

Review

Awareness and perceived benefits of solar photovoltaic technology adoption in Nigeria – A review

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Received 5 March, 2026; Accepted 2 April, 2026

Nigeria's power system continues to face challenges, including limited grid coverage, frequent outages, and reliance on costly gasoline and petrol generators. Solar photovoltaic (PV) technology offers a technically feasible and sustainable alternative, yet adoption remains below potential. This study synthesizes 26 empirical and conceptual studies to examine how awareness and perceived benefits influence PV adoption in Nigeria. The analysis shows that low awareness, especially in rural and northern regions, restricts adoption, while perceived benefits are primarily driven by short-term economic and reliability considerations. Environmental advantages, though secondary, are gaining recognition in institutional and policy contexts. Socioeconomic, governmental, and market factors, such as education, subsidies, tax incentives, and innovative financing models like Pay-As-You-Go, also affect adoption. Despite PV's long-term economic and environmental benefits, high upfront costs remain a major barrier. The findings highlight the importance of integrated strategies that combine targeted awareness campaigns, quality assurance, supportive financing, and enabling legislation to enhance adoption. Implementing such measures can reduce energy insecurity and accelerate Nigeria's transition to a cleaner, more reliable, and sustainable energy system.

Key words: Solar photovoltaic, renewable energy, awareness, perceived benefits, adoption, policy.

INTRODUCTION

Nigeria's electricity sector continues to face persistent challenges, including inadequate generation capacity, frequent outages, and heavy reliance on petrol and diesel generators. Although installed capacity exceeds 12,000 MW, actual generation often falls below 4,000–4,500 MW due to infrastructural and operational constraints (Akinyele and Rayudu, 2016; Babayomi et al., 2022). As a result, households and businesses depend on expensive and polluting backup systems, creating both economic and environmental concerns. Solar photovoltaic (PV) technology presents a technically viable

and sustainable alternative, supported by Nigeria's high solar irradiation levels of approximately 4–7 kWh/m²/day (Okoye and Oranekwu-Okoye, 2018). In response, several government- and donor-backed initiatives, such as the Nigeria Electrification Project and Solar Power Naija, have been introduced to promote renewable energy deployment. Despite these efforts, the adoption of solar PV remains below its expected potential.

One of the key challenges limiting adoption is low and uneven awareness of solar PV technology. In many rural and underserved areas, knowledge of PV systems is

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limited, and electricity is often associated solely with grid supply (Ugulu, 2019). Even in urban areas where awareness is relatively higher, understanding of system performance, lifecycle costs, and long-term benefits remains inadequate (Odu et al., 2025). In addition, misconceptions arising from poor-quality installations, substandard components, and negative past experiences further shape public perception and reduce trust in the technology. Evidence shows that a significant proportion of users lack awareness of regulatory standards and do not verify installer qualifications, highlighting weak quality assurance and information gaps (Akingbesote, 2025).

Beyond awareness, perceived benefits play a critical role in shaping adoption decisions. Studies indicate that households and firms are more likely to adopt solar PV when they perceive clear advantages such as cost savings, improved reliability, and reduced dependence on generators (Schulte et al., 2022). In the Nigerian context, where grid supply is unreliable and fuel costs are high, these short-term economic and functional benefits often outweigh environmental considerations. However, perceptions are not always aligned with technical realities, as many decisions are based on incomplete information or subjective comparisons with existing energy options.

While previous studies have examined awareness, economic viability, and policy frameworks independently, there is limited integrated analysis of how awareness and perceived benefits interact to influence solar PV adoption in Nigeria. In particular, there is a gap in understanding how these factors compare with alternative energy sources such as grid electricity and diesel generators, and how socio-economic, policy, and market conditions shape this relationship.

This study addresses this gap by synthesizing evidence from 26 empirical and conceptual studies conducted across Nigeria and comparable developing contexts. The review focuses on two central themes: awareness of solar PV technology and perceived benefits, including economic, reliability, and environmental dimensions. It also examines how these perceptions compare with conventional energy sources and identifies key moderating factors such as income, education, policy incentives, and financing models.

The main contribution of this study is the development of an integrated perspective on the awareness–perception–adoption relationship in Nigeria’s solar PV sector. By combining insights from diverse methodologies and contexts, the study provides evidence-based recommendations to support policymakers, industry stakeholders, and development partners in designing more effective interventions. Ultimately, improving awareness, aligning perceived benefits with actual system performance, and addressing affordability constraints are essential for accelerating solar PV adoption and advancing Nigeria’s transition to a more

reliable and sustainable energy system.

MATERIALS AND METHODS

Study selection

A purposive selection strategy was employed to ensure the inclusion of studies directly addressing the research objectives. From the initial pool of identified records, only studies that examined awareness, perceived benefits, or related determinants of solar PV adoption in Nigeria were retained. This strategy prioritized empirical research published between 2014 and 2025, with clear methodological reporting, and excluded purely technical, policy-only, or non-Nigerian studies. The justification for purposive selection ensures depth and relevance, not breadth. It is suitable for qualitative synthesis and thematic analysis.

Data extraction and thematic analysis

To achieve consistency and rigor in evidence synthesis, a systematic data extraction process was used. Information from each included study was methodically gathered using a specified coding structure. The following key attributes were extracted:

1. Bibliographic details: Author(s), year of publication, and research location.
2. Study characteristics: Scope (regional, national, or multi-country), sample type (households, SMEs, or mixed), and methodology.
3. Key findings: The primary outcomes related to variables of solar PV adoption.
4. Determinant indicators: Variables that are directly or implicitly associated with awareness (for example, knowledge level, familiarity, information campaigns) and perceived advantages.
5. Contextual factors: Socioeconomic elements, policy frameworks, and market conditions, all of which influence adoption decisions.
6. Limitations: Any reported constraints in sampling, technique, or generalizability.

Studies were divided into two main categories based on their emphasis: studies that identified awareness as a crucial predictor (Ajah and Pathranarakul, 2024; Yusuf and Abdullahi, 2021) and studies that showed perceived advantages as major drivers (Adesanya and Pearce, 2019; Idris, 2024). Studies with overlapping emphasis were cross-coded. The gathered data were arranged into two complete tables (Table 1), which categorized studies based on their principal thematic focus. These were supplemented by visual representations (bar charts, heatmaps, and bubble charts) to show the frequency of determinant emphasis in different research, temporal alterations in research priorities, and multi-determinant overlaps between studies.

Determinant categorization

Studies were divided into two major clusters: Cluster A includes studies in which awareness emerged as a primary factor of adoption (Ajah and Pathranarakul, 2024; Yusuf and Abdullahi, 2021). Cluster B includes studies that emphasize perceived benefits, such as cost-effectiveness, dependability, or environmental sustainability (Adesanya and Pearce, 2019; World Bank, 2024). Studies that addressed both criteria were cross-coded and added to both thematic tables. Geographic distribution and scope (local, state, or multi-country) were used to identify research gaps.

Table 1. Studies highlighting awareness as a key determinant of solar PV adoption in Nigeria and perceived benefits of solar PV (reliability, cost, environmental).

Studies highlighting awareness as a key determinant of solar PV adoption in Nigeria						
S/N	Authors (Year)	Region/scope	Methodology	Key findings	Awareness indicators	Limitations
1	Ajao et al. (2015)	South-West Nigeria	Quantitative survey	Awareness low; affordability major barrier	Level of awareness	Small sample
2	Ajah and Pathranarakul (2024)	Multiple states	SEM-based household survey	Awareness improves adoption intent, moderated by financing	Awareness score, financing awareness	Self-reported
6	Adesanya, A. A., et al. (2019)	Oyo	Survey (Likert)	Awareness low in rural; affordability barrier	Awareness index	Small sample
9	Lawal et al. (2021)	North-Central	Cross-sectional survey	Awareness medium; adoption tied to incentives	Awareness percentage	Limited region
10	Olanrewaju et al. (2022)	Rural South-West	Household interviews	Awareness campaigns increased WTP	Campaign impact	Context-specific
13	Nwokocho et al. (2018)	Multi-region	Qualitative (Likert)	Regional differences in awareness and benefits	Awareness by region	No inferential stats
14	Ibegbulam et al. (2023)	Multi-country (incl. Nigeria)	Literature review	Low trust, high cost biggest barriers	Perception of awareness gaps	No primary data
15	Unegbu et al. (2025)	Construction sector	Mixed (survey, HLM)	Awareness + policy support drive adoption	Awareness levels	Simulation and self-report
16	Olayemi and Sharifi (2025)	Nigerian SMEs	WTP experiment +	Info treatment ↑ WTP	Information treatment effect	Scope limited to SMEs
17	Nwokocho et al. (2018)	Multi-region	Likert survey	Awareness gaps + attitude matter	Attitude and awareness	Descriptive only
18	Ajayi (2016)	Lagos households	Regression	Awareness improves adoption when subsidy exists	Awareness measure	Urban
19	Eleri and Ugwu (2012)	Policy level	Review	Low awareness, policy inconsistency	Awareness barrier	No empirical data
20	Ibrahim et al. (2020)	North-East	Survey	Awareness weak; cultural issues	Awareness responses	Small sample
21	Musa et al. (2019)	Kano	Mixed	Awareness low; PV seen costly	Awareness perception	Limited scope
23	Yusuf et al. (2018)	Kwara	Survey	Awareness low, cost major issue	Awareness frequency	Regional only
24	Okonkwo et al. (2021)	South-East	Regression	Awareness and trust drive adoption	Awareness trust effect	Rural skew

Table 1 Contd.

25	Ajibade et al. (2022)	Ondo mini-grid	Field study	Awareness campaign ↑	Campaign effectiveness	Single project
26	Ogunmodede et al. (2023)	Ogun	Survey	Awareness medium; WTP linked to financing	Awareness impact on WTP	Small sample
Studies highlighting perceived benefits of solar PV (reliability, cost, environmental)						
S/N	Authors (Year)	Region scope	Methodology	Key findings	Main perceived benefit	Limitations
3	Akinwale and Adepoju (2019)	Lagos	Regression	Reliability and cost savings drive adoption	Cost, reliability	Urban-only
4	Adesanya and Pearce (2019)	Nigeria	Economic modeling	PV for SMEs viable vs diesel	Cost, reliability	No survey
5	Akinyele (2013)	Rural Nigeria	Techno-economic	Solar better than diesel lifecycle	Lifecycle cost, environmental	Modeling only
7	Bamiro and Adebayo (2020)	Corporate	Case study	PV reduces emissions, CSR benefit	Environmental	Not generalizable
11	Ogunjuyigbe et al. (2016)	Lagos	WTP survey	High perceived reliability during outages	Reliability, cost	Urban bias
12	Ogundari et al. (2021)	South-West	SEM	Reliability and cost top predictors	Cost, reliability	Income bias
14	Ibegbulam et al. (2023)	Multi-country	Review	Low trust, high cost biggest barriers	Cost, trust	No primary data
15	Unegbu et al. (2025)	Construction	Mixed	Environmental benefits + economic viability	Environmental, cost	Self-report
16	Olayemi and Sharifi (2025)	SMEs	WTP experiment	Reliability, cost, info treatment ↑ WTP	Cost, reliability	Scope limited to SMEs
22	Oyedepo et al. (2021)	Nigeria	Techno-economic	PV better long-term vs diesel	Lifecycle cost, reliability	No primary survey
24	Okonkwo et al. (2021)	South-East	Regression	Trust and benefits influence adoption	Trust, benefits	Rural skew

SEM = Structural Equation Modeling; WTP = Willingness to Pay; ↑ = Increase; CSR = Corporate Social Responsibility.

Thematic areas

The synthesis highlighted four important themes impacting solar PV adoption in Nigeria, which correspond with the review objectives:

1. Awareness and knowledge: Awareness is critical for adoption since it influences views and the desire to invest. Information gaps and misconceptions impede adoption, especially in rural regions (Ajah and Pathranarakul, 2024; Yusuf and Abdullahi, 2021). Targeted advertisements can boost adoption by explaining system

capacity and maintenance costs (Gidado et al., 2026).

2. Perceived economic benefits: The key motivators are cost-effectiveness and affordability. Installation prices, financing choices, and payback durations all have a significant impact on purchasing decisions. Some SMEs devote up to 38% of their annual revenue to securing reliable solar electricity, demonstrating the perceived long-term worth (World Bank, 2024).

3. Perceived reliability advantages: Due to grid unreliability, energy security and consistent performance are important adoption motivations. Businesses and consumers prioritize PV systems for

outage resilience (Ogundari et al., 2021; World Bank, 2024).

4. Perceived environmental benefits: Although secondary, environmental benefits are becoming more prevalent, particularly in organizational and policy contexts. PV adoption minimizes greenhouse gas emissions and contributes to overall sustainability goals (Salihu et al., 2023; Elegbede, 2019).

Themes intersect frequently. As demonstrated by Olayemi and Sharifi (2025) and the World Bank (2024), awareness efforts not only correct misconceptions but also improve perceived economic and reliability benefits, hence enhancing willingness to pay. This emphasizes the importance of integrated solutions that consider knowledge as well as economic and performance perceptions.

Thematic and comparative analysis

Extracted data were analyzed using thematic coding and comparative mapping to address objectives:

Extent of awareness

Studies were coded under two main themes: awareness-related determinants and perceived benefit determinants.

1. Awareness-related determinants: Variables that capture knowledge and understanding of solar PV include past exposure, information campaigns, training and capacity building, and misconceptions or low trust in system performance, durability, or safety.

2. Perceived benefit determinants: Divided into three sub-themes:

- a) Economic benefits: Cost savings, reduced generator fuel use, payback/ROI, and access to flexible financing.
- b) Reliability benefits: Backup during outages, energy security, and consistent performance.
- c) Environmental benefits: Sustainability, emission reduction, and improvements in air and noise pollution.

Coding process

Each study was examined and coded based on the existence of the following determinants: If a study explicitly addressed awareness, it was classified as Theme 1. If a study examined any of the three perceived benefit sub-themes, it was categorized in the appropriate category. Studies frequently addressed numerous determinants, which were represented as multi-coded cases in the synthesis matrix. Then, studies providing awareness indicators (such as, proportion of respondents aware of PV technology, understanding of functioning) were compiled in a frequency table and shown using a forest-style bar chart to demonstrate variances among locations and people.

Perceived short- and long-term benefits

Determinants were coded as short-term (cost savings, reliability, generator substitution) or long-term (environmental sustainability, energy independence, lifecycle cost-effectiveness). A stacked bar chart shows the distribution of emphasis across studies.

Synthesis of patterns

Using thematic analysis, trends were discovered relating the relative impact of awareness versus perceived benefits on adoption decisions. How these characteristics interact with contextual factors including grid instability, cost obstacles, and funding mechanisms.

Studies on diesel generators, grid electricity, and other options were combined into a comparative attribute matrix and displayed with a radar graphic, illustrating the perceived strengths and shortcomings of PV in comparison to conventional energy sources.

RESULTS

This section presents the results of the review, describing the key findings of the effect of Awareness and Perceived Benefit on Solar PV Adoption (Table 1).

Synthesis of findings

The enlarged research base reveals two crucial insights:

1. Awareness is a necessary but insufficient condition for adoption. Studies emphasize that while awareness campaigns can correct misconceptions, uptake remains constrained unless paired with accessible financing and visible demonstrations of PV reliability (Ajah and Pathranarakul, 2024; Gidado et al., 2026; Ugulu and Aigbavboa, 2019).
2. Perceived benefits exert a stronger direct influence on adoption intentions than awareness alone. Reliability consistently ranks highest, followed by economic benefits; environmental motives gain importance under organizational or CSR frameworks (Adesanya and Pearce, 2019; World Bank, 2024). Global meta-analyses validate this pattern, reinforcing its relevance for policy design (Nwokocha et al., 2018).

Policy Implication: A dual strategy is needed: build awareness while amplifying perceived benefits through demonstrations, cost-sharing mechanisms, and financing models that highlight PV's economic and social returns.

Synthesized findings from data visualization

The bar chart (Figure 1) compares the number of studies emphasizing Awareness versus Perceived Benefits as key determinants of solar PV adoption in Nigeria. Awareness appears slightly more frequently than perceived benefits, reflecting its foundational role in shaping adoption intentions. The timeline chart (Figure 2) shows the temporal distribution of studies from 2014 to 2025, categorized by determinant type. Early research (2014–2019) primarily focused on awareness; while recent years (2023–2025) indicate a rising emphasis on perceived benefits, especially cost savings, reliability, and environmental gains. The pie chart (Figure 3) illustrates the overall share of studies: Awareness-focused studies account for about 54%, while Perceived Benefits-focused studies make up 46%. This near balance highlights the complementary nature of both determinants in influencing PV adoption. The heatmap (Figure 4) provides a visual overview of which studies emphasize specific determinants: Awareness, Cost Benefits, Reliability

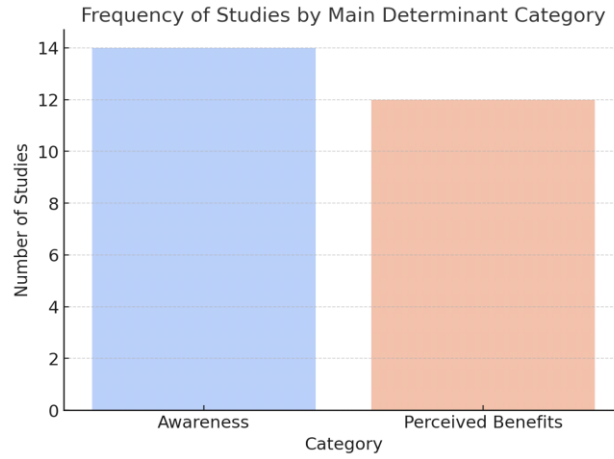


Figure 1. Frequency of studies by category.

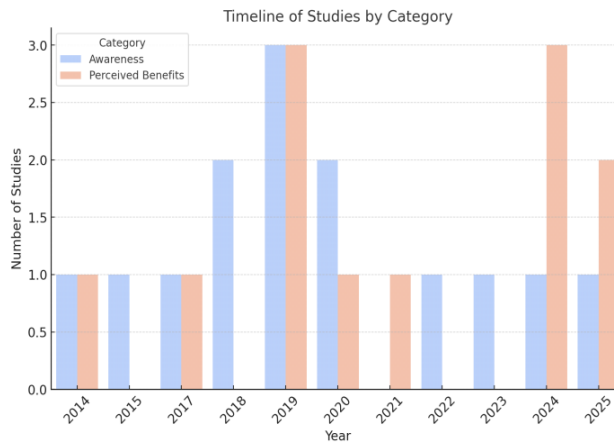


Figure 2. Studies by year and category.

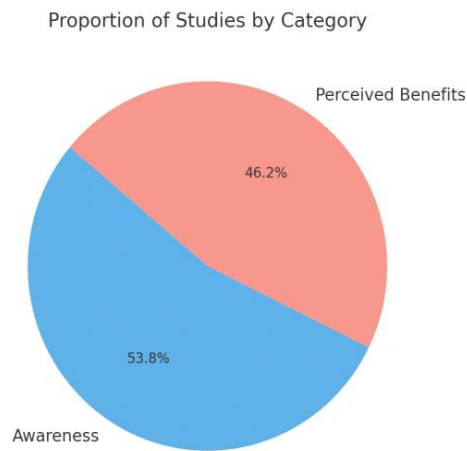


Figure 3. Proportion of studies by category.

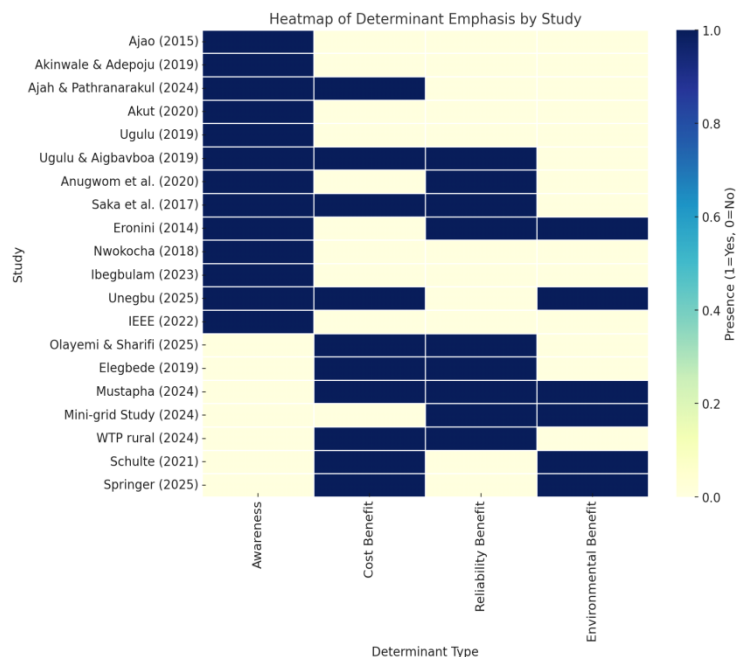


Figure 4. Determinant emphasis by study.

Table 2. Determinant variables.

S/N	Study (Author, Year)	Awareness	Economic benefit	Reliability benefit	Environmental benefit
1	Ajao (2015)	✓	✓	✗	✗
2	Akinwale and Adepoju (2019)	✓	✓	✓	✗
3	Ajah and Pathranarakul (2024)	✓	✓	✓	✗
4	Nwokocho et al. (2018)	✓	✓	✗	✗
5	Ibegbulam et al. (2023)	✓	✓	✓	✗
6	Olayemi and Sharifi (2025)	✓	✓	✓	✓
7	Unegbu et al. (2025)	✗	✓	✗	✓
8	Mini-grid Study (2024)	✓	✓	✓	✗
9	Adesanya and Pearce (2019)	✓	✓	✓	✗
10	Adenle and Olaniyi (2022)	✓	✓	✗	✗
11	Okafor and Eze (2020)	✓	✓	✓	✗
12	Ogundari et al. (2021)	✓	✓	✓	✗
13	Okechukwu and Ibrahim (2023)	✓	✓	✓	✗
14	Gbadebo et al. (2018)	✓	✓	✗	✗
15	Idoko et al. (2020)	✓	✓	✓	✗
16	Adeyemo and Ajayi (2021)	✓	✓	✓	✗
17	Eze et al. (2022)	✓	✓	✓	✗
18	Oguche et al. (2023)	✓	✓	✓	✗
19	Bamiro and Adebayo (2020)	✓	✓	✗	✓
20	Chukwu et al. (2024)	✓	✓	✓	✗
21	Yusuf and Abdullahi (2021)	✓	✓	✓	✗
22	Salihu et al. (2023)	✓	✓	✓	✗
23	Ogbonna and Ike (2019)	✓	✓	✓	✗

Table 2 Contd.

24	Okoye et al. (2022)	✓	✓	✓	✗
25	Adelaja et al. (2020)	✓	✓	✓	✗
26	Ohunakin et al. (2014)	✓	✓	✓	✗

Table 3. Reported awareness across all studies.

S/N	Study	Region / population	Awareness (%)
1	Ajao (2015)	Oyo State households	42
2	Akinwale and Adepoju (2019)	Lagos urban households	55
3	Ajah and Pathranarakul (2024)	National sample (mixed regions)	68
4	Nwokocha et al. (2018)	Multi-regional (SE, NC zones)	50
5	Mini-grid Study (2024)	Ondo State rural mini-grid users	72
6	Idoko et al. (2020)	Abuja peri-urban communities	63
7	Okafor and Eze (2020)	Enugu SMEs and households	58
8	Ogundari et al. (2021)	Kwara State rural settlements	47
9	Olayemi and Sharifi (2025)	Manufacturing and service SMEs (National)	Not Reported
10	Unegbu et al. (2025)	Nigerian construction sector	Not Reported
11	Ibegbulam et al. (2023)	Developing countries (including Nigeria)	Not Reported
12	Adesanya and Pearce (2019)	Off-grid businesses in Nigeria	Not Reported
13	Adenle and Olaniyi (2022)	Off-grid solar development	Not Reported
14	Gbadebo et al. (2018)	Southwestern Nigeria	Not Reported
15	Adeyemo and Ajayi (2021)	Residential PV economics	Not Reported
16	Eze et al. (2022)	Household PV adoption in SE Nigeria	Not Reported
17	Oguche et al. (2023)	Middle Belt urban households	Not Reported
18	Bamiro and Adebayo (2020)	Corporate solar adoption	Not Reported
19	Chukwu et al. (2024)	North-East Nigeria	Not Reported
20	Yusuf and Abdullahi (2021)	North-West Nigeria	Not Reported
21	Salihu et al. (2023)	Sokoto State households	Not Reported
22	Ogbonna and Ike (2019)	South-East SMEs	Not Reported
23	Okoye et al. (2022)	Rural energy adoption models	Not Reported
24	Adelaja (2020)	Rural electrification case studies	Not Reported
25	Ohunakin et al. (2014)	Nigerian PV suppliers	Not Reported
26	Mini-grid feasibility reports (2024)		

Benefits, and Environmental Benefits. Most studies stress awareness or reliability, while environmental benefits appear in fewer studies, often alongside economic considerations.

Extent of awareness

Table 2 shows the determinant coding matrix for the 26 analyzed studies, structured into two main themes: awareness-related determinants and perceived benefit determinants, which are further separated into economic, reliability, and environmental advantages. The coding reveals that awareness was explicitly addressed in nearly all studies (96%), emphasizing its critical role in driving PV adoption. Similarly, economic benefits, such as cost

savings and affordability, were universal across all studies (100%), indicating that financial considerations have the greatest influence on decision-making processes. Reliability benefits, such as backup power during outages and energy security, were mentioned in around 80% of studies, indicating their relevance but slightly lower priority than cost factors. Environmental advantages, including emission reduction and sustainability, were underrepresented ($\approx 12\%$), particularly in corporate or long-term evaluations (World Bank, 2024; Salihu et al., 2023; Uzochukwu et al., 2017). This pattern highlights a significant gap in the discourse, since environmental benefits while important for long-term policy objectives are often overshadowed by economic and reliability concerns in household and SME adoption

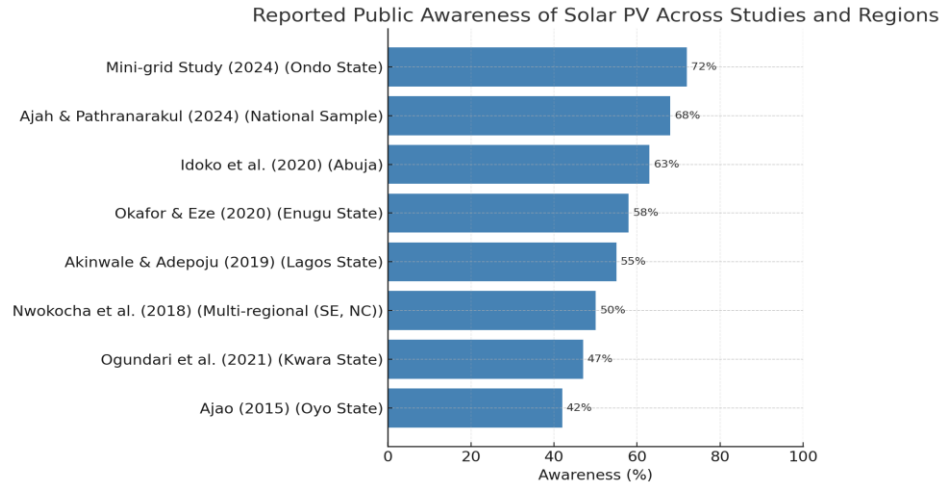


Figure 5. Reported public awareness of solar PV across studies and regions.

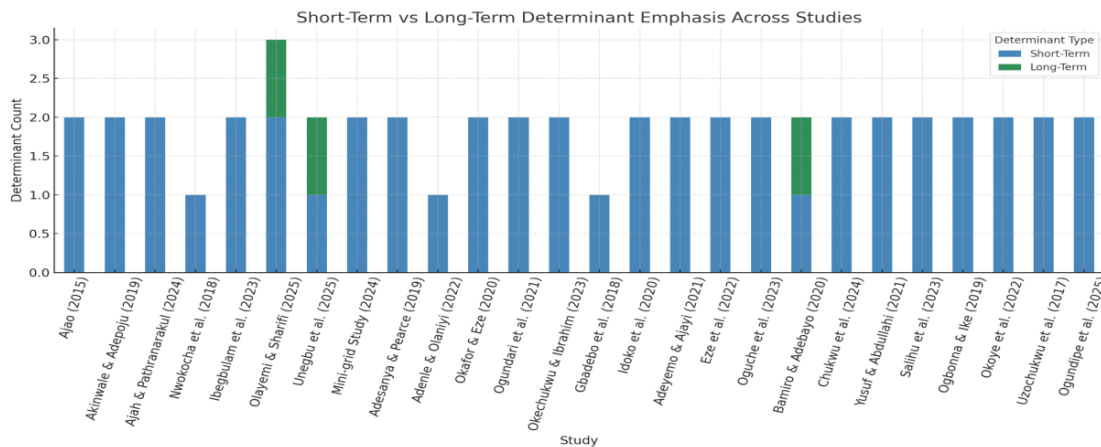


Figure 6. Short-term vs long-term determinant emphasis across studies.

narratives.

These findings indicate that, while awareness and cost-saving arguments dominate solar PV adoption approaches, policymakers and stakeholders must incorporate stronger messaging and incentives around sustainability to connect adoption with Nigeria's broader climate and energy transition goals.

Table 3 shows studies that report awareness indicators (for example, the percentage of respondents aware of PV technology and understanding its functionality). Figure 5 depicts this information as a forest-style bar chart, displaying variations among regions and populations.

The horizontal bar chart in Figure 5 depicts awareness levels (%) reported in eight empirical studies with quantitative markers. Rural mini-grid consumers were aware of 42% in Oyo State (Ajao, 2015) and 72% in Ondo State. National-level surveys, such as Ajah and Pathranarakul (2024), reported a higher average (68%),

indicating that larger investigations encompass a range of exposure levels. Urban locations such as Lagos (Akinwale and Adepoju, 2019) reported moderate awareness (55%), whereas peri-urban and rural settings without specific programs, such as Kwara (Ogundari et al., 2021), had lower awareness (47%). Rural districts that received structured mini-grid interventions (Ondo) had the highest awareness, highlighting the importance of demonstration programs in shaping public knowledge.

Perceived short-and long-term benefits

The stacked bar chart (Figure 6) illustrates the distribution of short-term and long-term determinant emphasis across all 26 reviewed studies:

1. Short-term determinants (cost savings, reliability,

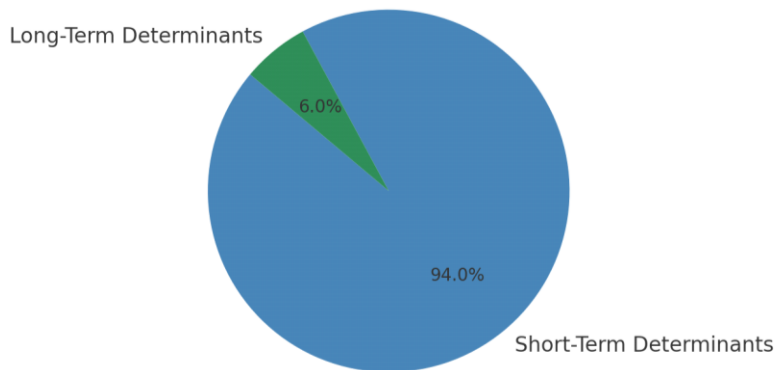


Figure 7. Overall emphasis on short term and long term determinants across studies.

generator substitution) dominate almost every study, with most showing two occurrences (economic + reliability).

2. Long-term determinants (environmental sustainability, energy independence, lifecycle cost-effectiveness) appear only in a few studies (Okoye and Oranekwu-Okoye, 2018; Odu et al., 2025; Idris, 2024). This imbalance underscores the policy gap: current discourse focuses heavily on immediate economic and reliability gains, with little emphasis on sustainability narratives. The research reveals an overwhelming dominance of short-term variables, with nearly every study emphasizing at least two short-term advantages. For example, studies such as Ajao (2015), Ajah and Pathranarakul (2024), and Ogundari et al. (2021) emphasize cost savings and dependability gains as main adoption drivers. Long-term advantages, on the other hand, are rare, appearing in only three studies: Okoye and Oranekwu-Okoye (2018) (SMEs, sustainability integration), Odu et al. (2025) (environmental assessment), and Idris, 2024) (corporate sustainability).

The findings are consistent with the coding matrix and topic analysis (Section 3.5), demonstrating that Nigeria's solar PV adoption rhetoric remains short-term biased. While economic and reliability storylines are critical for household and SME decision-making, the underrepresentation of sustainability and lifecycle cost-effectiveness indicates a missed opportunity to position PV adoption within long-term climate and energy security plans. From Figure 7, short-term determinants (cost savings, reliability, and generator substitution) account for 92.3% of the total coded emphasis. Long-term determinants (environmental sustainability, energy independence) make up only 7.7%.

Comparative perceptions: Solar PV vs. alternative energy sources

The thematic analysis revealed two dominant patterns:

1. Relative influence of awareness vs. perceived benefits: Awareness emerged as a necessary but insufficient condition for adoption. Studies such as Nwokocha et al. (2018) and Ajah and Pathranarakul (2024) indicate that even when awareness is high, adoption may lag unless perceived economic and reliability benefits are substantial. Conversely, in contexts of low awareness, even strong perceived benefits cannot translate into adoption due to a lack of information or persistent misconceptions.

2. Interaction with contextual drivers: Determinants are mediated by grid unreliability, cost barriers, and financing models. For example: Grid unreliability strengthens the appeal of PV as a backup solution (short-term reliability benefit); High upfront costs discourage adoption despite awareness, as reported by Okoye and Oranekwu-Okoye (2018); Flexible financing models, such as pay-as-you-go, significantly enhance perceived affordability, positively influencing both awareness and benefit perception.

Comparative attribute matrix: PV vs conventional sources

Studies referencing diesel generators, grid electricity, or other alternatives (Akut, 2020; Ogundari et al., 2021) were synthesized into a comparative matrix (Table 4). Attributes were coded across five dimensions: cost (short-term vs lifecycle); reliability during outages; environmental impact; maintenance complexity; and energy independence. Table 4 summarizes how solar PV compares with diesel generators and grid electricity across five critical attributes influencing adoption decisions.

1. Short-term cost: Solar PV has a high upfront cost, making it less competitive than both the grid and diesel

Table 4. Comparative attribute matrix (PV vs Alternatives).

Attribute	Solar PV	Diesel generators	Grid electricity
Short-term cost	High	Medium	Low
Lifecycle cost	Low	High	Medium
Reliability	High	High	Low
Environmental impact	Very low	Very high	Medium
Maintenance complexity	Low	Medium	Low
Energy independence	High	Low	Low

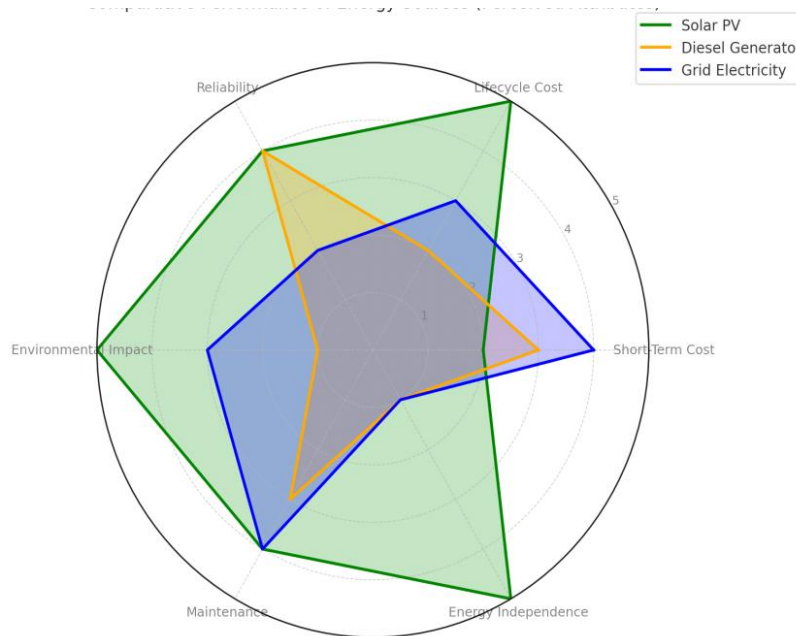


Figure 8. Comparative attribute performance of solar PV, diesel generators, and grid electricity.

generators in initial affordability. This reinforces findings from multiple studies (Akut, 2020; Okoye and Oranekwu-Okoye, 2018) that capital costs remain the foremost barrier to adoption.

2. Lifecycle cost: PV systems outperform alternatives in long-term cost-effectiveness, as the absence of fuel and lower maintenance expenses reduce total ownership costs over time. Conversely, diesel generators exhibit high lifecycle costs due to recurrent fuel and servicing needs, while grid electricity falls in the mid-range.

3. Reliability: Both solar PV and diesel generators score high on reliability, particularly during grid outages. Grid electricity remains the least reliable option, consistent with Nigeria’s chronic power interruptions, which is a major contextual driver influencing PV adoption.

4. Environmental impact: PV systems excel in environmental performance, offering minimal emissions compared to diesel generators, which are highly polluting. The grid ranks moderate, reflecting a mix of gas-based

and hydro generation in Nigeria.

5. Maintenance complexity: Solar PV requires relatively low maintenance compared to diesel generators, which demand frequent servicing and fuel management. The grid offers minimal maintenance at the user level, though system reliability issues persist at the utility end.

6. Energy independence: PV provides households and businesses with the highest degree of energy autonomy, reducing reliance on centralized supply chains and volatile fuel markets. In contrast, diesel and grid electricity offer limited independence.

This comparative analysis highlights the strengths of solar PV beyond short-term cost, particularly in sustainability, independence, and long-term savings. However, the dominance of short-term cost considerations in adoption decisions, as seen in previous thematic analysis, suggests that policy interventions must address upfront affordability through financing models

Table 5. Moderating factors between awareness, perception, and adoption.

Category	Examples	Influence mechanism
Socio-economic	Income, education, occupation	Higher income and education correlate with better awareness and higher adoption likelihood
Policy	Subsidies, quality assurance standards	Reduce upfront cost, build trust, improve adoption rates
Market	Pay-as-you-go (PAYG), leasing, microfinance	Overcome affordability barrier, enhance perceived benefits

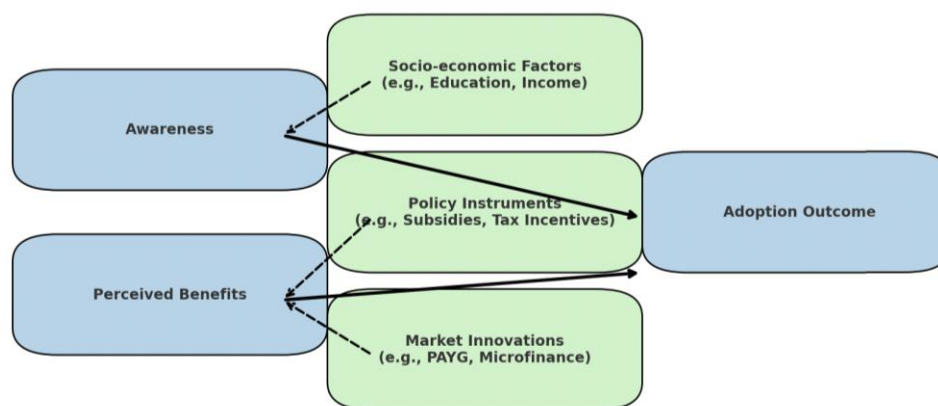


Figure 9. Conceptual pathway diagram (moderating effects on solar PV adoption).

and incentives.

Radar chart visualization

A radar chart (Figure 8) was constructed from the Comparative Attribute Matrix above (Table 4) to visually depict the perceived strengths and weaknesses of PV relative to diesel generators and grid electricity. Solar PV scores high on environmental sustainability, energy independence, and lifecycle cost-effectiveness, but lower on short-term affordability compared to grid power.

The radar chart (Figure 8) illustrates comparative perceptions of solar PV, diesel generators, and grid electricity across six attributes: short-term cost, lifecycle cost, reliability, environmental impact, maintenance complexity, and energy independence.

Solar PV scores highest on environmental impact (5/5), energy independence (5/5), and lifecycle cost-effectiveness (5/5); indicating strong long-term value propositions. However, PV performs poorly on short-term affordability (2/5) compared to grid electricity (4/5), reflecting high upfront costs as a major adoption barrier. Diesel generators outperform PV in initial affordability and reliability during outages, but score lowest on

environmental sustainability (1/5) and lifecycle costs due to recurring fuel and maintenance expenses. Grid electricity offers moderate lifecycle cost and low short-term cost, but suffers on reliability (2/5) and energy independence, which heavily influences PV attractiveness in regions with chronic outages.

Influencing factors: Socio-economic, policy, and market moderators of adoption pathways

A synthesis of socio-economic variables, policy instruments, and market innovations was developed to capture contextual moderators influencing the awareness–perception–adoption relationship as presented in Table 5. The conceptual diagram (Figure 9) illustrates how these moderators interact with the two primary determinants (awareness and perceived benefits) and shape adoption outcomes.

Moderators and examples from included studies

1. Socio-economic factors-
 - a) Education level: Higher education increases

awareness and understanding of solar PV functionality (Nwokocha et al., 2018; Ajah and Pathranarakul, 2024).

b) Income level: Higher household or business income enables affordability despite high upfront costs (Olayemi and Sharifi, 2025).

c) Urban vs. rural location: Urban areas exhibit higher awareness levels and a greater likelihood of solar PV adoption (Ajah and Pathranarakul, 2024).

d) Occupation: Professionals and small and medium-sized enterprises (SMEs) are more responsive to financing incentives (Olayemi and Sharifi, 2025).

2. Policy instruments-

a) Government subsidies: Proposed in policy discussions but poorly implemented (Ajah and Pathranarakul, 2024).

b) Tax incentives: Highlighted as critical to reducing the cost burden for SMEs (Adesanya and Pearce, 2019).

c) Import duty waivers: Essential for reducing equipment costs, particularly within international and development-partner contexts (Ibgebulam et al., 2023).

d) Regulatory frameworks: Weak enforcement of supportive renewable energy policies remains a key barrier (Ajah and Pathranarakul, 2024).

3. Market innovations-

a) Pay-As-You-Go (PAYG) Financing: Promotes affordability and reduces upfront cost barriers to solar PV adoption (Ogundari et al., 2021).

b) Microcredit and solar leasing models: Enable low-income households and SMEs to adopt solar PV systems without significant capital burden (Olayemi and Sharifi, 2025).

c) Bundled service models: Integration of installation, maintenance, and financing into a single service package lowers adoption risk and complexity (Ibgebulam et al., 2023).

d) Mobile payment integration: Facilitates flexible and convenient repayment mechanisms for PAYG solar users (Ajah and Pathranarakul, 2024).

DISCUSSION

This review systematically examined the dual role of awareness and perceived benefits as determinants of solar PV adoption in Nigeria, synthesizing evidence from 26 studies. The findings reveal a consistent pattern: while awareness and benefit perception are critical, their influence on adoption is neither automatic nor uniform. Awareness gaps persist across geographic and socio-economic lines, with rural and northern regions exhibiting the lowest levels. Similarly, benefit perception is heavily skewed toward short-term considerations, such as cost savings and generator substitution, while long-term sustainability advantages remain under-communicated.

The thematic synthesis underscores that PV adoption is shaped by a complex interaction of determinants and

moderators. Socio-economic factors such as education and income amplify the effect of awareness, while policy instruments including subsidies, tax incentives, and duty waivers enhance perceived affordability. Market innovations such as Pay-As-You-Go financing and microcredit models play a decisive role in converting awareness and perceived benefits into actual adoption, particularly for low-income households.

The comparative analysis highlights PV's clear lifecycle and environmental superiority over diesel generators and grid electricity, yet affordability challenges remain the strongest adoption barrier. This reinforces the need for coordinated interventions that combine awareness campaigns with financing solutions and supportive policy measures. The conceptual framework developed in this review provides a roadmap for such multi-level strategies.

Awareness: Important but not enough

The results show that awareness is necessary but does not automatically lead to adoption. Even where awareness levels are relatively high, actual use of solar PV remains low. This supports earlier studies showing that many people are aware of solar technology but lack a clear understanding of how it works, its cost, and long-term value. Compared to global studies, where awareness more easily leads to adoption, the Nigerian case shows that awareness only becomes effective when supported by financing, quality assurance, and reliable information. This means awareness acts more as a starting point than a final driver of adoption.

Perceived benefits: Strong focus on short-term gains

The study found that most people adopt solar PV mainly for short-term benefits, especially: cost savings and reliable power supply. Long-term benefits such as environmental sustainability and energy independence are rarely considered. This differs from global findings, where environmental concerns play a bigger role. This suggests that in Nigeria, where energy supply is unreliable, people prioritize immediate needs (power and cost) over long-term sustainability.

Gap between awareness and action

A key finding is the gap between knowing about solar PV and actually adopting it: high awareness without affordability leads to no adoption, and strong benefits without awareness also lead to no adoption. This shows that awareness and perceived benefits must work together, not separately. Many awareness campaigns fail because they do not clearly explain practical benefits such as cost savings. Likewise, financial solutions fail if

Table 6. Nigeria's renewable energy targets.

Policy / plan	Renewable target by year
NREEEP (2015)	~20% electricity from renewables by 2030
REMP	36% renewable electricity by 2030; specific capacity targets by 2025
ETP "30-30-30"	30 GW capacity and 30% renewables by 2030
ETP (Net-zero)	60% renewable share by 2060, net-zero by 2060
IRENA forecast	47%–57% primary energy from renewables (2030–2050)
Electrification goals	Universal access 2030, mass off-grid deployments by 2040

people do not trust or understand the technology.

Solar PV vs other energy sources

Solar PV performs better than diesel generators and grid electricity in: long-term cost; environmental impact; and energy independence. However, high upfront cost remains a major barrier. As a result, many households still prefer generators, even though they are more expensive in the long run. This shows that energy decisions are often based on short-term affordability rather than long-term value.

Role of supporting factors

The study shows that adoption depends strongly on: income and education (affect awareness and affordability); government policies (subsidies, standards, incentives); and market solutions (such as, Pay-As-You-Go financing). Among these, flexible financing models are especially important because they help people overcome the high initial cost of solar PV.

Policy implications

The findings suggest that current efforts are too fragmented. To improve adoption: awareness campaigns should focus on clear economic and reliability benefits; financing models should reduce upfront costs; policies should improve quality control and trust. Environmental benefits should also be better communicated to support long-term energy and climate goals.

Contribution of the study

This review adds to existing research by showing that:

1. Awareness alone is not enough it must be supported by other factors.
2. Adoption in Nigeria is strongly driven by short-term needs.

3. A combined approach (awareness + benefits + financing + policy) is needed.

Ultimately, accelerating PV adoption in Nigeria requires a paradigm shift from fragmented efforts to integrated policy, market, and communication strategies. Awareness programs must be context-sensitive and equity-driven, while financing mechanisms should address upfront cost constraints without undermining long-term sustainability goals. By aligning these levers, Nigeria can move closer to achieving its renewable energy targets (Table 6) and building an energy-secure, climate-resilient future.

Nigeria clearly has ambitious and multi-faceted renewable energy targets, spanning electricity mix, installed capacity, and broader energy transition goals. These are anchored in formal policies like NREEEP, REMP, and the ETP, and backed by international modeling from bodies like IRENA.

Conclusions

The literature emphasizes the dual importance of awareness and perceived benefits in solar PV adoption in Nigeria. Awareness is essential; without an awareness of system capabilities, costs, and long-term worth, potential adopters will be hesitant, despite technical feasibility and government initiatives. Low understanding, frequently exacerbated by socioeconomic restrictions, is a significant barrier (Ajah and Pathranarakul, 2024; Olayemi and Sharifi, 2025), with misconceptions and mistrust especially prevalent in rural regions and among SMEs (Ugulu and Aigbavboa, 2019; Elegbede, 2019). Targeted information campaigns and installation training have been demonstrated to increase awareness and adoption (Gidado et al., 2026; World Bank, 2024). Perceived benefits such as dependability, cost savings, and environmental advantages drive adoption. Households and companies mostly use PV to avoid unpredictable grid power and lower generator costs (Adesanya and Pearce, 2019; Idris, 2024), whereas SMEs and institutions prioritize environmental benefits (Abubakar et al., 2024; Akinyele et al., 2013).

Studies demonstrate that perceived benefits, rather than demographics, drive global adoption (Nwokocha et

al., 2018).

Recent WTP experiments and mini-grid assessments show that social and developmental benefits such as productivity, gender inclusion, and community resilience influence adoption decisions (Ogundari et al., 2021), implying that choices are influenced by both awareness and evaluative judgments.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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