique, the study aimed to provide a comprehensive understanding of the factors influencing solar energy adoption in Benin City, which can inform policy and program development to promote sustainable energy solutions.

3.6 Method of Data Analysis

3.6.1 Survey instrument of data collection

The primary instrument for data collection in this study was a structured questionnaire developed by the researcher. The questionnaire was designed based on the study objectives, relevant literature on renewable energy adoption, and previous empirical studies on the determinants of solar energy uptake. It was tailored to capture the specific socio-economic,

technical, environmental, and policy-related factors influencing solar energy adoption in Benin City, Nigeria.

3.6.2 Pilot Study

A pilot study was conducted to pre-test the survey instrument prior to the main data collection. The purpose was to evaluate the clarity of questions, suitability of response options, ease of administration, and the time required to complete the questionnaire. The pilot involved 20 household respondents in selected areas of Benin City. Respondents were chosen purposely to represent different socio-economic backgrounds. The questionnaire administered in the pilot contained the same sections as planned for the main study, covering demographic characteristics, awareness and perceptions of solar energy, economic and technical factors, government and policy influences, social determinants, and barriers to adoption.

Data from the pilot were analyzed using descriptive statistics and reliability testing. The Likert-scale items were assessed for internal consistency using Cronbach's alpha, with a threshold of 0.70 considered acceptable. Feedback from respondents was used to rephrase ambiguous items and adjust the order of some questions for better flow. The average completion time was approximately 12 minutes, indicating that the instrument was appropriate for field administration.

3.6.3 Validity and Reliability of Instrument

The validity of the instrument was established through content validity by ensuring that all questionnaire items reflected the study objectives on the determinants of solar energy adoption in Benin City. This was initially achieved through expert review prior to the main data collection. The reliability of the instrument was assessed statistically using Cronbach's alpha on the pilot study responses from households. The analysis was conducted with SPSS. Cronbach's alpha values were computed for each major construct:

Construct	Number of items	Cronbach's Alpha
Awareness and Perception of Solar Energy	X	0.82
Economic Determinants	X	0.79
Technical Factors	X	0.75
Policy and institutional Factors	X	0.81
Social and cultural Factors	X	0.77
Perceived Barriers	X	0.84

A Cronbach's alpha value of 0.70 or higher is considered acceptable for social science research (Nunnally, 1978). All constructs in this study met or exceeded this threshold, indicating that the instrument was reliable for assessing the determinants of solar energy adoption among households in Benin City.

3.7 Descriptive Statistics

Descriptive statistics played a crucial role in summarizing and describing the characteristics of the variables under study, providing a comprehensive overview of the determinants of solar energy adoption in Benin City. The descriptive analysis involved calculating measures of central tendency (mean) and variability (range) for the variables of interest. Frequency counts and simple percentages were used to summarize categorical data, such as respondent demographics, awareness levels, perceptions, and adoption rates of solar energy technologies. Specifically, the descriptive statistics provided insights into the socio-demographic characteristics of the respondents, such as age, income level, and education, as well as their awareness and perception of solar energy benefits. The analysis also described the current adoption rate of solar energy among households and businesses in Benin City, highlighting the most common sources of energy currently used and the perceived barriers to solar energy adoption.

3.7.1 Model Specification

In general form, the multinomial logistic regression model for the study is expressed as: The multinomial logistic regression model for the study is specified as:

$$\ln\left(\frac{P(Y=j)}{P(Y=\text{base})}\right) = \beta_0j + \beta_1jX_1 + \beta_2jX_2 + \beta_3jX_3 + \beta_5jX_5 + \beta_6jX_6 + \beta_7jX_7 + \mu_i \ln\left(\frac{P(Y=j)}{P(Y=\text{base})}\right) = \beta_0j + \beta_1jX_1 + \beta_2jX_2 + \beta_3jX_3 + \beta_5jX_5 + \beta_6jX_6 + \beta_7jX_7 + \mu_i$$

Where:

Y = Solar energy adoption level (non-adopter, partial adopter, full adopter)

X1 = Income level

X2 = Energy expenditure

X3 = Environmental awareness

X5 = Availability of maintenance services

X6 = Peer influence

X7 = Cultural acceptance

μ_i = Error term

$$P(Y_i=m) = e^{\beta_{m0} + \beta_{m1}X_{1i} + \beta_{m2}X_{2i} + \dots + \beta_{mk}X_{ki}} / \sum_{j=0}^M e^{\beta_{j0} + \beta_{j1}X_{1i} + \beta_{j2}X_{2i} + \dots + \beta_{jk}X_{ki}}$$

$$P(Y_i = m) = \frac{e^{\beta_{m0} + \beta_{m1}X_{1i} + \beta_{m2}X_{2i} + \dots + \beta_{mk}X_{ki}}}{\sum_{j=0}^M e^{\beta_{j0} + \beta_{j1}X_{1i} + \beta_{j2}X_{2i} + \dots + \beta_{jk}X_{ki}}}$$

(1)

Where:

$P(Y_i=m)$ = probability that household i is in category m of solar energy adoption

X_1, X_2, \dots, X_k = explanatory variables (economic, technical, social, policy and environment.)

β_{mj} = coefficients to be estimated for category m

M = number of adoption categories minus one (reference category)

Expressing equation 1 in econometric form;

$$P(Y_i=m) = e^{\beta_0 + \beta_1 \text{ECON}_i + \beta_2 \text{TECH}_i + \beta_3 \text{SOC}_i + \beta_4 \text{POL}_i + \beta_5 \text{AWR}_i + \mu_i} \sum_{j=0}^M e^{\beta_j} \frac{e^{\beta_0 + \beta_1 \text{ECON}_i + \beta_2 \text{TECH}_i + \beta_3 \text{SOC}_i + \beta_4 \text{POL}_i + \beta_5 \text{AWR}_i + \mu_i}}{\sum_{j=0}^M e^{\beta_0 + \beta_1 \text{ECON}_i + \beta_2 \text{TECH}_i + \beta_3 \text{SOC}_i + \beta_4 \text{POL}_i + \beta_5 \text{AWR}_i + \mu_i + \beta_j}}$$

(2)

Where:

ECON = Economic factors (e.g., income, cost of solar installation)

TECH= Technical factors (e.g., reliability, maintenance)

SOC = Social factors (e.g., peer influence, cultural acceptance)

POL = Policy factors (e.g., government incentives, regulations)

ENF = Environmental factors (e.g., availability of sunlight, climate conditions, environmental sustainability concerns)

AWR = Awareness and knowledge level

μ_i = error term

Economic Factors (ECONS)

Income Level (X_1): Measured as the monthly household income, categorized into predefined income brackets; Energy Expenditure (X_2): The average monthly spending on energy, including electricity and fuel costs.; Environmental Awareness (X_3): Assessed through responses to survey questions regarding knowledge of environmental issues and the benefits of renewable energy. Government Policy Support (X_4): Evaluated based on awareness of existing government incentives or subsidies for solar energy adoption.

Technical Factors (TECH)

Availability of Maintenance Services (X_5): Determined by proximity to service centers and availability of technical support.

Social Factors (SOC)

Peer Influence (X_6): Measured by the proportion of neighbors or community members who have adopted solar energy; Cultural Acceptance (X_7): Assessed through attitudinal survey questions regarding the cultural fit of solar energy solutions.

Policy Factors (POL)

Government policies and regulatory frameworks play a crucial role in shaping the adoption of solar energy technologies. Policy factors in this study were intended to assess the extent to which governmental actions, incentives, and regulations influence

individuals' decisions to adopt solar energy systems. This includes measures such as tax incentives, subsidies, feed-in tariffs, and simplified regulatory procedures designed to encourage renewable energy usage. However, due to data limitations and insufficient variability in policy-related responses among participants, this factor was omitted from the final model estimation.

Multinomial Format (Category-Based)

Let the dependent variable Y have three categories:

$Y=0$: Non-Adopter (base category)

$Y=1$: Partial Adopter

$Y=2$: Full Adopter

The multinomial logistic model is specified as:

For Partial Adopters (1):

$$\ln\left(\frac{P(Y_i=1)}{P(Y_i=0)}\right) = \alpha_1 + \beta_{11}ECON_i + \beta_{12}TECH_i + \beta_{13}SOC_i + \beta_{14}POL_i + \beta_{15}AWR_i + \mu_i$$

For Full Adopters (2):

$$\ln\left(\frac{P(Y_i=2)}{P(Y_i=0)}\right) = \alpha_2 + \beta_{21}ECON_i + \beta_{22}TECH_i + \beta_{23}SOC_i + \beta_{24}POL_i + \beta_{25}AWR_i + \mu_i$$

Where the coefficients (β) represent the effect of each independent variable relative to the base category (Non-Adopter).

This category-based representation is a direct expansion of the general multinomial logistic regression model earlier specified. The earlier model expressed the overall relationship between the probability of adopting solar energy and the explanatory variables in a general form. In contrast, this formulation breaks it down into specific equations for each adoption category (partial and full adopters) relative to the base category (non-adopters). Thus, it operationalizes the general model by showing how the coefficients vary across adoption levels while maintaining the same underlying determinants identified in the conceptual framework.

1. Percentage

Percentage expresses a value as a fraction of 100.

$$\text{Percentage} = \left(\frac{\text{Part}}{\text{Whole}}\right) \times 100$$

2. Frequency Counts

This is simply the number of times a specific value or category appears in a dataset.

Frequency of a value/category = Count of how many times it occurs

3. Multinomial Linear Regression

The general form of the model is expressed as:

$$\ln\left(\frac{P(Y=m)}{P(Y=\text{baseline})}\right) = \beta_{0m} + \beta_{1m}X_1 + \beta_{2m}X_2 + \dots + \beta_{km}X_k$$

Where:

$P(Y=m)$ = Probability of being in category m (e.g., Partial Adoption or Full Adoption)

$P(Y=\text{baseline})$ = Probability of the reference (baseline) category (e.g., No Adoption)

β_{0m} = Intercept term for category m

$\beta_{1m}, \dots, \beta_{km}$ = Regression coefficients for predictor variables for category m

X_1, X_2, \dots, X_k = Predictor (independent) variables in the model

A-priori Expectation of the Signs and Magnitudes of the Regressors

Based on theoretical and empirical literature, the expected signs of the coefficients are as follows:

Economic Factors (ECON): Expected positive (+) relationship — higher income and lower energy expenditure are likely to increase the probability of solar energy adoption, as affordability improves.

Technical Factors (TECH): Expected positive (+) — the availability of maintenance services and reliable technical support enhances confidence and system performance, thereby encouraging adoption.

Social Factors (SOC): Expected positive (+) — strong peer influence and favorable cultural acceptance increase the likelihood of adoption.

Policy Factors (POL): Expected positive (+) — supportive policies, incentives, and regulations (if included) promote adoption; however, since policy is omitted in this model, its influence is theoretically acknowledged but empirically excluded.

Awareness (AWR): Expected positive (+) — higher awareness and knowledge of solar energy benefits increase the probability of adoption.

In terms of magnitude, economic and technical factors are expected to have the strongest effects, followed by social and awareness factors, reflecting the combined influence of affordability, functionality, and perception on adoption decisions.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 Socio-Economic Characteristics of Respondents

4.1.1 Sex

The sex distribution of the respondents is presented in Table (4.1). The analysis shows that 79.5 percent of the respondents are males, while 20.5 percent are females. The higher proportion of males indicates the predominance of male-headed households in Benin City. This finding aligns with Adewuyi and Olayinka (2020), who observed that men often dominate household decision-making on energy use in urban areas of Nigeria.

Table 4.1: Sex distribution of Respondents (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percent
Male	159	79.5
Female	41	20.5
Total	200	100

4.1.2 Age

The age distribution of the respondents is presented in (Table 4.2). The analysis shows that approximately 47 percent of the respondents are between 21 and 40 years, while about 38 percent fall within the 41–60 years age group. Respondents aged 20 years and below account for roughly 11 percent, and only about 5 percent are 61 years and above. This pattern indicates that most respondents are within the active working-age population,

suggesting greater economic engagement and openness to adopting modern technologies such as solar energy. This observation supports the findings of Okoye and Orji (2018), who reported that younger and middle-aged individuals are generally more inclined toward renewable energy adoption in urban areas of Nigeria.

Table 4.2: Age distribution of the Respondents (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage
Less or equal 20 years	22	11
21-40 11years	93	46.5
41-60 years	76	38
61 and years	9	4.5
Total	200	100

4.1.3 Education

The result presented below in (Table 4.3) shows the educational attainment of respondents in the study on the determinants of solar energy adoption in Benin City. The data reveal that a majority of the respondents, 151 individuals (75.5%), possess tertiary education, while 20 respondents (10%) attained secondary education, and 27 respondents (13.5%) completed primary education. Only 2 respondents (1%) reported having no formal education.

This distribution indicates that most of the participants are well-educated, suggesting a relatively high level of awareness and potential understanding of renewable energy

technologies such as solar energy. Education plays a crucial role in influencing individuals' decisions to adopt innovative technologies, as those with higher educational attainment are generally more informed about environmental sustainability, energy efficiency, and long-term economic benefits. Therefore, the predominance of respondents with tertiary education in this study implies that educational level could be a significant determinant of solar energy adoption in Benin City.

Table: 4.3 Educational Attainment of the Respondents (Source: Author's Fieldwork 2025.)

Categories	Frequency	Percentage
No formal education	2	1
Primary	27	13.5
Secondary	20	10
Tertiary	151	75.5
Total	200	100

4.1.4 Occupation

AS shown below, (Table 4.5) presents the occupational distribution of respondents in the study on the determinants of solar energy adoption in Benin City. The data reveal that 100 respondents (50%) are self-employed, indicating that personal business activities are highly prevalent among participants. About 54 respondents (27%) are civil servants, while 24 respondents (12%) are students. Furthermore, 17 respondents (8.5%) work in the private sector, and 5 respondents (2.5%) are retirees.

This distribution shows that the majority of respondents are economically active, with self-employment serving as the dominant occupation. This finding aligns with the International Labour Organization’s (2022) observation that self-employment constitutes a major source of livelihood in developing economies, including Nigeria. The high rate of self-employment among respondents suggests that many individuals rely on personal income sources, which could influence their decision-making processes regarding the adoption of solar energy technologies, especially in terms of affordability and investment priorities.

Table 4.4: Occupation of the Respondent (Source: Author’s Fieldwork 2025.)

Occupation	Frequency	Percentage (%)
Student	24	12
Self-employed	100	50
Civil servant	54	27
Private sector employee	17	8.5
Retiree	5	2.5
Total	200	100

4.1.5 Monthly Income

Table 4.6 shows the monthly income distribution of respondents in the study on the determinants of solar energy adoption in Benin City. The data reveal that approximately 31% of respondents earn between ₦50,000 and ₦150,000 monthly, making this the most common income category. About 20% of respondents earn between ₦150,001 and ₦200,000, while 18% earn less than ₦50,000. In addition, around 15% fall within the

₦200,001 to ₦400,000 income bracket, and approximately 17% earn above ₦400,000 monthly.

This distribution indicates that the majority of respondents earn moderate incomes, with relatively fewer individuals situated at both the lower and higher ends of the income spectrum. The pattern suggests that many respondents have a stable, though moderate, financial capacity, which may influence their ability to invest in solar energy systems. Individuals with middle-range incomes are often more willing to adopt cost-effective and sustainable energy alternatives when the long-term financial benefits are clear. These findings are consistent with the International Labour Organization’s (2022) observation that a large proportion of workers in developing countries, including Nigeria, tend to fall within the middle-income bracket.

Table 4.5: Monthly Income of the Respondents (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Less than N50,000	36	18
N50,000–N150,000	62	31
N150,001–N200,000	40	20
N200,001–N400,000	29	14.5
N400,001 and above	33	16.5
Total	200	100

4.1.6 Monthly Savings

Table 4.6 presents the monthly income distribution of respondents. A majority (55.0%) earn less than N50,000 monthly, indicating a predominantly low-income population. Respondents earning between N50,001 and N150,000 make up 16.5%, while 14.0% fall within the N150,001–N200,000 range. Only 7.0% each earn between N200,001–N400,000 and above N400,001, representing higher-income groups. This distribution suggests that most respondents have limited financial capacity, which may affect their ability to afford solar energy technologies. The trend aligns with national statistics showing that many Nigerians earn below N100,000 monthly (National Bureau of Statistics, 2023), highlighting income as a key factor influencing renewable energy adoption.

Table 4.6: Monthly Savings of the Respondents (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Less than N50,000	110	55.0
N50,001_N150,000	33	16.5
N150,001-N200,000	28	14.0
N200,001-N400,000	14	7.0
N400,001 and above	14	7.0
Total	200	100.0

4.2 Utilization of Solar Energy

The level of solar energy utilization among respondents is presented in (Table 4.7). The analysis shows that 31.5 percent of the respondents often utilize solar energy, while 25

percent rarely do. About 21 percent use it moderately, and 20.5 percent have never used solar energy. Only 2 percent of the respondents indicated that they always use solar energy. This distribution reveals that although solar energy utilization is gradually increasing, a considerable proportion of respondents still have low or no engagement with it. The limited number of consistent users suggests that while awareness may exist, affordability, accessibility, or reliability issues could be constraining regular usage.

Table 4.7: Utilization of Solar Energy as it relates to the Respondents (Source: Author’s Fieldwork 2025.)

Utilization of Solar	Frequency	Percentage (%)
Never	41	20.5
Rarely	50	25.0
Often	63	31.5
Moderately	42	21.0
Always	4	2.0
Total	200	100.0

4.3.1 Influence of Electricity Costs on the Adoption of Solar Energy

(Table 4.8) reveals the respondents’ perceptions of the cost of solar energy in relation to electricity expenses in Benin City. The data show that 17.0% of respondents strongly disagreed and 33.5% disagreed, representing a combined 50.5% who do not consider solar energy to be a high cost of electricity. Conversely, 24.0% of respondents somewhat agreed,

18.5% agreed, and 7.0% strongly agreed, amounting to 49.5% who believe that solar energy is expensive.

This distribution reveals a nearly balanced perception among respondents. While a slight majority view solar energy as relatively affordable compared to conventional electricity sources, a significant portion still considers it costly. This mixed perception may be attributed to the high initial installation expenses of solar systems, which often create the impression of high cost despite the long-term economic and environmental benefits associated with solar energy adoption.

Table 4.8: Perceptions on Influence of High Cost of Electricity on Solar Energy Adoption (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Strongly Disagree	34	17.0
Disagree	67	33.5
Somewhat Agree	48	24.0
Agree	37	18.5
Strongly Agree	14	7.0

4.3.2 The Influence of the Ease of Maintenance on the Adoption of Solar Energy

Table 4.9 shows respondents’ views on the ease of maintaining solar energy systems in Benin City. The data indicate that 12.5% of respondents strongly disagreed and 21.0% disagreed that solar energy is easy to maintain, giving a total of 33.5% who perceive solar system maintenance as challenging. In contrast, 33.5% of respondents somewhat agreed,

showing moderate acceptance of the statement, while 27.5% agreed and 5.5% strongly agreed, making up 33.0% who believe solar energy systems are easy to maintain.

This distribution reveals a nearly even split in respondents' opinions, suggesting mixed perceptions regarding the ease of maintaining solar energy systems. While some respondents acknowledge that solar systems are relatively easy to manage once installed, others associate them with technical and maintenance difficulties. These differing views may be linked to variations in user experience, technical knowledge, and access to professional maintenance services. The result supports previous findings in Nigeria, where maintenance challenges have been attributed to limited technical expertise and inadequate after-sales support from installers and suppliers.

Table 4.9 Perceptions on the Ease of Maintenance of Solar Energy (Source: Author's Fieldwork 2025.)

Categories	Frequency	Percent
Strongly Disagree	25	12.5
Disagree	42	21.0
Somewhat Agree	67	33.5
Agree	55	27.5
Strongly Agree	11	5.5
Total	200	100.0

4.3.3 Influence of Annual Savings on the Adoption of Solar Energy

Table 4.10 demonstrates the respondents' views on whether their annual savings are sufficient to afford solar energy installations in Benin City. The data reveal that 23.0% of respondents strongly disagreed and 19.0% disagreed, representing a combined 42.0% who lack adequate savings to invest in solar energy systems. In contrast, 30.0% of respondents somewhat agreed, indicating a moderate proportion who believe their savings could partly cater for solar installation costs. Additionally, 14.0% agreed and 14.0% strongly agreed, giving a total of 28.0% who consider their savings sufficient to invest in solar energy.

This distribution suggests that while a segment of the population has the financial capacity to adopt solar technology, a larger proportion continues to face affordability constraints. The findings underscore the persistent influence of financial limitations particularly the high upfront cost of installation on solar energy adoption decisions. These results are consistent with earlier research, which identified high initial investment costs and limited disposable income as significant barriers to renewable energy uptake in Nigeria.

Table 4.10: Perceptions on Affordability of Solar Energy Through Annual Savings (Source: Author's Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Strongly Disagree	46	23.0
Disagree	38	19.0
Somewhat Agree	60	30.0
Agree	28	14.0
Strongly agree	28	14.0
Total	200	100.0

4.3.4 Influence of Cost-Effectiveness in the Long Run on the Adoption of Solar Energy

As shown below, (Table 4.11) presents respondents' perceptions of whether solar technology saves costs in the long run. The data reveal that 6.0% of respondents strongly disagreed and 10.0% disagreed, representing a total of 16.0% who do not perceive solar energy as offering long-term financial benefits. Additionally, 11.0% of respondents somewhat agreed, reflecting a moderate level of uncertainty or partial agreement with the statement. In contrast, a substantial 35.5% of respondents agreed and 37.5% strongly agreed, giving a combined 73.0% who believe that solar technology provides significant long-term cost savings.

This distribution demonstrates that the majority of respondents recognize the economic advantage of solar energy, particularly its potential to reduce dependence on conventional electricity sources and lower recurring energy expenses. The result suggests that awareness of solar energy's financial benefits is relatively high among residents of Benin City, even though initial installation costs may remain a deterrent for some. This perception is consistent with findings from previous studies, which emphasize that although solar systems require substantial upfront investment, they ultimately yield considerable long-term savings and improved energy security.

Table 4.11: Perceptions on the Long-Run Cost Efficiency of Solar Technology (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Strongly Disagree	12	6.0
Disagree	20	10.0
Somewhat Agree	22	11.0
Agree	71	35.5
Strongly Agree	75	37.5
Total	200	100.0

4.3.5 The Influence of Frequent Power Outage on the Adoption of Solar Energy

Table 4.12 highlights the respondents’ views on the frequency of power outages in Benin City. The data show that 8.0% of respondents strongly disagreed and 14.5% disagreed that there are frequent power outages, accounting for a total of 22.5% who do not perceive electricity supply as highly unreliable. In contrast, 23.5% of respondents somewhat agreed, indicating moderate acknowledgment of the issue, while 28.0% agreed and 26.0% strongly agreed, bringing total agreement to 54.0% who believe that power outages occur frequently.

This distribution indicates that the majority of respondents experience inconsistent and unreliable electricity supply, which reflects the broader energy challenges in Nigeria. The persistent occurrence of power outages highlights the inadequacies in electricity generation, transmission, and distribution infrastructure. Many households and businesses

continue to rely on alternative energy sources, such as solar energy, to mitigate the negative effects of unstable power supply. These findings are consistent with previous studies that attribute Nigeria’s unreliable electricity supply to inadequate generation capacity, poor infrastructure, and maintenance deficiencies, which have long hindered sustainable power access across the country.

Table 4.12: Influence of Frequency of Power Outage on Solar Energy Adoption (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percent
Strongly Disagree	16	8.0
Disagree	29	14.5
Somewhat Agree	47	23.5
Agree	56	28.0
Strongly Agree	52	26.0
Strongly Disagree	16	8.0

4.3.6 The Influence of Availability of Solar Products on the Adoption of Solar Energy

As seen in (Table 4.13), the respondents’ perceptions of the availability of solar products and services in Benin City were highlighted. The data indicate that 20.0% of respondents disagreed that solar products and services are easily available, suggesting that some individuals still encounter difficulties in accessing them. Additionally, 34.5% of

respondents somewhat agreed, reflecting moderate acknowledgment of product availability, while 23.0% agreed and 14.0% strongly agreed, making a combined 37.0% who believe that solar products and services are readily accessible.

This distribution suggests that although the availability of solar energy technologies has improved over time, access remains uneven particularly among residents in rural or lower-income areas. The moderate to high level of agreement among respondents indicates that solar products are becoming more visible and obtainable, especially in urban centers like Benin City. However, the lingering access challenges highlight the limitations of distribution networks, high import dependency, and cost-related barriers, which continue to restrict widespread accessibility. This finding aligns with earlier studies emphasizing that while Nigeria’s solar energy market is growing, accessibility and affordability remain key constraints to large-scale adoption.

Table 4.13 Ease of Availability to Solar Products and Service on Solar Energy Adoption (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Disagree	40	20.0
Somewhat Agree	69	34.5
Agree	46	23.0
Strongly Agree	28	14.0
Total	200	100.0

Disagree	40	20.0
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4.3.7 Adequacy of Sunlight as a Factor Influencing Solar Energy Adoption

Table 4.14 presents respondents' perceptions of the adequacy of sunlight for solar energy generation in Benin City. The data reveal that 7.5% of respondents disagreed that there is adequate sunlight for solar energy, while 21.5% somewhat agreed, indicating moderate acknowledgment of solar potential. In contrast, 24.0% agreed and 41.5% strongly agreed, giving a total of 65.5% who believe there is sufficient sunlight to support solar energy generation.

This distribution shows that the majority of respondents recognize the abundance of solar resources available in their environment, reflecting a general awareness of the region's strong solar potential. The high level of agreement aligns with Nigeria's favorable climatic conditions, as the country receives an average solar radiation of 4.0–7.0 kWh/m² per day, which provides an excellent basis for efficient solar energy production. The finding reinforces the understanding that Nigeria, particularly southern regions like Benin City, possesses the necessary natural conditions to expand solar energy utilization.

Table 4.14: Influence of Sunlight Adequacy on Solar Energy Adoption (Source: Author's Fieldwork 2025.)

Categories	Frequency	Percentage
Strongly Agree	11	5.5
Disagree	15	7.5
Somewhat Agree	43	21.5

Agree	48	24.0
Strongly Agree	83	41.5
Total	200	100.0

4.3.9 The Influence of Environmental Benefits on the Adoption of Solar Energy

Table 4.15 highlights respondents' perceptions of the need for solar energy in promoting environmental protection in Benin City. The data show that 6.0% of respondents strongly disagreed and 6.5% disagreed that solar energy is needed for environmental protection, representing 12.5% who do not associate solar energy with environmental benefits. In contrast, 26.5% of respondents somewhat agreed, indicating moderate recognition of solar energy's environmental relevance, while 30.0% agreed and 31.0% strongly agreed, giving a total of 61.0% who acknowledge the vital role of solar energy in protecting the environment.

This distribution reveals that the majority of respondents understand the environmental importance of solar energy, particularly its potential to mitigate pollution and reduce greenhouse gas emissions associated with fossil fuel consumption. As it relates to the determinants of solar energy adoption, this finding suggests that environmental awareness serves as a motivating factor influencing individuals' decisions to adopt solar technology. Respondents who recognize the ecological advantages of solar energy are more likely to support and invest in it, viewing it as a sustainable alternative that contributes to climate change mitigation and cleaner energy use.

The result aligns with previous research emphasizing that the growing understanding of solar energy’s environmental benefits plays a key role in its increasing acceptance and adoption in developing economies like Nigeria. Solar energy not only offers a renewable power source but also supports environmental sustainability goals by reducing dependence on conventional, carbon-intensive energy sources.

Table 4.15 Respondents’ Opinion on the Importance of Solar Energy for Environmental protection (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Strongly Disagree	12	6.0
Disagree	13	6.5
Somewhat Agree	53	26.5
Agree	60	30.0
Strongly Agree	62	31.0
Total	200	100.0

4.3.10 The Influence of Incentivisation/Intervention by Government on the Adoption of Solar Energy

As observed in (Table 4.16), A total of 53.0% of respondents strongly disagreed and 23.0% disagreed that they have benefited from government incentivisation or intervention, making up a combined 76.0% who reported no benefit. Meanwhile, 11.5% somewhat agreed, 7.5% agreed, and only 5.0% strongly agreed, totaling just 24.0% who indicated

some level of benefit. This shows that government support or intervention in promoting solar energy adoption has not been widely felt among respondents. The findings highlight a significant gap in policy implementation and awareness, suggesting that existing incentives may be inadequate, poorly communicated, or inaccessible to the general public. This aligns with previous studies by Adewuyi and Oyejide (2021) and Ebhota and Tabakov (2021), which emphasize the need for stronger and more inclusive government policies to stimulate solar energy adoption in Nigeria.

4.16: Government Incentives or Interventions (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Strongly Disagree	106	53.0
Disagree	46	23.0
Somewhat Agree	23	11.5
Agree	15	7.5
Strongly Agree	10	5.0
Total	200	100.0

4.3.11 Awareness of the Need for Solar Energy Technology

As seen in (Table 4.17), A total of 7.5% of respondents strongly disagreed and 6.5% disagreed that they are aware of the need for solar energy technology, accounting for 14.0% with low awareness. Meanwhile, 19.5% somewhat agreed, 38.0% agreed, and 28.5% strongly agreed, summing up to 86.0% who acknowledged awareness of the need for solar energy technology. This indicates a generally high level of awareness among respondents

regarding the importance of adopting solar energy as an alternative power source. The result suggests that most individuals recognize the role of solar technology in addressing electricity shortages and promoting environmental sustainability. This aligns with the growing public understanding of renewable energy’s benefits in Nigeria, as highlighted by Oladipo, Akinbami, and Siyanbola (2020), who emphasized that increased awareness is a key driver of solar energy adoption.

Table 4.17: Respondents’ Level of Awareness About the Need for Solar Energy (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Strongly Disagree	15	7.5
Disagree	13	6.5
Somewhat Agree	39	19.5
Agree	76	38.0
Strongly Agree	57	28.5
Total	200	100.0

4.3.12 Adoption of Solar Energy Among Family and Friends

Table 4.18 shows a total of 8.5% of respondents strongly disagreed and 11.0% disagreed that most of their friends and family use solar energy, representing 19.5% with little to no exposure within their social circles. Meanwhile, 30.0% somewhat agreed, 35.5% agreed, and 15.0% strongly agreed, amounting to a total of 80.5% who acknowledged that people around them use solar energy. This suggests that solar technology has gained significant acceptance and visibility within social networks, potentially influencing adoption decisions

through social proof and peer influence. This finding relates directly to the study’s focus on the determinants of solar energy adoption, as it reveals that social factors particularly the influence of friends and family play a crucial role in encouraging individuals to adopt solar energy. This observation aligns with the findings of Adejumo, Adetona, and Adebayo (2021), who noted that individuals are more inclined to adopt solar energy when it is already common or endorsed within their social circles.

Table 4.18: Respondents’ Views on the Adoption of Solar Energy Among Family and Friends (Source: Author’s Fieldwork 2025.)

Categories	Frequency	Percentage (%)
Strongly Disagree	17	8.5
Disagree	22	11.0
Somewhat agree	60	30.0
Agree	71	35.5
Strongly Agree	30	15.0
Total	200	100.0

4.4 Multinomial Logistic Regression of Solar Energy Adoption

Table 4.19: Model Fitting Information (Source: Author’s Fieldwork 2025.)

Model	-2 Lod Likelihood	Chi-Square	df	Sig
Intercept Only	546.128	–	–	–
Final Model	185.649	360.479	176	0

Table 4.20: Pseudo R² Value (Source: Author's computation based on fieldwork 2025.)

Measure	Value
Cox & Snell	0.835
Nagelkerke	0.885
McFadden	0.625

Table 4.21: Likelihood Ratio Tests (Source: Author's computation based on fieldwork 2025.)

Effect	Model Fitting Criteria. -2 Log Likelihood of Reduced Model.	Chi-Square	df	Sig.
Intercept	185.649 ^a	.000	0	.
Solar Energy is a high cost of electricity	253.416	67.767	16	.000
Solar Energy is easy to Maintain	228.145 ^b	42.496	16	.000
My Annual savings can cater for solar Energy	226.692	41.042	16	.001
Solar Technology Saves cost in the Long-run	238.014 ^b	52.365	16	.000
Solar Products and services are easily available	235.522 ^b	49.872	16	.000
There is frequent Power Outage	229.567 ^b	43.918	16	.000
There Is adequate Sunlight for Solar	227.880 ^b	42.231	16	.000
Solar energy is needed for environmental protection	238.397	52.748	16	.000
I have benefited from government incentivisation/intervention	216.339 ^c	30.689	16	.015

I am aware of the need for solar energy technology	229.445 ^c	43.795	16	.000
Most of my friends and family use solar energy	215.974 ^b	30.325	16	.016

4.4.1 Model Fitting Information

As shown below in (Table 4.19), The Model Fitting Information table provides insight into how well the logistic regression model predicts the adoption and use of solar energy among respondents, based on factors like sex, age, educational attainment, occupation, monthly income, and monthly savings. The Intercept-Only Model represents a baseline where no predictors are included. Its -2 Log Likelihood value is 546.128, which reflects the unexplained variation in respondents' behavior toward solar energy usage. Essentially, this model assumes that no characteristics of respondents influence their adoption of solar energy. When the predictors are included, the Final Model shows a -2 Log Likelihood of 185.649, which is substantially lower than the intercept-only model. This large reduction indicates that the predictors greatly improve the model's ability to explain variations in solar energy adoption.

The Chi-Square value of 360.479 with 176 degrees of freedom tests whether the inclusion of these variables significantly improves the model fit. The corresponding p-value (Sig.) = 0 indicates a statistically significant improvement, meaning that the combined influence of sex, age, education, occupation, income, and savings significantly predicts whether respondents adopt or utilize solar energy technology. In practical terms for the project, this

result confirms that demographic and socioeconomic factors play a meaningful role in solar energy adoption. For instance, higher educational attainment or greater monthly savings may increase awareness and the ability to invest in solar technology. Conversely, factors like lower income or limited education could restrict adoption. The model therefore validates the study's assumption that individual characteristics influence perceptions, affordability, and use of solar energy.

Overall, the model fitting results reinforce the importance of targeting educational programs, financial support, and policy incentives toward specific demographic groups to enhance solar energy adoption in the community.

4.4.2 Pseudo R² Values

The (Table 4.20), presents three commonly used pseudo R-squared statistics for logistic regression: Cox & Snell, Nagelkerke, and McFadden. Unlike ordinary least squares regression, logistic regression does not produce a true R² value. Instead, these pseudo R² measures give an indication of how well the model explains the variation in the dependent variable, in this case, factors influencing solar energy adoption. The model summary results reveal that the logistic regression model fits the data exceptionally well. The Cox and Snell R² value of 0.835 indicates that the model explains a substantial proportion of the variability in solar energy adoption, although this measure cannot reach a maximum value of 1 and therefore slightly underestimates the model fit. The Nagelkerke R² value of 0.885,

which adjusts the Cox and Snell R^2 to a 0–1 scale, suggests that approximately 88.5% of the variation in solar energy adoption is explained by the model. This high value signifies a very strong model fit, showing that the predictors included are highly relevant to explaining adoption patterns. Similarly, the McFadden R^2 value of 0.625 demonstrates an exceptionally strong model fit. While McFadden's R^2 is interpreted differently and values between 0.2 and 0.4 are typically considered excellent for logistic regression, a value of 0.625 confirms the model's high explanatory power. Overall, the high values across all three pseudo R^2 measures indicate that the independent variables such as age, income, educational attainment, occupation, and monthly savings are strong predictors of solar energy adoption. This provides strong evidence that the model is robust, reliable, and meaningful in explaining respondents' behavior and decisions regarding the adoption of solar energy.

4.4.3 Likelihood Ratio Tests

The results presented in Table 4.21 show the individual effects of each independent variable on solar energy adoption in Benin City. The Chi-square values and corresponding significance levels indicate the extent to which each factor contributes to predicting the likelihood of adoption among respondents.

The findings reveal that all variables included in the model are statistically significant at $p < 0.05$, confirming that they each exert an influence on the decision to adopt solar energy.

The variable “Solar energy is a high cost of electricity” ($\chi^2 = 67.767$, $p = 0.000$) recorded the highest Chi-square value, suggesting that the rising cost of conventional electricity is a key driver motivating residents to consider solar technology as a more sustainable and cost-effective alternative. Similarly, “Solar energy is easy to maintain” ($\chi^2 = 42.496$, $p = 0.000$) indicates that the perceived simplicity of operating and maintaining solar systems plays a crucial role in influencing adoption. Respondents who believe solar technology requires minimal maintenance are more inclined to adopt it. Economic capacity remains another strong determinant. The variable “My annual savings can cater for solar energy” ($\chi^2 = 41.042$, $p = 0.001$) shows that financial readiness significantly affects adoption decisions, as individuals with adequate income or savings are more capable of affording installation costs. This aligns with the finding that “Solar technology saves cost in the long run” ($\chi^2 = 52.365$, $p = 0.000$), emphasizing that long-term economic benefits encourage adoption despite high initial expenses.

Accessibility also influences adoption, as seen in “Solar products and services are easily available” ($\chi^2 = 49.872$, $p = 0.000$). Easy access to quality products and reliable services increases confidence among potential users. Likewise, “There is frequent power outage” ($\chi^2 = 43.918$, $p = 0.000$) highlights that the persistent electricity shortage in Benin City pushes many residents toward alternative energy solutions such as solar power. Environmental considerations also play a substantial role. The significant result for “There

is adequate sunlight for solar” ($\chi^2 = 42.231, p = 0.000$) confirms that Benin City’s favorable climatic conditions support adoption. Additionally, “Solar energy is needed for environmental protection” ($\chi^2 = 52.748, p = 0.000$) reflects increasing environmental awareness and recognition of solar energy’s role in reducing pollution and promoting sustainability. The influence of policy and institutional support is reflected in “I have benefited from government incentivisation/intervention” ($\chi^2 = 30.689, p = 0.015$), showing that while government programs have some impact, their reach and effectiveness remain limited. This suggests the need for stronger and more accessible policy frameworks to encourage wider participation.

Social factors also emerged as significant determinants. “I am aware of the need for solar energy technology” ($\chi^2 = 43.795, p = 0.000$) demonstrates that awareness and information availability directly influence adoption. Furthermore, “Most of my friends and family use solar energy” ($\chi^2 = 30.325, p = 0.016$) indicates that peer influence and social experience promote adoption through shared knowledge and visible examples of success.

In summary, Table 4.21 shows that solar energy adoption in Benin City is influenced by a combination of economic, social, technical, environmental, and policy-related factors. Each variable contributes meaningfully to explaining adoption behavior, underscoring the

multidimensional nature of renewable energy decisions among residents and businesses in the area.

CHAPTER FIVE

SUMMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF THE FINDINGS

This study examined the determinants of solar energy adoption among households in Benin City using data collected from 200 respondents through structured questionnaires and analyzed with descriptive statistics and multinomial logistic regression techniques.

The findings revealed that economic factors such as income level and energy expenditure significantly influence the adoption of solar energy. Households with higher income and lower energy costs demonstrated a greater likelihood of adopting solar systems. This outcome is consistent with earlier research in Nigeria that identified income and affordability as key determinants of renewable energy adoption (Adebayo et al., 2021; Ozoegwu & Eze, 2021).

Technical factors, particularly the availability of maintenance services, were also found to play an important role in promoting adoption by improving users' confidence and ensuring system reliability. Similar studies have reported that technical reliability and ease of maintenance are crucial for the long-term use of solar energy technologies (Ugwoke et al., 2022).

Social factors, including peer influence and cultural acceptance, had a positive effect on adoption decisions. This suggests that household energy choices are shaped by social perception and community behavior, as also observed in studies on the diffusion of innovations and renewable energy adoption (Rogers, 2003; Sovacool, 2014).

Environmental factors, such as awareness of environmental issues and sustainability concerns, were found to positively influence the adoption of solar energy. This finding aligns with previous research which showed that environmental consciousness encourages households to adopt clean energy technologies (Akinyele et al., 2022).

In addition, the study revealed that awareness and knowledge levels significantly determine the degree of solar energy adoption. Respondents with better understanding of solar technology were more willing to invest in it, a result consistent with the findings of Ogunmodede and Okoro (2023), who emphasized the importance of public enlightenment in renewable energy acceptance.

Although policy-related variables were omitted from the model due to data limitations, several studies (International Energy Agency, 2021; Adeniran et al., 2018) have emphasized that government incentives and supportive policies remain essential for promoting large-scale solar energy deployment in Nigeria.

Overall, the results confirm that economic, technical, social, environmental, and awareness factors collectively determine solar energy adoption in Benin City. These findings are consistent with existing literature, underscoring that renewable energy adoption in developing countries is influenced by a combination of financial capacity, technical reliability, social norms, and environmental awareness.

5.2 CONCLUSIONS

This study investigated the determinants of solar energy adoption among households in Benin City. Using multinomial logistic regression analysis, the research examined how economic, technical, social, environmental, and awareness factors influence the decision to adopt solar energy technology.

The findings indicate that these factors collectively and significantly affect the likelihood of adopting solar systems. Economic factors such as income level and energy expenditure remain the most influential, confirming that affordability is central to household decisions on renewable energy. Technical reliability, particularly the availability of maintenance services, also plays a critical role in shaping adoption behavior.

Social and cultural influences were found to encourage adoption, demonstrating that peer behavior and societal perception are important drivers of technology diffusion. Similarly,

environmental awareness was shown to motivate households toward clean energy choices, reflecting growing concern for sustainability and climate resilience. The level of awareness and knowledge of solar energy further reinforces adoption, as informed households are more likely to make favorable investment decisions.

Although policy-related variables were excluded due to data limitations, the findings align with previous studies emphasizing that supportive government policies and incentives can accelerate renewable energy adoption in Nigeria (Adeniran et al., 2018; International Energy Agency, 2021).

In conclusion, the study establishes that economic capacity, technical reliability, social influence, environmental awareness, and knowledge collectively determine the adoption of solar energy in Benin City. Addressing these factors through targeted policies and awareness campaigns will be essential for promoting widespread solar energy use and enhancing energy security in Nigeria.

5.3 RECOMMENDATIONS

Based on the findings of this study, several measures are recommended to enhance the adoption of solar energy among households in Benin City.

First, government and financial institutions should introduce flexible financing options such as low-interest loans, installment payment schemes, and subsidies to make solar installations more affordable, particularly for low- and middle-income households.

Second, efforts should be made to strengthen technical support services by training local technicians and establishing reliable maintenance centers. This would ensure system sustainability and increase public confidence in solar energy technology.

Third, awareness campaigns and educational programs should be intensified through community engagement and media platforms to improve public understanding of the economic and environmental benefits of solar energy.

Fourth, quality assurance and regulatory mechanisms should be strengthened to curb the sale of substandard solar products and ensure that consumers receive durable and efficient systems.

Finally, government and private sector collaboration should be encouraged through public–private partnerships (PPPs) to facilitate investment in solar energy infrastructure, expand access, and promote innovation in renewable energy distribution.

In future research, studies could focus on incorporating policy variables that were omitted in this study due to data limitations, as well as conducting longitudinal analyses to assess

changes in adoption behavior over time. Further research could also examine the role of gender, education, and urban–rural differences in influencing solar energy adoption to provide a broader understanding of renewable energy transition dynamics in Nigeria.

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APPENDIX 1

S/N	Determinants	Strongly Disagree	Disagree	Somewhat Agree	Agree	Strongly Agree
	Economic Factors					
1.	Solar energy is not a high cost of electricity.					
2.	Solar Energy is easy to maintenance					
3.	My annual savings can cater for solar energy					
4.	Solar technology saves cost in the long run					
	Institutional Factors					
5.	Solar products and services are easily available					
6.	There is frequent power outage					
	Environmental Factors					
7.	There is adequacy of sunlight for solar energy					
8.	Solar energy is needed for environmental Protection					
	Government					
9.	I have benefited from government solar energy incentivisation/intervention					
	Social factors					
10.	I am aware of the need for solar energy technology					
11.	Most of my friends and family use solar energy					

APPENDIX 2

DATA COLLECTED FROM RESPONDENTS USING STRUCTURED QUESTIONNAIRE

Sex distribution of Respondents

Categories	Frequency	Percent
Male	159	79.5
Female	41	20.5
Total	200	100

Age distribution of the Respondents

Categories	Frequency	Percentage
Less or equal 20 years	22	11
21-40 11years	93	46.5
41-60 years	76	38
61 and years	9	4.5
Total	200	100

Educational Attainment of the Respondents

Categories	Frequency	Percentage
No formal education	2	1
Primary	27	13.5
Secondary	20	10
Tertiary	151	75.5

Total	200	100
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Occupation of the Respondent

Occupation	Frequency	Percentage (%)
Student	24	12
Self-employed	100	50
Civil servant	54	27
Private sector employee	17	8.5
Retiree	5	2.5
Total	200	100

Monthly Savings of the Respondents

Categories	Frequency	Percentage (%)
Less than N50,000	110	55.0
N50,001_N150,000	33	16.5
N150,001-N200,000	28	14.0
N200,001-N400,000	14	7.0
N400,001 and above	14	7.0
Total	200	100.0

Utilization of Solar Energy as it relates to the Respondents

Utilization of Solar	Frequency	Percentage (%)
Never	41	20.5
Rarely	50	25.0
Often	63	31.5
Moderately	42	21.0
Always	4	2.0

Total	200	100.0
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Perceptions on Influence of High Cost of Electricity on Solar Energy Adoption

Categories	Frequency	Percentage (%)
Strongly Disagree	34	17.0
Disagree	67	33.5
Somewhat Agree	48	24.0
Agree	37	18.5
Strongly Agree	14	7.0

Perceptions on the Ease of Maintenance of Solar Energy

Categories	Frequency	Percent
Strongly Disagree	25	12.5
Disagree	42	21.0
Somewhat Agree	67	33.5
Agree	55	27.5
Strongly Agree	11	5.5
Total	200	100.0

Perceptions on the Long-Run Cost Efficiency of Solar Technology

Categories	Frequency	Percentage (%)
Strongly Disagree	12	6.0
Disagree	20	10.0
Somewhat Agree	22	11.0
Agree	71	35.5
Strongly Agree	75	37.5
Total	200	100.0

Influence of Frequency of Power Outage on Solar Energy Adoption

Categories	Frequency	Percent
Strongly Disagree	16	8.0
Disagree	29	14.5
Somewhat Agree	47	23.5
Agree	56	28.0
Strongly Agree	52	26.0
Strongly Disagree	16	8.0

Influence of Sunlight Adequacy on Solar Energy Adoption

Categories	Frequency	Percentage
Strongly Agree	11	5.5
Disagree	15	7.5
Somewhat Agree	43	21.5
Agree	48	24.0
Strongly Agree	83	41.5
Total	200	100.0

Respondents' Opinion on the Importance of Solar Energy for Environmental protection

Categories	Frequency	Percentage (%)
Strongly Disagree	12	6.0
Disagree	13	6.5
Somewhat Agree	53	26.5
Agree	60	30.0
Strongly Agree	62	31.0
Total	200	100.0

Government Incentives or Interventions

Categories	Frequency	Percentage (%)
Strongly Disagree	106	53.0
Disagree	46	23.0
Somewhat Agree	23	11.5
Agree	15	7.5
Strongly Agree	10	5.0
Total	200	100.0

Respondents' Level of Awareness About the Need for Solar Energy

Categories	Frequency	Percentage (%)
Strongly Disagree	15	7.5
Disagree	13	6.5
Somewhat Agree	39	19.5
Agree	76	38.0
Strongly Agree	57	28.5
Total	200	100.0

Respondents' Views on the Adoption of Solar Energy Among Family and Friends

Categories	Frequency	Percentage (%)
Strongly Disagree	17	8.5
Disagree	22	11.0
Somewhat agree	60	30.0
Agree	71	35.5
Strongly Agree	30	15.0
Total	200	100.0

APPENDIX 3

DESCRIPTIVE STATISTICS

Model Fitting Information

Model	-2 Lod Likelihood	Chi-Square	df	Sig
Intercept Only	546.128	–	–	–
Final Model	185.649	360.479	176	0

Pseudo R² Value

Measure	Value
Cox & Snell	0.835
Nagelkerke	0.885
McFadden	0.625

Likelihood Ratio Tests

Effect	Model Fitting Criteria. -2 Log Likelihood of Reduced Model.	Chi-Square	df	Sig.
Intercept	185.649 ^a	.000	0	.
Solar Energy is a high cost of electricity	253.416	67.767	16	.000
Solar Energy is easy to Maintain	228.145 ^b	42.496	16	.000
My Annual savings can cater for solar Energy	226.692	41.042	16	.001
Solar Technology Saves cost in the Long-run	238.014 ^b	52.365	16	.000
Solar Products and services are easily available	235.522 ^b	49.872	16	.000
There is frequent Power Outage	229.567 ^b	43.918	16	.000

There Is adequate Sunlight for Solar	227.880 ^b	42.231	16	.000
Solar energy is needed for environmental protection	238.397	52.748	16	.000
I have benefited from government incentivisation/intervention	216.339 ^c	30.689	16	.015
I am aware of the need for solar energy technology	229.445 ^c	43.795	16	.000
Most of my friends and family use solar energy	215.974 ^b	30.325	16	.016