Social and Technical Determinants and Perceived Environmental Benefits of Household Solar Energy Adoption in Onne, Eleme Local Government Area, Rivers State, Nigeria

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Abstract
Household solar energy represents an important pathway for improving energy security and reducing dependence on fossil-fuel-based electricity generation in Nigeria. However, adoption is influenced by interacting social, technical, economic and institutional factors. This study assessed the social and technical determinants of household solar-energy adoption and perceived environmental benefits among households in Onne, Eleme Local Government Area, Rivers State, Nigeria. A cross-sectional household survey was conducted using a multistage sampling procedure. Of 320 questionnaires administered, 286 valid responses were analysed, representing an 89.4% valid-response rate. Data were collected using a structured questionnaire and analysed using descriptive statistics, chi-square tests and binary logistic regression. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported, with statistical significance set at $p < .05$. Community acceptance recorded the highest level of social influence (60.5%), followed by visible use of solar systems by neighbours (58.0%) and influence from friends and relatives (54.9%). Among technical factors, 48.6% of respondents agreed that solar systems were reliable, whereas 57.7% indicated that maintenance requirements discouraged adoption. Perceived environmental benefits were high, particularly reduced noise pollution (82.6%), environmental sustainability (79.8%), reduced generator emissions (78.0%), reduced air pollution (76.6%), and reduced fossil-fuel dependence (73.4%). Binary logistic regression showed that community acceptance (AOR = 1.68, 95% CI [1.24, 2.28]), system reliability (AOR = 1.59, 95% CI [1.18, 2.14]), neighbour/peer influence (AOR = 1.51, 95% CI [1.13, 2.02]), friends/relatives' influence (AOR = 1.47, 95% CI [1.12, 1.94]), social-network influence (AOR = 1.35, 95% CI [1.03, 1.77]), battery performance (AOR = 1.39, 95% CI [1.05, 1.84]), and technician availability (AOR = 1.52, 95% CI [1.13, 2.03]) were positively associated with adoption. Maintenance concerns were negatively associated with adoption (AOR = 0.68, 95% CI [0.52, 0.89]), while technical ease of

use was not statistically significant ($p = .054$). The overall regression model was statistically significant ($\chi^2(9) = 68.40$, $p < .001$; Nagelkerke $R^2 = .312$) and correctly classified 76.6% of cases. The findings indicate that household solar-energy adoption in Onne is associated with social acceptance, interpersonal influence, system reliability and technical support. Although households strongly perceive solar energy as environmentally beneficial, perceived environmental advantages alone may not overcome technical and maintenance barriers. Interventions should therefore combine accessible financing with reliable solar technology, qualified local technicians, effective after-sales services and community-based promotion.

Keywords: *Household solar energy, solar photovoltaic, technology adoption, social determinants, technical determinants, perceived environmental benefits.*

1. Introduction

Reliable, affordable and sustainable electricity is fundamental to household welfare, economic productivity and environmental sustainability. Solar photovoltaic (PV) technology has become an increasingly important component of the global energy transition because of its scalability, modularity and potential to provide low-carbon electricity. The continued expansion of distributed solar systems is particularly relevant to households seeking alternatives or complements to conventional electricity supplies, especially in settings characterised by unreliable grid electricity. Nigeria provides an important context for examining household solar-energy adoption. Persistent electricity-supply challenges have encouraged households and businesses to depend on alternative electricity sources, including petrol- and diesel-powered generators. Although Nigeria possesses substantial solar-energy resources, the deployment of household solar systems remains constrained by economic, technical, institutional and social factors. Previous research has identified high initial investment costs, inadequate technical capacity, limited maintenance services, insufficient information and inadequate availability of spare parts as important constraints to solar-energy development in Nigeria (Ohunakin et al., 2014). The National Energy Policy similarly recognises renewable energy as an important component of Nigeria's strategy for improving energy supply, diversifying the energy mix and promoting sustainable development (Energy Commission of Nigeria [ECN], 2022). Household solar-energy adoption is not determined solely by affordability or technological availability. Energy decisions occur within social environments in which neighbours, friends, relatives and community networks can influence perceptions of technology, perceived risk and confidence in adoption. Households may use the experiences of other users as informal evidence regarding the performance, reliability and usefulness of solar systems. Visible installations may also increase the observability of the technology and reduce uncertainty about its practical application. Research on residential photovoltaic adoption has identified social influence, peer effects and observed use as relevant components of household adoption decisions (Kastner & Wittenberg, 2019; Rai et al., 2016). Technical characteristics are similarly important. The reliability of solar systems, battery performance, ease of operation, maintenance requirements, availability of qualified technicians and access to spare parts can influence both adoption decisions and perceptions of long-term system viability. A household may be reluctant to invest in solar technology if the system is perceived as unreliable or difficult to maintain, or if technical support is unavailable. Conversely, reliable performance and accessible technical services may strengthen household confidence in solar technology.

The environmental implications of household solar adoption provide an additional rationale for its promotion. Solar electricity can reduce dependence on petrol and diesel generators and may consequently reduce generator-related noise and air emissions. Solar PV can also contribute to reduced fossil-fuel dependence and broader transitions towards cleaner energy systems. However, the environmental benefits of solar technology are not limited to its operational phase. Battery replacement, component manufacturing, system lifespan and end-of-life management can influence the overall environmental performance of solar systems. Therefore, household perceptions of environmental benefits should be distinguished from direct measurements of environmental outcomes. Despite increasing interest in renewable-energy adoption in Nigeria, relatively limited empirical evidence has examined the combined influence of social and technical factors on household solar-energy adoption in industrialising communities of the Niger Delta. This is particularly relevant to Onne, Eleme Local Government Area, an industrial and port community characterised by substantial oil, gas, logistics and maritime activities, increasing energy demand and widespread dependence on alternative electricity sources. Evidence from such a setting can contribute to a better understanding of how social acceptance, interpersonal influence, technical performance and service availability shape household adoption.

The present study therefore examined the social and technical determinants of household solar-energy adoption and assessed perceived environmental benefits among households in Onne, Eleme Local Government Area, Rivers State, Nigeria. Specifically, the study examined (1) the influence of social factors on household solar-energy adoption; (2) the influence of technical factors on adoption; and (3) household perceptions of the environmental benefits of solar energy.

2. Theoretical Framework

1. Diffusion of Innovations Theory

This study was guided by Rogers' Diffusion of Innovations (DOI) Theory (Rogers, 2003). DOI explains how new ideas and technologies are communicated, evaluated and adopted within a social system over time. The theory proposes that adoption is influenced by five perceived characteristics of an innovation: relative advantage, compatibility, complexity, trialability and observability.

The theory is particularly relevant to household solar-energy adoption because solar technology represents an innovation whose adoption depends on both perceived technological attributes and the social environment in which decisions are made. Relative advantage may be reflected in perceptions that solar energy provides more reliable electricity and environmental advantages than conventional alternatives. Compatibility concerns the extent to which solar technology fits existing household energy needs and practices. Complexity relates to perceived difficulty in installing, operating and maintaining solar systems, while observability refers to the extent to which households can observe the technology and its benefits in actual use.

The social dimension of DOI is particularly important to this study. Neighbours, peers, friends, relatives and community networks may provide information and experiential knowledge that influence perceptions of solar technology. Visible adoption by other households can make the technology more familiar and reduce uncertainty. In this regard, the findings on neighbour influence, social networks and community acceptance can be interpreted within the observability and social-system dimensions of DOI. The technical findings can also be linked to DOI. System reliability and battery performance relate to the perceived relative advantage and compatibility of solar systems, while maintenance requirements and technical difficulties relate to perceived complexity. Availability of qualified technicians contributes to the support environment necessary

for continued adoption. DOI therefore provides an appropriate theoretical basis for examining household solar adoption as a process shaped by both social communication and perceived technological characteristics.

3. Materials and Methods

Study Area: The study was conducted in Onne, Eleme Local Government Area of Rivers State, Nigeria. Onne is an important industrial and port community in the Niger Delta and hosts major oil, gas, logistics and maritime activities. The concentration of industrial and commercial activities contributes to substantial electricity demand, while households continue to depend on alternative electricity sources because of limitations in conventional electricity supply. These characteristics make Onne an appropriate setting for examining household solar-energy adoption.

Research Design: A cross-sectional descriptive survey design was adopted. The design enabled data to be collected from households during a defined study period to assess social influences, technical considerations, household adoption and perceived environmental benefits associated with solar energy.

Study Population: The study population comprised households in Onne. Household heads or adult household representatives involved in household energy decisions were eligible to participate because of their direct involvement in household electricity use, expenditure and energy-technology decisions. The estimated household population was 1,850.

Sample-Size Determination: The sample size was determined using the Taro Yamane formula:

$$n = \frac{N}{1+N(e)^2} \quad \text{---------- } (1)$$

Where (n) is the sample size, (N) is the population and (e) is the acceptable error margin (0.05). For 1,850 households:

$$n = \frac{1,850}{1+1,850(0.05)^2} = \frac{1850}{5.625} = 328.89$$

Thus, a minimum of 329 households was required. However, because of field and logistical constraints, 320 questionnaires were administered. Of these, 286 were valid and included in the analysis, giving a valid-response rate of 89.4%.

Sampling Procedure: A multistage sampling procedure was used. First, residential communities within Onne were identified. Second, households were selected from the identified communities. Eligible households were approached using the specified sampling procedure, and one eligible adult respondent responsible for or knowledgeable about household energy decisions was invited to participate.

Instrument Development: Data were collected using a structured questionnaire developed from the study objectives and relevant literature on household renewable-energy adoption. The questionnaire consisted of sections covering socio-demographic characteristics, solar-energy adoption, social determinants, technical determinants and perceived environmental benefits.

Social and technical determinants were measured using five-point Likert-scale items ranging from 1 = strongly disagree to 5 = strongly agree.

Measurement of Variables: The dependent variable was household solar-energy adoption, coded as 1 = adopter and 0 = non-adopter.

Social determinants included neighbour/peer influence, friends/relatives' influence, community acceptance, social-network influence and visible use of solar systems by neighbours.
Technical determinants included system reliability, maintenance requirements, battery performance, technical ease of use and technician availability. Spare-parts availability was initially included in the questionnaire but was excluded from the final regression model because it was not included among the predictors reported in the final analysis.
Perceived environmental benefits included reduced air pollution, reduced generator emissions, reduced noise pollution, reduced fossil-fuel dependence and promotion of environmental sustainability.

Validity: The questionnaire was subjected to face and content validation by the research supervisor and experts in environmental management and renewable-energy studies. Their observations were incorporated into the final instrument to improve clarity, relevance and coverage of the study variables.

Reliability: A pilot test was conducted among households outside Onne with characteristics similar to those of the study population. Internal consistency was assessed using Cronbach's alpha. A coefficient of 0.70 or greater was considered acceptable. The final manuscript should report the actual Cronbach's alpha coefficient obtained for the instrument and, where available, the coefficients for the individual social, technical and environmental-benefit scales.

Data Collection: Questionnaires were administered directly to selected respondents by the researcher and trained research assistants. Participants were informed about the purpose of the study, and informed consent was obtained before questionnaire administration. Completed questionnaires were checked for completeness and retrieved for analysis.

Data Analysis: Data were coded and analysed using IBM SPSS. Descriptive statistics, including frequencies, percentages, means and standard deviations, were used to summarise respondents' characteristics and responses to the study variables. Chi-square tests were used to assess associations between categorical variables where appropriate.
Binary logistic regression was used to identify social and technical factors associated with household solar-energy adoption. Adoption status was entered as the binary dependent variable, while the social and technical indicators were entered as explanatory variables. Adjusted odds ratios (AORs), 95% confidence intervals and p-values were reported. Statistical significance was set at $p < .05$. Model significance was assessed using the likelihood-ratio chi-square statistic, while Nagelkerke R^2 was used as an indication of the model's explanatory strength. Classification accuracy was also reported.

Ethical Considerations: Ethical principles governing human-participant research were observed throughout the study. Participation was voluntary, and informed consent was obtained before questionnaire administration. Respondents were informed of their right to decline participation or withdraw without penalty. No names or direct personal identifiers were collected. Information obtained from participants was treated confidentially and used solely for academic purposes. Results were reported in aggregate form.

4. Result

Household Solar-Energy Adoption: Of the 286 valid respondents, approximately 30.1% reported current household solar-energy adoption, while 69.9% were non-adopters. This indicates that although solar energy was recognized and considered environmentally beneficial by many households, actual adoption remained substantially lower than general acceptance of the technology.

Social Determinants of Solar-Energy Adoption: Social factors were important perceived influences on household solar-energy adoption. Community acceptance recorded the highest level of agreement (60.5%), followed by visible use of solar systems by neighbours (58.0%) and influence from friends and relatives (54.9%). Neighbour/peer influence and social-network influence recorded agreement levels of 50.7% and 50.0%, respectively.

Table 1. Social Determinants of Household Solar-Energy Adoption

Social determinant	Strongly agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly disagree n (%)	Mean ± SD
Neighbour/peer influence	48 (16.8)	97 (33.9)	72 (25.2)	49 (17.1)	20 (7.0)	3.36 ± 1.16
Friends/relatives influence	52 (18.2)	105 (36.7)	68 (23.8)	43 (15.0)	18 (6.3)	3.46 ± 1.13
Community acceptance	61 (21.3)	112 (39.2)	64 (22.4)	35 (12.2)	14 (4.9)	3.60 ± 1.09
Social networks provide information	45 (15.7)	98 (34.3)	79 (27.6)	46 (16.1)	18 (6.3)	3.37 ± 1.12
Visible use by neighbours encourages adoption	57 (19.9)	109 (38.1)	66 (23.1)	38 (13.3)	16 (5.6)	3.53 ± 1.12

Source: Field Survey, 2026.

Technical Determinants of Solar-Energy Adoption: Technical considerations showed varying levels of influence. System reliability recorded a mean score of 3.28 ± 1.17, with 48.6% of respondents agreeing that solar systems were reliable. Maintenance requirements represented a notable concern, with 57.7% agreeing that maintenance requirements discouraged adoption. Battery performance and technical ease of use recorded agreement levels of 43.7% and 46.5%, respectively. Only 34.6% agreed that qualified technicians were readily available, indicating a potential technical-service constraint.

Table 2. Technical Determinants of Household Solar-Energy Adoption

Technical determinant	Strongly agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly disagree n (%)	Mean ± SD
Solar systems are reliable	41 (14.3)	98 (34.3)	71 (24.8)	52 (18.2)	24 (8.4)	3.28 ± 1.17
Maintenance requirements discourage adoption	68 (23.8)	97 (33.9)	59 (20.6)	42 (14.7)	20 (7.0)	3.53 ± 1.19

Battery performance is satisfactory	36 (12.6)	89 (31.1)	78 (27.3)	55 (19.2)	28 (9.8)	3.17 ± 1.17
Solar technology is technically easy to use	39 (13.6)	94 (32.9)	76 (26.6)	51 (17.8)	26 (9.1)	3.24 ± 1.16
Qualified technicians are readily available	28 (9.8)	71 (24.8)	82 (28.7)	69 (24.1)	36 (12.6)	2.95 ± 1.18

Source: Field Survey, 2026.

Environmental Benefits of Solar-Energy Adoption: Respondents demonstrated strong recognition of the perceived environmental benefits of solar energy. Reduction in noise pollution recorded the highest level of agreement (82.6%), followed by promotion of environmental sustainability (79.8%), reduced generator emissions (78.0%), reduced air pollution (76.6%) and reduced fossil-fuel dependence (73.4%).

Table 3. Perceived Environmental Benefits of Solar Energy

Environmental benefit	Strongly agree n (%)	Agree n (%)	Neutral n (%)	Disagree n (%)	Strongly disagree n (%)	Mean ± SD
Reduces air pollution	98 (34.3)	121 (42.3)	41 (14.3)	18 (6.3)	8 (2.8)	3.99 ± 0.99
Reduces generator emissions	105 (36.7)	118 (41.3)	38 (13.3)	17 (5.9)	8 (2.8)	4.03 ± 0.98
Reduces noise pollution	112 (39.2)	124 (43.4)	32 (11.2)	13 (4.5)	5 (1.7)	4.14 ± 0.90
Reduces fossil-fuel dependence	91 (31.8)	119 (41.6)	48 (16.8)	20 (7.0)	8 (2.8)	3.93 ± 1.01
Promotes environmental sustainability	102 (35.7)	126 (44.1)	39 (13.6)	13 (4.5)	6 (2.1)	4.07 ± 0.94

Source: Field Survey, 2026.

Binary Logistic Regression of Social and Technical Determinants: Binary logistic regression identified several social and technical factors that were significantly associated with household solar-energy adoption. Community acceptance was the strongest social predictor (AOR = 1.68, 95% CI [1.24, 2.28]). Neighbour/peer influence, friends/relatives' influence and social-network influence were also positively associated with adoption.

Among technical factors, system reliability was positively associated with adoption (AOR = 1.59, 95% CI [1.18, 2.14]). Battery performance and technician availability were also positively associated with adoption. In contrast, maintenance requirements were negatively associated with adoption (AOR = 0.68, 95% CI [0.52, 0.89]). Technical ease of use did not reach the conventional 5% significance threshold ($p = .054$).

The overall model was statistically significant, $\chi^2(9) = 68.40$, $p < .001$. The Nagelkerke R^2 was .312, while 76.6% of cases were correctly classified.

Table 4. Binary Logistic Regression of Social and Technical Determinants of Solar-Energy Adoption

Predictor	B	SE	Wald	p-value	AOR	95% CI
Neighbour/peer influence	0.412	0.148	7.74	0.005	1.51	1.13–2.02
Friends/relatives influence	0.387	0.141	7.54	0.006	1.47	1.12–1.94
Community acceptance	0.521	0.156	11.14	0.001	1.68	1.24–2.28
Social-network influence	0.298	0.139	4.60	0.032	1.35	1.03–1.77
System reliability	0.465	0.152	9.35	0.002	1.59	1.18–2.14
Maintenance requirements	−0.381	0.137	7.73	0.005	0.68	0.52–0.89
Battery performance	0.329	0.145	5.15	0.023	1.39	1.05–1.84
Technical ease of use	0.274	0.142	3.72	0.054	1.32	0.99–1.74
Technician availability	0.418	0.149	7.87	0.005	1.52	1.13–2.03
Constant	−2.147	0.512	17.58	<0.001	0.12	—

Note. Outcome = solar-energy adoption (1 = adopter, 0 = non-adopter). *Maintenance requirements were coded such that higher scores represented greater perceived barriers. Model $\chi^2 = 68.40$, df = 9, $p < 0.001$; Nagelkerke $R^2 = 0.312$; classification accuracy = 76.6%.
Source: Field Survey, 2026.

5. Discussion

The findings indicate that household solar-energy adoption in Onne is associated with interacting social and technical factors. Community acceptance recorded the highest level of social influence and remained a significant positive predictor of adoption in the adjusted logistic regression model. Households exposed to a socially supportive environment may therefore be more likely to view solar technology as acceptable and practical. This finding is consistent with the Diffusion of Innovations framework, which emphasises the role of social systems, communication networks and observed experiences in the diffusion of new technologies (Rogers, 2003). It is also consistent with research showing that social influence and descriptive norms can shape household photovoltaic investment decisions (Kastner & Wittenberg, 2019).

Neighbour/peer influence and friends/relatives' influence were also positively associated with adoption. These relationships suggest that households may rely on information and experiences obtained from people within their immediate social networks when evaluating solar technology. Visible installations can provide households with an opportunity to observe the technology in practice and reduce uncertainty concerning its usefulness and performance. Rai et al. (2016) similarly identified neighbours and installers as important information sources in residential PV adoption. The finding also corresponds with the observability component of DOI Theory, under which visible evidence of an innovation can facilitate its diffusion.

System reliability was the strongest technical predictor of adoption. A one-unit increase in the reliability score was associated with approximately 59% higher odds of solar-energy adoption, holding the other variables in the model constant. This finding highlights the importance of dependable system performance in household energy decisions. In a context where solar systems are expected to provide an alternative or supplementary electricity source, perceptions of unreliable equipment may substantially weaken willingness to invest.

Maintenance requirements were negatively associated with adoption. Households expressing greater concern about maintenance had lower odds of adoption. This finding is important because

the value of a solar system extends beyond the initial installation. Batteries, inverters and other components require appropriate maintenance and eventual replacement. Where households perceive these requirements as costly, inconvenient or technically demanding, adoption may be discouraged. Previous Nigerian research has identified technical capacity, maintenance and related infrastructure as important constraints to wider solar-energy deployment (Ohunakin et al., 2014).
Battery performance and technician availability were also positively associated with adoption. These findings indicate that households evaluate solar technology not only in terms of whether it can generate electricity but also in terms of whether the system can store and reliably deliver energy and whether technical assistance is available when problems arise. The relatively low proportion of respondents reporting ready availability of qualified technicians further highlights the importance of the local technical-service ecosystem.
Technical ease of use was not statistically significant at the 5% level ($p = .054$). Although the direction of the association was positive, the confidence interval marginally included the null value. This suggests that ease of use may be relevant to household perceptions but did not provide sufficient independent evidence of an association with adoption after adjustment for the other social and technical factors. The result also illustrates the importance of considering several technical characteristics simultaneously rather than assuming that perceived simplicity alone determines adoption. The study further found strong perceptions of the environmental benefits of solar energy. Reduced noise pollution recorded the highest level of agreement, followed by environmental sustainability, reduced generator emissions, reduced air pollution and reduced fossil-fuel dependence. These perceptions are understandable in a context where households may depend on petrol- and diesel-powered generators to supplement conventional electricity supply. Solar electricity can reduce generator operation when it substitutes for fossil-fuel-based household electricity use, thereby potentially reducing associated noise and air emissions.
However, these findings represent perceived environmental benefits, not direct environmental measurements. The high level of agreement indicates that households recognise solar energy as environmentally preferable, but it does not establish actual reductions in ambient air pollutants, greenhouse-gas emissions or noise levels in Onne. Future studies should therefore complement household perception surveys with direct measurements of generator use, fuel consumption, ambient air quality, noise levels and greenhouse-gas emissions.
The environmental dimension should also be considered from a lifecycle perspective. Solar PV systems and batteries require raw materials, manufacturing, transportation, replacement and eventual disposal. Consequently, the environmental advantages of household solar systems depend partly on system lifespan, maintenance, battery technology and end-of-life management. This consideration strengthens the argument for quality assurance, durable systems, battery-recycling mechanisms and responsible electronic-waste management.
Summarily, the regression model was statistically significant, with Nagelkerke $R^2 = .312$. This indicates that the social and technical variables included in the model accounted for a meaningful proportion of the variation in household adoption, although substantial variation remained unexplained. Other factors, including household income, acquisition cost, access to credit, electricity expenditure, education, awareness, perceived economic benefits and government support, may also influence adoption and should be examined in future research.
The findings therefore reinforce the central proposition of Diffusion of Innovations Theory that technological adoption occurs within a social system and is influenced by perceptions of the characteristics and usefulness of an innovation. For household solar energy in Onne, improving

adoption requires more than awareness creation. It requires socially acceptable and demonstrably reliable systems supported by accessible technical services.

6. Limitations of the Study

This study has several limitations. First, the cross-sectional design means that associations between social and technical factors and solar-energy adoption cannot be interpreted as causal relationships. Second, the study relied on self-reported perceptions, which may be affected by recall bias and social desirability bias. Third, perceived environmental benefits were not supported by direct measurements of air pollution, noise, greenhouse-gas emissions or fossil-fuel consumption. Fourth, the minimum calculated sample size was 329 households, whereas 320 questionnaires were administered and 286 valid responses were analyzed; consequently, the final analytical sample was smaller than the initially calculated minimum. Fifth, the study was conducted in Onne and therefore its findings may not be directly generalizable to all communities in Rivers State or Nigeria because solar-energy adoption is context-dependent. Finally, the regression model focused primarily on social and technical determinants and did not comprehensively assess potentially important economic and institutional factors such as household income, upfront system cost, access to credit, government incentives and electricity expenditure.

7. Conclusion

Household solar-energy adoption in Onne is associated with important social and technical factors. Community acceptance, neighbour/peer influence, friends and relatives, and social-network influence were positively associated with adoption, demonstrating the importance of the social environment in household energy decisions. System reliability, battery performance and technician availability were also positively associated with adoption, whereas maintenance concerns were negatively associated with adoption. Households expressed strong perceptions of the environmental benefits of solar energy, particularly its potential to reduce noise pollution, generator emissions, air pollution and fossil-fuel dependence. However, these perceptions did not necessarily translate into widespread adoption, indicating an important gap between environmental recognition and actual household uptake. Promoting household solar-energy adoption in Onne therefore requires an integrated strategy that combines affordable financing, reliable and quality-assured systems, accessible technical and after-sales services, installer training, battery-management mechanisms and community-based information programmes. Strengthening these social and technical conditions can improve household confidence in solar technology and support a more reliable and environmentally sustainable household energy transition.

8. Recommendations

1. **Expand affordable financing:** Government, financial institutions and solar providers should offer flexible credit and instalment schemes to reduce upfront costs and improve household adoption.
2. **Strengthen technical support and quality assurance:** Quality standards, technician training, maintenance, warranties and spare-parts availability should be improved to address reliability and maintenance barriers.
3. **Leverage community networks:** Community demonstrations, peer education and trusted social networks should be used to increase acceptance, reduce uncertainty and promote solar adoption.

4. **Integrate environmental and adoption education**: Awareness programmes should combine environmental benefits with practical information on cost, system selection, maintenance and battery management to bridge the awareness–adoption gap.

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