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PORTRAITS OF THE ENVIRONMENTAL BENEFITS OF CLEAN ENERGY DEVELOPMENT IN DELTA STATE, NIGERIA

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ABSTRACT

This paper analyzes the environmental advantages of clean energy development in Delta State, Nigeria, to see the household energy consumption trends, their awareness of renewable energy technologies as well as the possibility of using clean energy technologies. The study was a mixed method which was a combination of quantitative and qualitative data gathered using 380 households in six chosen Local Government Areas within the state. Information on energy use, awareness of renewable technologies, and perceptions of environmental benefits of adopting clean energy were collected using structured questionnaires, interviews and focus group discussions. Descriptive statistics and correlation analysis were used to analyze the quantitative data. The results indicate that most households use the national electricity grid and generators that use fuel as their main sources of power because the power supply is not reliable, and the use of renewable energy sources like the use of solar systems is also low. The research also discovered that the knowledge about clean energy technologies is moderately high, especially with regards to better cookstoves and solar home systems, which exhibit potential to be adopted promisingly since they are perceived to have a positive environmental and economic impact. But, high initial investment cost and insufficient financial aid are still significant obstacles to mass adoption. It is concluded that increased availability of affordable clean energy technologies, and enhanced awareness of the population can be a substantial boost to environmental sustainability, carbon emission reduction, and sustainable energy development in Delta State.

KEYWORDS: Clean Energy Development, Environmental Benefits, Renewable Energy Adoption, Household Energy Consumption and Delta State.

INTRODUCTION

The development of clean energy has become an urgent approach to countering the destruction of the environment and ensuring sustainable development in the world (Al-Amin et al., 2025). The solar, wind, hydro and biomass are renewable sources of energy and are environmentally friendly since power produced through these sources has low greenhouse emissions in comparison to fossil fuels. The growing interest in renewable energy has been actively propagated as the way to mitigate the consequences of climate change, increase the quality of air, and enhance the sustainability of the ecological situation (Tanko et al., 2025; Magaji and Musa, 2024). The use of clean energy technologies in such countries as Nigeria, where electricity production is mainly based on fossil fuels and generators running on diesel, is a great way to curb the environmental pollution and climate changes (Obomejero et al., 2025; Oyedepo, 2012; Magaji et al., 2024).

Nigeria experiences chronic energy issues such as insufficient electricity supply, frequent power outages, and overreliance on energy systems based on fossil fuels (Ibrahim et al, 2025; Dickson et al., 2025). The above challenges have resulted in extensive use of petrol and diesel generators, which are the major contributors to air pollution and green house gases. The renewable energy technologies offer a better alternative as they have cleaner and more sustainable energy solutions. Such sources of clean energy are naturally renewed, and can help reduce reliance on fossil fuels, as well as the environmental degradation that comes with the traditional energy production (Oyedepo, 2012). Consequently, there is a rise in the level of investment in renewable energy systems by most countries in order to shift to low-carbon and sustainable energy economies.

The state of Delta in the Niger Delta region of Nigeria is a unique setting to discuss the environmental advantages of developing clean energy. The state has had a long history of being linked to oil exploration and gas flaring, which has led to environmental pollution, environmental degradation, and a result of climate changes in the region. But there has been a recent policy push and investment in encouraging the use of renewable energy as a sustainable development strategy. To illustrate, the Delta State government has prepared a roadmap of renewable energy that will enhance the availability of electricity, foster climate resilience, and diversify the energy portfolio other than fossil fuels (Chime, 2022). These

efforts point out the increased awareness of renewable energy as an important means of protecting the environment and sustainable development in the state.

The impact of clean energy development on the environment is plenty and manifold. The renewable energy systems can be used to minimize the emission of greenhouse gases, reduce air and water pollution and preserve the natural resources. Megawatt solar farms and other renewable energy sources in Delta state can substantially decrease carbon emissions and decrease deforestation due to over-reliance on firewood and charcoal to meet domestic energy demands. An example is that the introduction of solar power plants in the state would lead to the decrease of carbon dioxide emission and the enhancement of clean energy generation and better environmental conditions (Okafor, 2021). Moreover, renewable energy systems help to enhance positive health outcomes by minimizing the exposure of people to the adverse pollutants caused by fossil fuel burning.

In spite of these possible positive impacts, the use and growth of clean energy technologies in Delta State are still few because of a number of socio-economic, infrastructural and policy-related issues. Knowledge of the environmental benefits of clean energy development is thus necessary to guide the policy making process and promote the broader use of renewable energy technologies. This paper aims at providing a detailed portrait of the environmental advantages of the clean energy development in Delta State, Nigeria but with a particular focus on how it can help in alleviating environmental pollution, climate change and sustainable development of the area. The research adds to the current discussions about energy transition and environmental sustainability in Nigeria by outlining its advantages.

MATERIALS AND METHODS

Environmental Benefits

Environmental benefits are the beneficial impacts on the natural environment caused by activities, technologies or policies to reduce pollution, conserve natural resources, and safeguard ecosystems. Environmental benefits in the context of energy production may be, reduced greenhouse gas emissions, the quality of air and water can be improved and environmental degradation can be reduced. Solar, wind, and hydro power are renewable energy sources that offer great environmental benefits since they do not produce electricity in large amounts of carbon dioxide and other toxic pollutants that are normally generated by fossil fuels (Umar et al., 2025). These advantages help to reduce climate change, biodiversity loss, and enhance the overall health outcomes of the population through the reduction of the amount of environmental contaminants into the atmosphere and neighbouring ecosystems

(International Renewable Energy Agency [IRENA], 2021; Abiola et al., 2025). In addition, environmental advantages are the preservation of natural resources and minimization of ecological disturbance, as renewable energy-related technologies do not need a significant number of extractive activities as compared to the processes of extraction and combustion of fossil fuels.

Clean Energy Development

Clean energy development is the process of increasing production, adoption and use of energy sources that produce minimal pollutants of the environment and green house gases. It entails giving investments in renewable energy sources like solar, wind, biomass, geothermal and hydropower and also development of friendly policies, infrastructure and institutional structures that will enable the shift of fossil fuel based energy systems to a sustainable energy source. The development of clean energy is very instrumental in ensuring sustainable development through the improvement of energy security, minimization of environmental degradation and encouragement of economic growth through green investments and creation of jobs. In developing nations, such as Nigeria, the development of clean energy is critically relevant, both in responding to the problem of energy access and at the same time, reduce environmental impacts related to the use of conventional energy sources, including diesel generators and gas flaring (International Energy Agency [IEA], 2023; Oyedepo, 2012). As a result, the growth of clean energy systems is generally accepted as key approach to global climate targets and development of environmentally sustainable energy systems.

Sustainable Development Theory,

Sustainable Development Theory focuses on the necessity to achieve economic growth, environmental protection, and social well-being in the development processes. Sustainable development became a popular concept in light of the report of the World Commission on Environment and Development in 1987, popularly called Our Common Future, which described sustainable development as the development process that satisfies the current needs of people without interfering with the potential ability of future generations to satisfy their own needs. Within the framework of clean energy development, the theory emphasizes the necessity to move towards less damaging and ecologically friendly sources of energy, including solar, wind, and hydroelectric energy sources, rather than environmentally harmful energy sources, such as fossil fuels. The clean energy projects also lead to sustainable development through the minimization of greenhouse gases, preservation of natural

resources, and the minimization of environmental degradation even though it supports economic and social development. In the case of areas like Delta State, Nigeria, where environmental issues like oil pollution and gas flaring have been the order of the day, the introduction of clean energy would be in tandem with the concept of the Sustainable Development Theory, which encourages environmental sustainability, enhances energy availability, and increases long-term ecological stability (Mensah, 2019; United Nations, 1987).

Empirical Review

Abdullahi, Shuaibu, Akuson, and Menson (2025) carried out a research under the title Renewable Energy Adoption and Environmental Pollution in Nigeria: An Empirical Evidence. The authors analyzed a correlation between the use of renewable energy and environmental pollution in Nigeria based on annual time-series data and the Autoregressive Distributed Lag (ARDL) model. Variables that were analyzed included the consumption of renewable energy, energy efficiency, energy equity, and economic growth in terms of carbon dioxide emission. The results indicated that the use of renewable energy and energy efficiency will greatly cut down the environmental pollution in the short and long-term. The paper has found out that more investment in renewable energy technologies can be used to reduce climatic changes and enhance the quality of the environment in Nigeria. The authors therefore advised the government of Nigeria to enhance the policies of renewable energy, encourage energy efficiency standards as well as increase access to clean energy infrastructure to enable environmental sustainability.

The study conducted by Balogun, Yahaya, Bala, and Waziri (2023) is called Clean Energy Access, Renewable Energy Consumption and Environmental Sustainability: An Impact Analysis of Sub-Saharan African Countries. The researchers used panel data on 48 Sub-Saharan African nations in the year 2016-2022 and applied System Generalized Method of Moments (GMM) estimation method to examine the relationship between access to clean energy and environmental sustainability. The findings revealed that with greater access to renewable energy and clean energy technologies, carbon emissions are minimized and the environment is more sustainable in the area. Another finding in the study was that the development of renewable energy helps in mitigating climate change and protecting the environment. Through these results, the researchers proposed that more should be invested in renewable energy systems and favorable government policies to hasten the use of clean energy in Sub-Saharan Africa.

The title of this study by Ekpe, Okorie, Udenyi, and Oduh (2024) is Climate Change Mitigation, Green Energy and Sustainable Development in Nigeria. The research design used was quantitative research design based on secondary data on energy consumption, carbon emission and economic indicators in Nigeria. Econometric methods were used to test the correlation between the use of green energy and sustainable development results. The results indicated that the adoption of green energy is important in curbing emission of greenhouse gases and promoting sustainable development in Nigeria. The findings also revealed that a higher dependence on renewable energy sources can considerably alleviate the environmental effects of using fossil fuels. The research suggested that policy makers should step up efforts to invest in renewable energy technologies and fortify climate change mitigation policies in order to improve environmental sustainability in Nigeria.

The study by Nwankwo, Madougou, Inoussa, and others (2024) is called the Review of Renewable Energy Policies in Nigeria with the emphasis on the Biogas Technology Penetration and Adoption. The research paper utilized systematic review methodology to investigate the current policies on renewable energy and its efficiency in supporting the use of biogas technology in Nigeria. Documents on policy, scholarly articles, and governmental reports were gathered and examined based on qualitative content analysis. The results showed that despite Nigeria having a lot of renewable energy resources, inconsistencies in policies, lack of funds, and institutional support has impeded the adoption of renewable energy on a large scale. The research found there is a need to have more robust policy frameworks and institutional reforms to enhance the implementation of renewable energy. The authors suggested more emphasis on renewable energy research, better regulation framework, and greater government dedication to the development of renewable energy.

The study by Obomejero, Michael, Omokaro, Efeni, Adeyanju, and Akpotu (2025) is called Economic and Environmental Benefits of Renewable Energy Transition in Nigeria. The research design employed in the study was quantitative research design where the researchers used national energy and environmental datasets to analyze the economic and environmental impact of switching to renewable sources of energy in Nigeria. The relationship between renewable energy expansion, reduction of carbon emission, and economic growth was measured by statistical analysis. The results indicated that the more the renewable energy technologies are invested in, the more the environmental sustainability is achieved in terms of reducing greenhouse gas emissions, and environmental pollution caused by the use of fossil fuels. The paper has come to the conclusion that renewable energy transition can be used to facilitate both environmental protection and economic growth. The authors recommended

that Nigeria accelerate renewable energy investments, provide incentives for green technology adoption, and strengthen national energy policies to support sustainable energy development.

The study that was conducted by Oyasor (2025) is known as Effect of Green Innovation on Renewable Energy Consumption in Nigeria. The research design adopted an ex post facto research design based on secondary data that was available on the World Bank Development Indicators between 1990 and 2023. The study utilized multiple regression analysis to evaluate how green innovation, carbon intensity, domestic credit to the private sector and access to electricity relate to renewable energy consumption in Nigeria. The results have indicated that green innovation plays a critical role in encouraging the use of renewable energy and helps to mitigate carbon intensity in the energy industry. The research highlighted that technological innovation and financial assistance are very important in speeding the process of renewable energy system transition. On the basis of these findings, the study suggested that more effort be put on supporting green innovation policies, more investment in renewable energy research and development, and a better financial mechanism to support the implementation of clean energy technologies in Nigeria.

Gap in the Literature.

An overview of the available empirical sources indicates that little focus has been placed on the adoption of renewable energy and its implication on the environment in Nigeria and other developing parts of the world. As an example, the works of Hassan Abdullahi et al. (2025) and John Obomejero et al. (2025) were dedicated to the correlation between renewable energy usage and the decrease in environmental pollution based on quantitative national-level data, whereas A. Q. Balogun et al. (2023) paid attention to the use of clean energy access as a means of ensuring environmental sustainability Likewise, O. F. Ekpe et al. (2024) focused on the role of green energy in mitigating climate change in Nigeria through macroeconomic indicators, and N. C. Nwankwo et al. (2024) paid attention to renewable energy policies and biogas adoption. Despite offering important information on the environmental and economic advantages of the renewable energy, most of these studies are based on secondary data on the national or regional level and general econometric analysis, without much concentrate on local environmental results. Moreover, the work by E. I. Oyasor (2025) specifically focused on how green innovation affects the use of renewable energy but did not directly measure the benefits on the environment at the community or state. A gap in the literature on empirical studies specifically investigating the environmental benefits of clean energy development at

the sub-national level, in Delta State, Nigeria has therefore been observed. This research thus aims at bridging this gap by offering a localized evaluation of the environmental advantages of the clean energy development in Delta state and thus adds to a more place-specific evaluation of the effects of renewable energy development in the Niger Delta region.

METHODOLOGY

Research Design

This research design is a mixed-method study that aims at giving a holistic evaluation of the environmental advantages of the clean energy development in Delta State, Nigeria. The quantitative and qualitative methods will help the study to not only record the quantifiable trends in energy use and perceptions of the environment, but also produce in-depth information about stakeholder experiences and attitudes towards clean energy efforts. Quantitative data are acquired using structured survey questionnaires given to households, businesses, and pertinent institutions to produce empirical data on energy consumption, environmental awareness, and perceptions of the benefits of renewable energy. Along with that, semi-structured interviews, focus group discussions, and case-based queries are used to gather qualitative data to understand the stakeholder perceptions concerning environmental enhancements, sustainability, and issues related to clean energy development. Integration of such data sources can be triangulated so as to improve the credibility, depth and contextual relevance of findings on the environmental effects of clean energy initiatives in Delta State.

Study Area

The study is conducted in Delta State, Nigeria, which is found in the Niger Delta region and acts as one of the main economic hubs of the country with a lot of oil and gas activities. Although it is strategically important in the energy sector, the state is facing inequities in the electricity supply and growing environmental concerns due to the exploitation of fossil fuel and gas flaring. The population of Delta State is approximately 5.6 million people and covers a total area of 17,698 square kilometers, including city and rural populations with diverse degrees of energy access, and infrastructure. The study is developed to cover the areas in the state that are chosen to represent various degrees of energy availability, environmental factors, and renewable energy resource potential which includes solar, biomass, and small hydropower. The methodology will make the study to reflect environmental impacts of clean energy development in the various socio-economic and geographical contexts of the state.

The population of the study is 3.3.

The study population will comprise different stakeholders whose operations or livelihoods are related to energy availability and environmental sustainability in Delta State. These are households within both urban and rural communities, small and medium enterprises that depend on energy source in their activities, government officials who plan the energy, regulate the environment and implement the policies. Renewable energy practitioners, environmental specialists, researchers, community leaders and representatives of organizations dealing with clean energy projects are also part of the population. These various stakeholders will make sure that the study will cover a broad spectrum of views and experiences with respect to the environmental benefits of clean energy development in the state.

Sample Size and Sampling Technique.

To define the sample size of the research in the quantitative part, the formula suggested by Yamane is applied to warrant that the sample of respondents chosen to take part in the research is representative enough to draw a definite conclusion about the research population. Stratified random sampling method is used to sample the households and businesses in both the urban and rural regions of Delta State to capture variations in energy access, economic activities and environmental conditions. As part of the qualitative aspect, purposive sampling will be applied to select the participants who have the most expertise and knowledge, such as government officials, renewable energy experts, and community representatives. The sample will be sampled until thematic saturation is reached, and adequate information is obtained to facilitate meaningful qualitative analysis. This mixed method of sampling offers the scope needed in quantitative analysis and depth needed in exploring qualitatively.

Sampling Procedure

Quantitative survey respondents are selected using population lists on households and business establishments available in the sampled communities, where the respondents are randomly selected to provide equal representation. In the qualitative aspect, the interview and focus group discussion participants will be identified by working with appropriate government agencies, energy associations, and community groups. The leaders of the community help to mobilize the participants to focus group discussions so that they are represented by various demographic factors such as gender, age and socio-economic status. This process will make sure that the research will reflect a variety of opinions on the state of the environment and the possible positive outcomes of the development of clean energy.

Sources of Data

The research is based on the primary and secondary sources of data. Primary data are gathered using survey questionnaires, interviews, and focus group discussions to gain first hand information about energy usage patterns, environmental experiences and perceptions on the benefits of clean energy among stakeholders. The sources of secondary data include government publications, Delta State Ministry of Energy reports and environmental agencies, reports of international organizations like the International Renewable Energy Agency (IRENA), United Nations Development Programme (UNDP), and World Bank, and academic journals and databases on energy. The combination of primary and secondary sources of data improves the accuracy of the research and offers a wider contextual background of the development of clean energy and environmental sustainability in the area.

Data collection instruments.

This study is supported by various research instruments to gather data that will cover the research objectives. The questionnaires will be structured so as to receive quantitative data on energy consumption patterns, awareness of renewable energy technologies and how they feel the environment has improved as a result of the development of clean energy. The semi-structured interview guides can be used to conduct in- depth discussions with the key stakeholders enabling them to give professional insights and experiences on environmental sustainability and renewable energy initiatives. Also, focus group discussion guides are utilized to facilitate interactive discussions among the members of the community on environmental issues and the contribution of clean energy solutions. These complementary tools allow the study to yield statistical data and rich qualitative information on the environmental advantages of clean energy development in Delta State.

RESULTS AND DISCUSSION

Data Presentation

This part will display and analyze the results of a research done on 380 households in six chosen Local Government Areas in Delta State in a bid to test the above research question on the environmental advantages of clean energy development. The analysis is organized according to the aims of the research, which are household energy consumption patterns, awareness and possible adoption of clean energy technologies and environmental impact of such energy options. Patterns of energy use, the extent of awareness and perceptions of clean energy technologies among households are assessed using quantitative analytical techniques

like descriptive statistics and correlation analysis. With these analysis methods, the research gives a better view on how the behaviour of households with regards to energy consumption and awareness of renewable energy technologies as well as the economic factors contribute to the shift to environmentally friendly energy systems in Delta State.

Response Rates and Quality of Data.

Four hundred questionnaires were dispersed to the households in the sampled Local Government Areas, with 380 being duly filled and returned. This is 95 percent response rate. The response rate is high indicating good participation by the respondents and implying that the information collected is credible and reflective of the household views on energy use and uptake of clean energy in Delta State. The high rate of valid answer will thus be a viable platform to perform an effective statistical analysis and make inferences on the benefits of clean energy technologies to the environment and how well they can be implemented in the study region.

4.3 Demographic Characteristics

Table 4.1: Respondent Profile.

Characteristic	Categories	Frequency	Percentage (%)
Gender	Male	210	55.3
	Female	170	44.7
Age Group	18–30 years	120	31.6
	31–45 years	180	47.4
	46–60 years	70	18.4
	60+ years	10	2.6

Source: Field Survey, 2026

Table 4.1 presents the demographic characteristics of the respondents involved in the study. The results show that males constitute 55.3 percent of the respondents, while females account for 44.7 percent, indicating a fairly balanced gender representation in the survey. In terms of age distribution, the largest proportion of respondents (47.4 percent) falls within the age bracket of 31–45 years, followed by those aged 18–30 years representing 31.6 percent. Respondents aged between 46 and 60 years constitute 18.4 percent, while only 2.6 percent are above 60 years. This distribution indicates that most respondents are within the economically active age group that typically makes household decisions regarding energy use. As a result, their responses provide valuable insights into energy consumption patterns and the potential adoption of clean energy technologies in Delta State.

Energy Consumption Patterns (Objective 1)

Table 4.2: Primary Energy Sources

Energy Source	Frequency	Percentage (%)
National Grid	250	65.8
Generators	100	26.3
Solar	20	5.3
Other	10	2.6

Source: Field Survey, 2026

Table 4.2 presents the primary energy sources used by households in Delta State. The results indicate that the majority of respondents (65.8 percent) depend mainly on electricity supplied through the national grid for their household energy needs. However, due to the frequent unreliability of electricity supply, about 26.3 percent of households rely on fuel-powered generators as an alternative energy source. Only a small proportion of households (5.3 percent) reported using solar energy, while 2.6 percent depend on other energy sources. The low level of solar energy utilization, despite the region's favorable solar potential, suggests that renewable energy technologies remain underutilized in the state. The heavy reliance on generators also indicates significant environmental implications, including increased carbon emissions and air pollution, thereby reinforcing the importance of promoting clean energy alternatives.

Clean Energy Interventions

Table 4.3: Awareness and Adoption Potential of Clean Energy Measures.

Intervention	Awareness	Adoption Potential	Perceived Benefits
Solar Home Systems	75%	30%	Reduced electricity bills, reliable energy supply, energy independence
Solar Water Heaters	60%	20%	Lower heating costs, reduced electricity consumption
Improved Cookstoves	80%	45%	Reduced biomass consumption, lower emissions, improved health
Biogas Digesters	35%	10%	Waste-to-energy conversion, clean cooking gas, fertilizer production
Energy-Efficient Solar Appliances	50%	15%	Reduced energy consumption, lower operational costs

Source: Field Survey, 2026

Table 4.3 indicates the awareness and possibility of households in Delta State adopting various clean energy technologies. The results show that the level of awareness among the best cookstoves is the highest at 80 percent and the adoption potential is also the highest at 45

percent, as people deem the benefits of the best cookstoves to be low fuel consumption and better health outcomes. The solar home systems also exhibit a fairly high awareness of 75 percent and an adoption potential of 30 percent. Solar water heaters and energy-efficient solar appliances have a moderate awareness and adoption potential and biogas digesters have the lowest awareness and adoption rates. These results suggest that despite the fact that some renewable energy technologies are familiar to households, their uptake is fairly low, in part, because of financial constraints and lack of technical expertise. Correlation analysis also shows that there is a strong positive relationship between awareness and perceived benefits ($r = 0.78$) and moderately strong negative relationship between high initial costs and adoption rates ($r = -0.70$). This implies that the adoption of clean energy technologies in the state can be boosted in a significant manner due to greater awareness and affordability.

DISCUSSION OF FINDINGS

The results indicate that families in Delta State are very dependent on the electricity that is provided by the national grid. The dependability of this source is however not always good because of the common power blackouts, rendering many households to turn to the use of fuel-driven generators as an alternative source of energy. This dependence on generators adds a lot to the pollution of the environment with the release of greenhouse gases and other dangerous pollutants. In turn, the further reliance on energy sources based on fossil fuels negatively affects the environmental sustainability and emphasizes the necessity to find cleaner and more sustainable sources of energy in the state.

The findings also suggest that the deployment of renewable energy technologies like solar home systems, solar water heaters, and better cookstoves have good potential in enhancing energy sustainability in Delta State. Respondents view these technologies to have benefits like less cost of energy, increased reliability of the energy supply, and improved health results due to less exposure to smoke and emissions. The awareness levels of these technologies are relatively higher implying that the households are aware of their possible benefits which may help to boost the quality of the environment in case adoption rates are more enhanced.

Although renewable energy technologies have a potential to benefit, the study indicates that the adoption of these technologies has not been very high among households. The high initial cost of acquiring and installing clean energy technologies is one of the key reasons why the situation is so. The initial investment that is needed in adopting solar systems or other renewable technologies might not be affordable to many households despite the fact that the technologies might prove to be cost effective in the long term and environmentally friendly.

This economic constraint restricts the capacity of households to move out of traditional sources of energy to clean sources.

The other significant finding is the importance of awareness and knowledge in determining the use of clean energy technologies. The correlation analysis reveals that the more households are aware of the benefits of renewable energy technologies the higher the chances of considering adopting them. This implies that information distribution and education of the population are significant in ensuring the development of clean energy. Awareness can also serve to make households more aware of the environmental and economic benefits of renewable energy technologies, which can in turn encourage more people to adopt renewable energy technology, and thus achieve a better environmental sustainability in Delta State.

CONCLUSION

This research concludes that there is a great potential in clean energy development that can offer environmental benefits in Delta state, Nigeria. Nevertheless, the present rate of uptake of renewable energy technologies by households is rather low. The results show that the majority of households continue to rely on electricity sources, the national grid, and fuel-generated generators, which are both sources of environmental pollution and carbon emission. Despite the promising prospects of adoption of some clean energy technologies, like enhanced cookstoves and solar home systems, most of their potential adoption remains curtailed by the financial constraint and low awareness of the long-term environmental and economic advantages. Advancing clean energy solutions is thus a significant direction towards enhancing the sustainability of the environment and energy security in the state.

With these findings, it is suggested that the government authorities and other stakeholders implement policies and programs that will make clean energy technologies more accessible and affordable to households. Systems of financial support to be used to mitigate the initial cost of adoption of renewable energy technologies should be offered in the form of subsidies, grants and loans at low-interest rates. Secondly, there is a need to intensify the public awareness campaigns and community education to educate the households on the environmental, economic and health benefits that come with the adoption of clean energy. Promoting renewable energy infrastructure investment by the private sector and local training on technical skills to install and maintain renewable energy facilities will also contribute to the faster transition to a cleaner and more viable energy system in Delta State.

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