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Impact of Solar Photovoltaic System in Residential Homes and Industries in Akure, Ondo State

Akinduro Ifeoluwa Reuben
Department of Industrial Technology and Vocational Education
Adekunle Ajasin University, Akungba Akoko Ondo State
Email: ifeoluwa.akinduro@aaua.edu.ng

Abstract: *This study explores how solar photovoltaic (PV) systems are influencing residential homes and industries in Akure, Ondo State. A descriptive survey design was adopted, and the study covered 240 homes and 30 industry owners. Using simple random sampling, 80 homes and 20 industry owners were selected. Data was gathered through a structured questionnaire validated by three experts from the Department of Industrial Technology and Vocational Education, Adekunle Ajasin University. To ensure reliability, a pilot test involving fifteen homes outside the study area was conducted, and the instrument produced a Cronbach Alpha coefficient of 0.78. The questionnaire was administered with the help of two research assistants, and the collected data was analyzed using mean and standard deviation for the research questions, while t-test was used to test the hypotheses at the 0.05 level of significance. Findings showed that solar PV systems offer strong independence from utility supply, demonstrate high persistence, and are considered reliable due to their low maintenance demands. Results also indicated no significant difference between the views of homeowners and industry owners regarding the impact of solar PV systems in Akure. However, several challenges were identified, including high import taxes on solar panels, costly system maintenance, limited awareness of solar PV benefits, high upfront costs, inadequate policies promoting the solar market, and high interest rates on solar-related purchases. Based on these findings, the study recommends regular workshops and training for technical personnel as well as government policies that support solar PV users, which would enhance adoption and effective utilization of solar PV systems.*

Keywords: *Solar photovoltaic system, Technology, Technical, Homes, Industry*

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1. Introduction

Solar photovoltaic (PV) refers to a system that converts sunlight directly into electricity using special semiconductor cells. It works through the photovoltaic effect, where light energy produces an electric current. PV systems provide clean and renewable power for homes, businesses, and large-scale solar installations. Solar photovoltaic (PV) technology is increasingly reshaping energy access and sustainability strategies across developing nations. The rapid decline in PV module costs, advances in storage, and policy emphasis on renewable energy are accelerating adoption globally (Nigeria Energy, 2023). In sub-Saharan Africa, and particularly in Nigeria, solar PV has emerged as a viable response to chronic electricity shortages and rising fossil fuel costs. Nigeria's Renewable Energy Roadmap identifies solar as a key

driver for achieving universal access to electricity and for diversifying the country's energy mix (Nigeria Energy, 2023). Akure, the capital of Ondo State, reflects this national trend as both households and industries are turning to solar energy to reduce dependence on the national grid and to sustain operations during power outages.

Despite its growing popularity, solar PV adoption in Nigeria varies significantly between residential users and industrial establishments. Residential uptake is often influenced by factors such as cost, access to credit, perceived reliability, and user awareness, whereas industrial adoption tends to be driven by the desire to minimize production downtime and energy costs (Wali, 2025). Studies showed that socioeconomic factors, including income, education level, and access to financing, strongly predict household adoption of solar systems (Ojomo, 2023). For industries, PV investment decisions depend on energy demand profiles and expected financial returns (Owusu-Sekyere, 2024). Understanding how these dynamics unfold in Akure is important because the city has a diverse mix of households, small enterprises, and manufacturing firms with varying energy needs and economic capacities.

Technical performance and environmental benefits remain central to assessing the impact of PV systems. Research has shown that factors such as panel orientation, irradiance levels, temperature, and maintenance practices significantly affect system efficiency in tropical environments like Nigeria (Haruna, 2024). In Akure, which enjoys an average solar radiation intensity of 5.26 kWh/m² per day, these site-specific parameters play a major role in determining energy output and cost savings. Government-led solar initiatives, such as the Light-Up Akure Project and the installation of over 1,600 solar-powered streetlights, indicate a growing institutional commitment to renewable energy (Ondo State RAAMP, 2024; Punch, 2024). Assessing the real-world performance of residential and industrial PV systems against such policy efforts provides a practical benchmark for evaluating effectiveness and sustainability.

However, technical output alone does not guarantee user satisfaction or long-term success. The sustainability of solar adoption depends on maintenance culture, the reliability of after-sales support, and the strength of local markets for spare parts and skilled technicians. Poor installation practices and substandard components have been reported to reduce PV system performance across Nigeria (Haruna, 2024). Furthermore, policy uncertainty and limited access to affordable financing often constrain potential adopters, particularly in middle- and low-income communities (Ojomo, 2023). Therefore, studying both the technical and socio-economic dimensions of solar PV systems in Akure will provide a comprehensive understanding of their overall impact.

This study, therefore, investigates the impact of solar photovoltaic systems in residential homes and industries in Akure, Ondo State. It aims to determine how PV systems influence energy reliability, cost savings, and environmental sustainability while identifying the challenges faced by users and system providers. By combining household and industrial surveys, technical measurements, and policy analysis, the research seeks to bridge the gap between measured performance and user experience. The findings will not only highlight the local benefits of PV adoption but also provide insights that can inform state-level renewable energy planning and guide investors and policymakers toward more inclusive solar development strategies (Owusu-Sekyere, 2024; Nigeria Energy, 2023).

1.1 Statement of the Problem

Despite Nigeria's abundant solar energy potential, many households and industries continue to rely on unreliable grid supply and costly diesel generators, especially in urban centres where power interruptions are frequent. The capital-intensive nature of solar photovoltaic (PV) systems, combined with limited access to finance and inadequate consumer awareness, constrains uptake even in areas where the need is greatest (Ugulu, 2019). In Akure, Ondo State, this gap is particularly concerning: interest in solar solutions is increasing, but there is limited evidence on their real-world performance, cost savings and long-term maintenance or sustainability (Ismail *etal* 2012; Hassan *etal,* 2023).

Moreover, the challenges go beyond technology and cost. Standardization issues, weak regulatory frameworks, quality control problems, and inadequate after-sales service continue to undermine confidence in solar PV systems and retard broader adoption (ScienceNaija, 2025). For industries in Akure, where continuous power supply is critical for productivity, the absence of empirical data about the real-world economic, environmental and reliability impacts of solar PV may be limiting investment decisions and policy support. Without clear local evidence of benefits and constraints, stakeholders may struggle to design effective interventions that ensure sustainable solar deployment in both homes and industrial settings.

1.2 Purpose of the Study

The main purpose of this study is to determine the impact of solar photovoltaic system in residential homes and industries in Akure, Ondo state. The specific purposes are to:

1. determine the impact of solar photovoltaic systems on residential homes and industries in the Akure, Ondo State.

2. determine why the level of the utilization of solar photovoltaic systems is low in Akure, Ondo State.
3. identify possible solutions to the common barriers preventing solar photovoltaic systems from having greater positive impact on the residential homes and industries situated in Akure, Ondo State.

1.3 Research Questions

1. What is the impact of solar photovoltaic systems on residential homes and industries in the Akure, Ondo State?
2. What is responsible for low usage of solar PV in Akure, Ondo State?
3. What are the strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries in the Akure, Ondo State?

1.4 Hypotheses

The null hypotheses were formulated and tested at 0.05 level of significance

H_{O1}: There is no significant difference in the mean response between residential home owners and industry owners on the impact solar photovoltaic systems have had on residential homes and industries in Akure, Ondo State.

H_{O2}: There is no significant difference in the mean response between residential home owners and industry owners on what is responsible for low usage of solar PV in Akure, Ondo State.

H_{O3}: There is no significant difference in the mean response between residential home owners and industry owners on the strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries in Akure, Ondo State.

2. Literature Review

Aquila *et al.* (2020) investigated the factors influencing solar PV utilization in Akure. The study employed a survey research design. Three residential estates in Akure, Ondo State, Nigeria formed the study areas. The study was conducted between June 2019 and July 2019. The study surveyed 292 households located in the three residential estates in Akure, Ondo State and 219 retrieved questionnaire were found usable for the analysis. Data was analyzed using the mean ranking of the influencing factors. The results revealed that the highest-ranking factor influencing utilization of Solar PV for energy services is that Solar PV is a good backup against power failure. This is as a result of the erratic power supply in Nigeria which has not only failed to meet the need of household but also hampered economic growth. However, the least ranking factor influencing solar PV utilization for energy services is Ability to sell electricity to the national grid. Cooperation between private enterprises and relevant government agencies supported by 'political will' is required to promote the aforementioned factors influencing the solar PV utilization for energy services in Nigeria. Utilization of solar PV as an energy source for energy service ensure access to affordable, reliable, sustainable and modern energy for all. The research recommended that government support for solar PV intervention should be further encouraged.

Enongene *et al.* (2019) assessed the potential of solar PV-systems in residential buildings in Lagos Metropolitan Area, Nigeria. Nigeria has enormous solar energy potential; it is the most populous country in Africa and occupies a significant place in the development of Africa. Yet, it is a country with one of the lowest per capita electricity consumption in the world – at 149 kWh per capita for a population of about 170 million, about 7% of Brazil's and 3% of South Africa's. To achieve this goal, this study employed the survey of 150 residential buildings in three local government areas (LGAs) in Lagos State, Nigeria to obtain electric load data. HOMER Pro was used to size the PV-systems and to determine the levelized cost of electricity (LCOE). The computed energy results of the study for the base case scenario revealed the PV array, lead acid battery and the converter (inverter) of the PV-systems to be in the following range: 0.3–76 kW; 2 to 176 kWh; and 0.1–13.2 kW respectively. Economic analysis revealed a LCOE of the systems in the range of 0.398 USD/kWh to 0.743 USD/kWh. The use of PV-system generated electricity in the dwellings has potential for an annual reduction of greenhouse gas emissions in the range of 31.24 kgCO2eq to 7456.44 kgCO2eq. Clearly, the use of solar PV systems in residential buildings possesses potentials for enabling Nigeria to attain its climate change mitigation targets indicated in her Nationally Determined Contributions (NDCs).

Moosa (2025) examined the impact of solar photovoltaic (PV) installations in the eThekwini Metropolitan Municipality, focusing on economic and environmental benefits, implementation challenges, and policy recommendations. The primary objective is to evaluate solar PV as a sustainable alternative to coal-powered and diesel-generated electricity. A quantitative research approach was adopted, utilising the eThekwini Municipality – GIS Department's solar map viewer to calculate potential annual savings from solar energy adoption. Six locations with mixed property uses including commercial, residential, industrial, and special-use properties were analyzed to visualize potential cost savings and energy efficiency gains. The findings indicate that switching from coal-generated power to solar power can

lead to significant economic savings, with electricity cost reductions of 20–30% for businesses and households. The municipality's feed-in tariff program has further incentivized adoption, and over 5,000 participants now contribute excess energy to the grid. Additionally, the solar sector has created approximately 1,500 local jobs in installation, maintenance, and manufacturing. From an environmental perspective, solar PV adoption has resulted in a 15% reduction in municipal carbon emissions, aiding in climate change mitigation. However, challenges such as high upfront installation costs and a lack of awareness persist, limiting widespread adoption. Solar PV systems offer significant economic and environmental benefits, but financial and educational barriers must be addressed. The study recommends expanding financial incentives, enhancing public awareness campaigns, and streamlining regulations to facilitate increased adoption. These efforts will contribute to a more sustainable and energy-efficient future for eThekwini.

Wee (2016) Examine the effect of residential solar photovoltaic systems on home value: A case study of Hawaii. An investment in solar photovoltaic (PV) is considered a home improvement, and should be reflected in home sales prices. However, uncertainty about PV policies and information asymmetries may result in an imperfect pass-through. Hawaii serves as an illustrative case study to assess the impact of PV on home prices because Hawai'i has the highest number of PV installations per capita nationwide. Applying a hedonic pricing model using home resale and PV building permit data from 2000 to 2013 for O'ahu, I find that the presence of PV adds on average 5.4% to the value of a home. The value of PV exceeds total average installed costs because many of Hawaii's electricity circuits have reached legal limits for PV installations and thus many neighborhoods could technically no longer install additional PV capacity. Therefore, the value of the system goes beyond its capital investment on average, by $5000 to incorporate expected electricity savings.

3. Methodology

This study adopted a descriptive survey research design, which was considered appropriate because it allowed the researcher to gather detailed opinions and perceptions from a large group of respondents. The study was carried out in Akure, Ondo State, an area experiencing increasing interest in solar photovoltaic systems. The population consisted of 240 residential homes and 30 industry owners who were using or had experience with solar PV systems. Using simple random sampling, 80 residential homes and 20 industry owners were selected to participate. A structured questionnaire served as the main instrument for data collection. To ensure the quality and clarity of the instrument, it was validated by three experts from the Department of Industrial Technology and Vocational Education, Adekunle Ajasin University, Akungba Akoko. A pilot test involving fifteen homes outside the study area was conducted to determine the reliability of the instrument. The Cronbach Alpha coefficient obtained was 0.78, indicating that the questionnaire was reliable for the study. The administration of the instrument was carried out by the researcher with support from two trained research assistants familiar with the study area. Completed questionnaires were retrieved and analyzed using mean and standard deviation to answer the research questions. The hypotheses were tested using the t-test at the 0.05 level of significance to determine whether differences existed between the views of home owners and industry owners. Ethical considerations were strictly followed throughout the study. Respondents were informed about the purpose of the research, and their participation was voluntary. They were assured of confidentiality, and no personal identifiers were included in the data. The information collected was used solely for academic purposes, and respondents had the right to withdraw at any stage without any consequences.

4. Results and Discussion

4.1 Research Question One

What is the impact of solar photovoltaic systems on residential homes and industries in the Akure, Ondo State?

Table 1

S/N	Items	$\overline{X}$	SD	Remark
1	Solar PV system has strong independence from utilities	3.45	.672	Agreed
2	Solar PV system has strong persistence	3.64	.689	Agreed
3	Solar PV system is highly reliable because of low rate maintenance	3.80	.512	Agreed
4	Solar PV system are easy to install	3.70	.577	Agreed
5	Solar PV system can be monitored with Solar Log app	3.48	.717	Agreed
6	Solar PV system is safer in installation than other sources of energy	3.59	.605	Agreed
7	Reduction or exemption of payment of electricity bills	3.55	.687	Agreed
8	Solar PV system has the tendency of technological advancement even after installation	3.62	.678	Agreed
9	Solar PV systems increases productivity as there will be constant power supply	3.47	.758	Agreed
10	Solar PV systems has low cost of maintenance, therefore the user spend less	3.59	.637	Agreed

Table 1 showed that both the residential home owners and industry owners agreed on all items from 1 to 10. This is because none of the mean response was below 2.50 which was the coastline mark of agreed on the 4-points response options. The standard deviation score ranged between 0.512 and 0.758. This showed that the responses of the residential home owners and industry owners on the items were not divergent.

4.2 Research Question Two

What is responsible for low usage of solar PV in Akure, Ondo State?

Table 2

S/N	Items	$\overline{X}$	SD	Remark
11	Higher tax rate on the importation of solar panels	3.50	.718	Agreed
12	High cost of maintenance	3.67	.493	Agreed
13	Lack of proper awareness of PV system	3.55	.716	Agreed
14	High cost of solar PV system	3.49	.674	Agreed
15	Lack of appropriate policy to expand the solar market	3.44	.868	Agreed
16	High interest rates on solar PV system sales	3.49	.659	Agreed
17	Lack of technical knowledge and maintenance culture	3.46	.731	Agreed
18	Lack of research and development on solar PV system	3.30	.990	Agreed
19	Weather and climate conditions	3.54	.593	Agreed
20	Component failure due to device becoming un-operational shortly after installation	3.34	.742	Agreed
21	Lack of domestic production of relevant parts	3.50	.704	Agreed

Table 2 showed that both the residential home owners and industry owners agreed on all items. This was because none of the mean responses were below 2.50 which was the bench mark of agreed on the 4-point response options. The

standard deviation score ranged between 0.493 and 0.990. This showed that the responses of the residential home owners and industry owners on the items were not divergent.

4.3 Research Question Three

What are the strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries in the Akure, Ondo State?

Table 3

S/N	ITEMS	$\bar{X}$	SD	Remark
22	Proper awareness on PV system	3.55	.592	Agreed
23	Proper installation of solar PV system	3.55	.657	Agreed
24	Proper awareness on the usage of solar PV system	3.52	.689	Agreed
25	Proper handling of solar PV system	3.62	.582	Agreed
26	Installation of panels in a few inches above the roof so the airflow can cool the panel.	3.59	.653	Agreed
27	Ensure that the panels are constructed by light colour material, to reduce heat absorption	3.63	.614	Agreed
28	Avoid installation of solar panels in shaded areas	3.51	.703	Agreed
29	Monitoring of solar panel output using energy management software	3.66	.572	Agreed

Table 3 showed that both the residential home owners and industry owners agreed on all items from 1 to 10. This was because none of the mean responses were below 2.50 which was the bench mark of agreed on the 4-point response options. The standard deviation score ranged between 0.572 and 0.703. This showed that the responses of the residential home owners and industry owners on the items were not divergent.

4.4 Hypothesis Testing

Table 4: T-test on impact solar photovoltaic systems have had on residential homes and industries in Akure, Ondo State

Respondents	N	X	SD	Df	Tcal	P-value	Remark
Residential home Owners	80	3.55	.745	98	2.692	0.008	NS
Industry owners	20	3.50	.513				

Table 4 showed that there is no significant difference in the responses of residential homes and industries owners on all the items as impact solar photovoltaic systems have had on residential homes and industries owners, in Akure, Ondo State; therefore the null hypothesis of no significant difference was upheld at 0.05 level of significance where the t-cal is 2.692 and the P-value 0.008.

Table 5: T-test on what is responsible for low usage of solar PV.

Respondents	N	X	SD	Df	Tcal	P-value	Remark
Residential home Owners	80	3.49	.763	98	1.764	0.018	NS
Industry owners	20	3.70	.470				

Table 5 showed that there was no significant difference in the responses of residential homes and industries owners on all the items as what is responsible for low usage of solar PV; therefore, the null hypothesis of no significant difference was upheld at 0.05 level of significance where the t-cal is 1.764 and the P-value is 0.018.

Table 6: T-test on the strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries in the Akure, Ondo State

Respondents	N	X	SD	Df	Tcal	P-value	Remark
Residential home Owners	80	3.65	.576	98	1.073	0.286	NS
Industry owners	20	3.45	.759				

Table 6 showed that there was no significant difference in the responses of residential homes and industries owners on all the items as strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries in Akure, Ondo State; therefore the null hypothesis of no significant difference was upheld at 0.05 level of significance where the T-cal is 1.073 and the P-value is 0.286.

4.5 Discussion of Findings

The result from Table 1 showed the findings on impact of solar photovoltaic systems had on residential homes and industries in Akure, Ondo State. The findings of the study among others showed Solar PV system has strong independence from utilities, Solar PV system has Strong persistence, Solar PV system is highly reliable because of low rate maintenance, Solar PV system are easy to install, Solar PV system can be monitor with Solar Log app. The findings of the study is in line with the study of Enongene *et al.* (2019) assessed the potential of solar PV-systems in residential buildings in Lagos Metropolitan Area, Nigeria. Their findings indicate that switching from coal-generated power to solar power can lead to significant economic savings, with electricity cost reductions of 20–30% for businesses and households. The result of the hypothesis on the impact of solar photovoltaic systems had on residential homes and industries in Akure, Ondo State shows that there was no significant difference in the responses of residential home owners and industry owners on the impact solar photovoltaic systems have had on residential homes and industries in Akure, Ondo State.

The result on Table 2 showed the findings on what is responsible for low usage of solar PV. The findings of the study among others included higher tax rate on the importation of solar panels, high cost of maintenance, lack of proper awareness of PV system, high cost of solar PV system, lack of appropriate policy to expand the solar market, high interest rates on solar PV system sales, lack of technical knowledge and maintenance culture. The findings of the study concur with Moosa (2025) whose findings determine challenges such as high upfront installation costs and a lack of awareness persist, limiting widespread adoption. Solar PV systems offer significant economic and environmental benefits, but financial and educational barriers must be addressed. The result of the hypothesis on what is responsible for low usage of solar PV shows that there was no significant difference in the responses of residential homeowners and industry owners on what is responsible for low usage of solar PV.

The result from Table 3 reveals the findings on strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries in the Akure, Ondo State. The findings of the study among others revealed proper awareness on PV system, proper installation of solar PV system, proper awareness on the usage of solar PV system, proper handling of solar PV system, installation of panels in a few inches above the roof so the airflow can cool the panel. The findings of the study are in line with Aquila *et al.* (2020) who noted utilization of solar PV as an energy source for energy service ensure access to affordable, reliable, sustainable and modern energy for all. The result of the hypothesis on the strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries in the Akure, Ondo State showed that there was no significant difference in the responses of residential home owners and industry owners on the strategies for encouraging the usage of solar photovoltaic systems in residential homes and industries.

5. Conclusion and Recommendations

5.1 Conclusion

Based on the findings of the study, several key conclusions were drawn. Solar photovoltaic (PV) systems, which rely on PV power generation, remain one of the most promising renewable energy options available today. The study highlights that Nigeria, including Akure in Ondo State, is blessed with abundant solar resources that can be harnessed to improve electricity access and reduce dependence on conventional power sources. Findings revealed that solar PV systems have a significant positive impact on both residential homes and industries. Respondents acknowledged the reliability of solar PV, especially its ability to provide a stable alternative when public electricity supply fails. Its low maintenance requirement also contributes to its value within the community. However, the study also identified major limitations affecting widespread adoption. The high cost of installation remains the biggest barrier for many households and industry owners. Additional challenges such as limited awareness, high import taxes on solar components, and inadequate supporting policies further restrict the growth of solar PV usage while solar PV systems hold strong

potential to transform energy access and support sustainable development, improvement in awareness, cost reduction strategies, and supportive government policies are essential. Increasing public education on the benefits and long-term savings of solar PV systems can help boost acceptance and encourage more residents and industries to embrace this clean and reliable energy source.

5.2 Recommendations

Based on the findings, the following recommendations were proffered:

1. Concerned institutions should organize workshops and training for technical personnel for efficient handling of solar PV system.
2. Government should make policies that will be favorable to solar PV customers which in turn will increase the level of utilization of solar PV systems.
3. Government should ensure standard of goods, and quality of materials used is specified and complied with standard organizations to meet the equipment operation effectiveness and potentials..

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