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RENEWABLE ENERGY POLICY: A DRIVER OF HOUSEHOLD INCOME GROWTH AND FOOD SECURITY IN CROSS RIVER SOUTH SENATORIAL DISTRICT, NIGERIA

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This study examined renewable energy policy as a driver of household income growth and food security in Cross River South Senatorial District, Nigeria. Specifically, the study investigated the influence of access to renewable energy on household income growth and the effect of the utilization of renewable energy technologies on household food security. A correlational research design was adopted. A sample size of 400 of households across the seven Local Government Areas of Cross River South Senatorial District was selected for the study using a multistage sampling technique. Data were collected through a structured questionnaire and analyzed using descriptive statistics and Simple Linear Regression. The findings revealed that access to renewable energy significantly enhanced household income growth by improving productivity and reducing energy costs. More so, the utilization of renewable energy technologies significantly improved household food security through increased agricultural productivity, food preservation, and income diversification. The study concluded that effective renewable energy policies can promote sustainable livelihoods and recommended increased investment in affordable renewable energy infrastructure and technologies.

Keywords: household food security, household income growth, renewable energy.

Introduction

Renewable energy has become a key pillar of sustainable development because of its ability to stimulate economic growth, improve livelihoods, promote environmental sustainability, and strengthen food security. As climate change threatens agricultural productivity and energy demand continues to rise, governments are increasingly promoting clean energy sources such as solar, wind, biomass, hydropower, and biogas. Unlike fossil fuels, renewable energy reduces greenhouse gas emissions, lowers energy costs, and expands electricity access, particularly in underserved rural communities (International Energy Agency [IEA], 2024; United Nations, 2023). In Sub-Saharan Africa, the adoption of renewable energy has been associated with improved agricultural productivity, reduced post-harvest losses, increased

household incomes, and diversification of rural livelihoods (Lee et al., 2020; Bayer et al., 2020). In Nigeria, rural electrification initiatives have contributed to stronger agricultural value chains and enhanced performance of small and medium enterprises (Ogunleye, 2020; Oyedepo, 2019).

Nigeria is richly endowed with renewable energy resources, including abundant solar radiation, biomass, hydropower, and wind potential. Despite these advantages, access to reliable electricity remains inadequate, especially in rural communities where agriculture is the principal source of livelihood (Energy Commission of Nigeria, 2023). According to the World Bank (2024), millions of households still depend on expensive and environmentally harmful energy sources such as diesel generators and firewood. This energy deficit constrains agricultural production, limits agro-processing, increases production costs, and contributes to poverty and food insecurity.

To address these challenges, the Nigerian government has introduced several renewable energy policies, including the National Renewable Energy and Energy Efficiency Policy (NREEEP), the Renewable Energy Master Plan (REMP), the Nigeria Energy Transition Plan, and the Rural Electrification Strategy and Implementation Plan (RESIP). Through these initiatives and solar mini-grid projects implemented by the Rural Electrification Agency, government aims to expand electricity access, encourage private-sector investment, support agricultural value chains, and promote inclusive socioeconomic development (Federal Ministry of Power, 2022). These policies extend beyond electricity generation by providing institutional support, financing mechanisms, technological innovation, and community participation to improve household welfare.

Access to renewable energy contributes significantly to household income growth by reducing energy costs, extending productive working hours, supporting microenterprises, improving agricultural processing, and creating employment opportunities within renewable energy value chains (IRENA, 2023). Reliable electricity enables households to engage in income-generating activities such as food processing, refrigeration, irrigation, tailoring, welding, and other small businesses. Similarly, renewable energy technologies enhance food security by improving irrigation, processing, storage, preservation, and marketing of agricultural products, thereby increasing food availability and reducing post-harvest losses (FAO, 2023).

Cross River South Senatorial District possesses substantial agricultural potential due to its fertile soils, favorable climate, abundant rainfall, and diverse natural resources. Farming, fishing, and agro-based enterprises constitute the primary livelihoods of many households. Major crops include cassava, yam, rice, maize, cocoa, oil palm, plantain, and vegetables. However, inadequate electricity infrastructure, high energy costs, and limited access to renewable energy technologies continue to constrain agricultural productivity and rural economic development. Farmers experience significant post-harvest losses due to poor storage facilities, while agro-processors rely heavily on costly fossil fuels, reducing profitability and household income.

Although previous studies have examined renewable energy adoption, rural electrification, and agricultural development in Nigeria, limited empirical evidence exists on how renewable

energy policy implementation simultaneously influences household income growth and food security in Cross River South Senatorial District. This study addresses this gap by examining the effects of renewable energy access and utilization on household income and food security, thereby providing evidence to support effective policy formulation and sustainable rural development. The study was guided by the following research questions and hypotheses:

1. To what extent does access to renewable energy influence household income growth in Cross River South Senatorial District, Nigeria?
2. How does the utilization of renewable energy technologies affect household food security in Cross River South Senatorial District, Nigeria?

Hypotheses

The following null hypotheses were tested:

1. Access to renewable energy has no significant influence on household income growth in Cross River South Senatorial District, Nigeria.
2. Utilization of renewable energy technologies has no significant influence on household food security in Cross River South Senatorial District, Nigeria.

Theoretical framework

The Sustainable Livelihoods Framework (SLF) was developed by Robert Chambers and Gordon Conway in 1992 and later refined by the UK Department for International Development (DFID) in 1999 as a framework for analysing poverty, livelihood security, and sustainable development. Chambers and Conway (1992) define a livelihood as the capabilities, assets, and activities required for a means of living. A livelihood is considered sustainable when it can withstand shocks and stresses, maintain or enhance its assets and capabilities, and provide opportunities for future generations without degrading natural resources.

The SLF identifies five forms of livelihood capital that influence household well-being like human capital (education, skills, and health), natural capital (land, water, and forests), physical capital (infrastructure, electricity, and technology), financial capital (income, savings, and credit), and social capital (networks, trust, and institutions). It assumes that households with greater access to these assets are better positioned to pursue productive livelihood strategies and improve their welfare. The framework also emphasizes that government policies, institutions, and development programmes significantly influence access to these assets and, consequently, livelihood outcomes such as poverty reduction, increased income, and improved food security.

The theory is relevant to this study because renewable energy policies strengthen several livelihood assets. By expanding access to electricity through solar systems, mini-grids, and biomass technologies, renewable energy improves physical capital and supports income-generating activities, including irrigation, agro-processing, refrigeration, and small businesses. It also enhances human capital by improving education, healthcare, and technical skills through reliable electricity. Furthermore, renewable energy strengthens financial capital by reducing household expenditure on conventional fuels, allowing savings to be invested in productive ventures. Finally, renewable energy improves food security by supporting solar-powered irrigation, food processing, drying, and cold storage, thereby increasing agricultural

productivity, reducing post-harvest losses, and enhancing food availability, accessibility, utilization, and stability.

Literature review

Access to renewable energy and household income growth

Huang et al. (2020) examined the relationship between renewable energy development and rural household economic performance in China using panel data from 2003–2017. Applying a two-way fixed-effects model and panel Granger causality analysis, the study found that investments in hydropower, solar energy, and bioenergy significantly increased rural household income and consumption. The authors concluded that renewable energy infrastructure promotes rural economic development by reducing production costs and creating livelihood opportunities. Similarly, Alola and Yıldırım (2019) analyzed quarterly data from the United States (1973–2018) using the Autoregressive Distributed Lag (ARDL) model and found that renewable energy consumption significantly increased real disposable household income in both the short and long run, thereby improving household welfare. Carabajal et al. (2024) investigated the socioeconomic effects of solar mini-grids among 2,658 households and businesses in rural Kenya and Nigeria. Using baseline and follow-up surveys, the study found significant increases in household income, business productivity, and living standards after access to renewable electricity, demonstrating the role of decentralized renewable energy in stimulating local economic development. Likewise, Liu et al. (2026) reported that renewable energy development in China significantly reduced household energy poverty by increasing household income, improving infrastructure, and enhancing environmental quality, particularly in less-developed regions. However, Moutinho et al. (2019), using panel cointegration and ARDL analysis across fifteen European Union countries, observed that renewable energy expansion initially increased electricity prices, imposing financial burdens on low-income households. The authors recommended complementary social protection policies during the energy transition. Di Falco and Lynam (2023), analyzing household data from 17 Sub-Saharan African countries, found that higher household income increased the adoption of cleaner energy technologies, supporting the energy ladder hypothesis. In Nigeria, Akinwale et al. (2022) employed the Heckman two-stage model on data from 304 households and found that household income significantly influenced willingness to adopt and invest in renewable energy technologies, suggesting that improved access to renewable energy can enhance household welfare and income-generating opportunities.

Utilization of renewable energy technologies and household food security

Scholars have examined the relationship between renewable energy utilization and household food security, particularly in developing countries where energy poverty limits agricultural productivity and household welfare. In Nigeria, Otekunrin (2023) analyzed Living Standards Measurement Study (LSMS) panel data (2010–2016) using the Generalized Estimating Equations (GEE) model. The study found that households using clean energy sources such as liquefied petroleum gas (LPG) and electricity recorded higher dietary diversity and lower food insecurity than those relying on biomass fuels, concluding that greater access to renewable energy can improve food security and nutrition. Similarly, Onyeneke (2021) assessed Nigeria's National Clean Cookstoves Programme in Kwara State through a survey of 161 beneficiary households. Regression analysis revealed that improved cookstoves reduced cooking costs and time, enhanced health, increased disposable income, and

strengthened household food security. Burney et al. (2010) examined solar-powered drip irrigation in northern Benin using household surveys and matched-pair village comparisons. The findings showed significant improvements in vegetable production, household income, dietary diversity, and nutrition, demonstrating the contribution of renewable energy to year-round food production.

Huang et al. (2020) investigated renewable energy investments in rural China using panel data and a two-way fixed-effects model. Although food security was not directly measured, increased household income and consumption resulting from renewable energy adoption indirectly enhanced food access. Likewise, Wang (2022), using the GTAP-E-PowerS model across 141 countries, found that household renewable electricity reduced energy costs, increased food expenditure, and stimulated agricultural output. In Nigeria, Ifegbesan (2021) reported that rural households were willing to adopt renewable technologies because of lower energy costs and improved disposable income for food purchases. Although existing studies consistently demonstrate the positive effects of renewable energy on household welfare and food security, evidence from Nigeria remains limited at the household level, particularly in Cross River South Senatorial District. Most studies emphasize technology adoption or willingness to pay rather than assessing the direct impact of renewable energy policy on household food security, highlighting an important empirical gap (Akinwale et al., 2022).

Materials and methods

Research design

A correlational research design was used for this study. Correlational research is a type of non-experimental research method in which a researcher measures two variables, understands and assesses the statistical relationship between them with no influence from any extraneous variable (Creswell & Creswell, 2018). This research design was considered to be most appropriate for the study because, the study involved the collection of data, analyzing the data to establish relationship between the variables of the study.

Areas and Scope of the Study

The study was conducted in Cross River South Senatorial District, Cross River State, Nigeria. Cross River South Senatorial District comprised of Akpabuyo, Bakassi, Calabar Municipal, Calabar South, Odukpani, Akamkpa, and Biase Local Government Areas.

Population, Sample Size, and Sampling Techniques

The population of this study comprised 2,032,000 households across the seven Local Government Areas (LGAs) of Cross River South Senatorial District: Akamkpa, Akpabuyo, Bakassi, Biase, Calabar Municipal, Calabar South, and Odukpani (National Population Commission, 2022). The target respondents were household heads and adult household members aged 18 years and above who possess adequate knowledge of household energy sources, income-generating activities, and food security. These respondents were selected because they are primarily responsible for decisions relating to household energy use, livelihoods, and food consumption. The sample size was determined using the Taro Yamane (1967) formula, which is appropriate for finite populations and probability sampling techniques (Igbe et al., 2026). Based on this calculation, a sample of 400 households was selected for the study.

A multi-stage sampling technique was employed. In the first stage, all seven LGAs in Cross River South Senatorial District were purposively included to ensure adequate representation of urban, peri-urban, and rural households with different levels of renewable energy access. In the second stage, one ward was selected from each LGA using simple random sampling. In the third stage, one community was randomly selected from each chosen ward, ensuring every community had an equal chance of participation and minimizing selection bias. In the final stage, household lists obtained from community leaders and local government records served as the sampling frame. Using systematic random sampling, 57 households were selected from each of six communities and 58 households from one larger community, giving a total of 400 households. After randomly selecting the first household, every 10th household was subsequently chosen until the required sample size was attained. This approach enhanced representativeness, minimized interviewer bias, and ensured reliable coverage of households across the study area.

Method of Data Analysis

Inferential statistics such as simple linear regression was used in analysing the hypotheses.

Results

Access to renewable energy and household income growth

Linear regression was used to test the influence of access to renewable on household income growth.

Table 1 Influence of access to renewable energy on household income growth (Simple Linear Regression)

Predictor variable	R	R^2	Df	F	B	T	Sig.
Constant	.923[a]	.852	393	2277.711	.115	2.205	.000
Household income						47.725	.000

Source: Field work, 2026

The result presented in table 2 showed that there was a significant influence of access to renewable energy and household income growth in Cross River South District, Nigeria. R=.923, R^2=.852. F(1, 393)= 2277.711, P<.000]. This hypothesis is therefore not confirmed. This result showed that access to renewable energy made a contribution of 85.2% to the total of household income growth. This means that precision agriculture, improved seeds, mechanization, and digital technologies aid farmers to increase their farm production culmination to house income growth. The result therefore entails that there is a significant positive relationship between access to renewable energy and household income growth in Cross River South District, Nigeria.

Utilization of renewable energy technologies and household food security

Linear regression was used to test the influence of utilization of renewable energy technologies and household food security.

Table 2: Influence of utilization of renewable energy technologies and household food security (Simple Linear Regression)

Predictor variable	R	R^2	Df	F	B	T	Sig.
Constant	.946[a]	.895	393	3333.853	.084	2.062	.000
Technology and household food security						57.740	.000

Source: Field work, 2026

The result presented in table 3 showed that there was a significant influence of utilization of renewable energy technologies and household food security in Cross River South-District, Nigeria. R=.946, R^2=.895. F(1, 393)= 3333.853, P<.000]. This hypothesis is therefore not confirmed. This result showed that utilization of renewable energy technologies made a contribution of 89.5% to the total of utilization of renewable energy technologies and household food security. This means that initiatives, such as the Transforming Irrigation Management in Nigeria (TRIMING) project, have demonstrated the potential of improved irrigation systems to enhance agricultural productivity, increase food security, and generate employment. The result therefore entails that there is a significant positive relationship between utilization of renewable energy technologies and household food security in Cross River South District, Nigeria.

Discussion

The findings showed that access to renewable energy significantly influences household income growth in Cross River South Senatorial District, Nigeria. Households using renewable energy technologies such as solar home systems, solar-powered irrigation pumps, mini-grids, and biomass energy recorded higher incomes than those relying on traditional energy sources. This improvement is linked to lower energy costs, increased productivity, extended business hours, and expanded income-generating opportunities. Reliable electricity supports agro-processing, refrigeration, micro-enterprises, and digital businesses, thereby enhancing household economic activities. These findings agree with Komatsu et al. (2011), who reported that renewable electricity increased household income in rural Bangladesh by promoting productive activities. Similarly, Khandker et al. found that rural electrification raised household income by about 21% through improved agricultural productivity and expansion of non-farm enterprises. The results support the Sustainable Livelihoods Framework (Chambers & Conway, 1992; DFID, 1999), which views energy as a vital form of physical capital that enhances livelihood outcomes through its interaction with human, financial, social, and natural capital.

The study also found that the utilization of renewable energy technologies significantly improves household food security. Households using solar-powered irrigation, solar dryers, cold storage facilities, biogas digesters, and improved biomass cookstoves experienced better food availability, accessibility, utilization, and stability than those relying on conventional energy sources. Renewable energy enhances agricultural productivity, reduces post-harvest losses, improves food processing and preservation, and strengthens resilience against food insecurity. These findings are consistent with FAO (2023), which reported that renewable energy supports reliable irrigation, efficient processing, and storage, leading to improved

food security. Likewise, IRENA (2022) concluded that renewable energy increases farm productivity, enables year-round farming through solar irrigation, and reduces spoilage with renewable-powered storage systems. These results further validate the Sustainable Livelihoods Framework, which emphasizes that access to productive assets, technologies, and supportive institutions strengthens household resilience and promotes sustainable livelihoods.

Conclusion

A major conclusion of this study is that renewable energy policy is a significant driver of household income growth and food security in Cross River South Senatorial District, Nigeria. The findings show that improved access to renewable energy and the adoption of renewable energy technologies enhance household livelihoods by creating income-generating opportunities, reducing energy costs, increasing agricultural productivity, supporting value addition, and improving food availability and access. Renewable energy should therefore be regarded not only as an environmental or energy intervention but also as a strategic tool for rural development, poverty reduction, and food security enhancement.

The study contributes to knowledge by providing empirical evidence from Cross River South Senatorial District, an area that has received limited scholarly attention. Unlike many previous studies that focused mainly on environmental or macroeconomic outcomes, this research examined how renewable energy access and utilization influence household income growth and food security. The findings support the Sustainable Livelihoods Framework by demonstrating that access to modern energy strengthens livelihood assets, improves productive capacity, diversifies income sources, and enhances resilience to economic and food-related shocks.

The correlational research design proved appropriate for examining the relationships among the study variables under natural conditions without experimental manipulation. Although correlation does not establish causality, it provides reliable statistical evidence useful for policy formulation and future longitudinal studies. Moreso, the findings align with previous studies conducted in Nigeria and other developing countries, confirming that renewable energy improves household welfare, agricultural productivity, and food security. However, differences remain regarding implementation, financing, institutional capacity, and long-term sustainability, indicating the need for further research.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. The federal, state, and local governments should prioritize investment in decentralized renewable energy systems such as solar mini-grids, solar home systems, and community-based renewable energy projects. Expanding access to reliable, affordable, and sustainable energy will enable households to engage in productive economic activities, establish small-scale enterprises, reduce dependence on costly fossil fuels, and improve household incomes while promoting rural development and reducing energy poverty.
2. Governments, development partners, and financial institutions should provide low-interest loans, grants, and targeted subsidies to support the adoption of renewable energy technologies, including solar panels, solar-powered irrigation systems, biodigesters, and improved biomass cookstoves. Affordable financing will lower adoption costs, encourage

wider utilization of clean energy technologies, and enhance agricultural productivity, entrepreneurship, and other income-generating activities.

3. Renewable energy policies should also support productive sectors such as agriculture, agro-processing, fisheries, cottage industries, and rural enterprises. Reliable renewable energy for production, processing, storage, and value addition will increase productivity, create employment, strengthen local economies, and reduce poverty.

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