BUFT Journal of Business & Economics (BJBE)
ISSN 2664-9942 (Print)
2024 Volume 5, Pg: 365-379
DOI: https://doi.org/10.58481/BJBE/2423

Determinants of Solar Home Systems Adoption among Riverine Island Dwellers: A Case Study of Sirajganj District in Bangladesh

Md. Rasel Rana[1*], Habibur Rahman[2]

ARTICLE INFO

Article History
Received: February 28, 2024
Accepted: May 28, 2024

Keywords:
Solar Home Systems,
Renewable Energy Adoption,
Riverine Islands Dwellers,
Sirajganj District, Bangladesh.

JEL Classification:
P28, Q2, Q4

ABSTRACT

Purpose: This study aims to identify the determinants of solar home systems adoption among riverine island dwellers, focusing on the Sirajganj district in Bangladesh.

Methodology: The research, based on a comprehensive survey of 200 households, utilized logistic regression analysis and descriptive statistics.

Findings: The study finds that 'education of the household head', 'access to credit', and 'monthly household income' significantly affected solar home systems adoption at different level of significance. Factors leading to adopt solar home systems included lack of electricity access, focus on energy security, and cost savings, along with access to loans or installments and community connections. Conversely, non-adopters faced barriers such as perceived high initial costs, lack of installment facilities, and insufficient awareness.

Practical Implications: The study highlights the importance of credit accessibility, educational background, and household income in promoting solar home systems adoption. Policymakers and stakeholders can use these insights to tailor interventions addressing specific determinants and encourage widespread adoption.

Originality/Value: This research provides valuable new insights into promoting sustainable energy initiatives in similar contexts.

Limitations: The study's limitations include its small sample size and potential regional variations. Further research is recommended to validate and extend these findings across diverse geographical settings.

1. Introduction

1.1 Background of the Study

The advancement of modern civilization is deeply intertwined with the widespread accessibility of electricity. Unfortunately, nearly 775 million people globally find themselves without access to this vital resource, predominantly concentrated in the remote rural landscapes of Asia and Sub-Saharan region of Africa (Azimoh et al., 2016; Cozzi et al., 2022). Recognizing this, governments and policymakers have prioritized the widespread provision of electricity as a catalyst for rural development (Jibran & Arsalan, 2016). The absence of electricity leaves an indelible mark on the lifestyle of rural populations, curbing both their social progress and economic productivity (Pode, 2013). Despite a 2.3% increase in global power generation in 2022, aligning with historical trends

* Corresponding Author

1. Graduate Research Student, Department of Economics, Begum Rokeya University, Rangpur, Bangladesh, E-mail: raafsan.rasel@gmail.com, Orcid ID: https://orcid.org/0009-0000-7237-2573
2. Associate Professor, Department of Economics, Begum Rokeya University, Rangpur, Bangladesh, E-mail: habib.eco.83@gmail.com

(+2.5% per year over 2010-2019), significant challenges persist in ensuring universal access to electricity (Enerdata, 2023).

Bangladesh is one of the countries facing myriad challenges in terms of electricity consumption (Mondal et al., 2010). Renewable energy technology can help overcome these challenges. A promising alternative lies in renewable energy technology, such as solar power, addressing the domestic and commercial energy needs of non-electrified rural communities (Palit, 2013). As Bangladesh is a country with a sub-tropical location, this means that most of the country's surface receives sufficient solar radiation for photovoltaic (PV) technology, with a daily average of 4-6.5 $kWhm^{-2}$ (Hasanuzzaman et al., 2015; Hossain et al., 2017; Mondal & Denich, 2010). Ensuring the affordability and availability of solar home systems for rural consumers can be significantly enhanced through the provision of financial services such as proper loans and credits (Tahsina et al., 2019). Specifically targeting underprivileged and rural communities burdened by significant fuel expenditures for household chores and economic productivity, renewable energy ventures in developing nations aim to provide affordable and sustainable energy (Laufer & Schäfer, 2011).

One region facing substantial challenges in adopting solar home systems is the riverine islands (chars) of Bangladesh. Chars, dynamic landforms shaped by the erosion and deposition of sediments by major rivers like the Brahmaputra, Jamuna, and Padma, are home to about 6.5 million of the country's poorest and most marginalized people (Sarker et al., 2003). Char dwellers grapple with frequent natural disasters, social issues, and limited access to modern energy sources, making them highly vulnerable to climate change impacts (Ahmed et al., 2021; Babul et al., 2022). Solar home systems have the potential to transform the lives of char dwellers by providing electricity for lighting, communication, entertainment, education, health, and productive activities. If we want to improve rural electrification in a developing country like Bangladesh, it necessitates a shift from conventional grid electricity due to substantial investment requirements for infrastructure establishment, insufficient power production, and distribution limitations (Komatsu et al., 2011).

1.2 Statement of the Problem

Bangladesh faces significant risks associated with greenhouse gas emissions, primarily due to its vulnerability to the impacts of climate change (Eckstein et al., 2021; Islam et al., 2015). Being low-lying and densely populated, the country is particularly susceptible to rising sea levels, leading to increased coastal flooding and salinity intrusion that threaten agricultural lands, water sources, and coastal communities (Halder, 2023; Jakariya, 2016). This escalating water level poses a significant threat to riverine islands in Bangladesh, where many are already experiencing the impacts of sea-level rise and alterations in river flow patterns. As water levels rise, these islands face the risk of submersion, resulting in the displacement of communities and loss of valuable land (Hossain & Rahman, 2021). In Bangladesh, heavy reliance on nonrenewable energy sources contributes to carbon emissions. A crucial solution involves increasing the utilization of renewable energy, particularly solar, which can reduce the carbon footprint, address energy poverty, and foster economic development. However, despite the potential benefits, the adoption of solar home systems in Bangladesh remains low, with just over 4 million systems installed, impacting more than 12 percent of the entire Bangladeshi population (CPI, 2017). The adoption of solar home systems assumes heightened importance for several reasons. Firstly, it acts as a catalyst for addressing energy poverty in marginalized communities such as riverine islands, providing a decentralized and sustainable energy source. Secondly, it aligns with environmental sustainability goals by mitigating the environmental impact associated with traditional energy sources. Additionally, solar home systems adoption promotes economic development by opening avenues for income-generating activities and improving the overall quality of life. Furthermore, solar home systems foster resilience against energy crises by decentralizing power generation.

Despite extensive global research on determinants of solar home systems adoption, there has been limited focus on Bangladesh, particularly Riverine Islands. Few researchers such as Komatsu et al. (2013), Marzia et al. (2018), Tahsina et al. (2019), and Sunny et al. (2022) have shed light on various factors influencing adoption, including government policies and financing availability in diverse contexts. Komatsu et al. (2013) found that non-income factors such as mobile phone usage and kerosene consumption influence solar home systems adoption in rural Bangladesh. Marzia et al. (2018) emphasized the role of government policies and decreasing solar panel costs in driving adoption. Tahsinaet al. (2019) identified microcredit, age, location, and solar home systems size as significant factors affecting payment methods. Sunny et al. (2022) found that farming experience, environmental awareness, and ownership of irrigation machinery significantly influenced the adoption of solar irrigation facilities (SIFs) in rural areas. Hence, to fill this literature gap, a study will be conducted in Sirajganj district, northern Bangladesh, focusing on determining the factors of solar home systems adoption among riverine islands dwellers affected by riverbank erosion. The study aims to provide policy recommendations for promoting solar home systems uptake among this vulnerable population.

2. Literature Review

Extensive research has indeed been conducted on the adoption of renewable energy, particularly in the realm of solar power. This topic has garnered significant attention in recent years as countries strive to transition towards more sustainable energy sources. Several factors identified in the literature influence the uptake of solar power within national or regional contexts. These factors include sociodemographic characteristics, cultural norms, incentives, barriers, attitudes towards energy conservation, and government policies (Dias et al., 2021; Kang et al., 2012; Steg, 2008). Additionally, the rural-urban divide significantly affects energy consumption based on demographic characteristics (Cai & Jiang, 2008; Pachauri & Jiang, 2008).

Exploring factors like altered pricing structures and information availability, research delves into how policies shape energy consumption patterns (Albadi & Saadany, 2008; Herter, 2007; Ueno et al., 2006; Vine et al., 2013). Psychological aspects, including social norms, past experiences, and attitudes toward energy conservation, impact household acceptance of energy-saving activities (Mizobuchi & Tanizaki, 2018; Murtagh et al., 2014; Urban & Ščasný, 2012; Wang et al., 2011). Despite government initiatives, household inertia remains a challenge, emphasizing the influence of social networks in adoption (Graziano, 2014; Grieve et al., 2012; Mundaca et al., 2020; Walton & Ford, 2020).

Few studies focus on household solar energy adoption in Sub-Saharan region of African off-grid communities. In East Africa, factors like awareness, accessibility, and affordability drive the adoption of off-grid solar technology (Ondraczek, 2013). Kenya, Tanzania, and Uganda show varied adoption factors, including falling PV solar technology prices, international support, and favorable government conditions (Hansen et al., 2015). Seychelles emphasizes credit access and monthly household income in solar PV system adoption (Etongo & Naidu, 2022). In rural western Kenya, neighborhood effects play a significant role in solar home systems adoption (Opiyo, 2019).

Tanzania's study reveals that wealth and family size impact the speed of solar home systems adoption, even among electrified households using solar panels as backup (Smith & Urpelainen, 2014). Rahut et al. (2018) identify demographic factors influencing solar energy adoption in Ethiopia, Kenya, and Uganda. In Uganda, energy appliances beyond lighting and phone charging impact comfort and security for solar home systems adopters (Hirmer & Guthrie, 2017).

The socio-technical impact of picoPV systems in Ethiopia, barriers to solar PV development in Sub-Saharan region of Africa, and the insufficient contribution of solar home systems in South Africa highlight challenges (Monyei et al., 2018; Quansah et al., 2016; Roche & Blanchard, 2018). Studies in rural South Africa and Sri Lanka emphasize improved quality of life and safety with solar home systems (Azimoh et al., 2015; Wijayatunga & Attalage, 2005).

In Pakistan, drivers for solar PV adoption include local market accessibility and environmental friendliness, while barriers include cost and insufficient government financing (Qureshi et al., 2017). In rural Indian communities, factors influencing knowledge and willingness to pay for solar home systems include age of the household head, education level, income, and electricity access (Irfan et al., 2021; Urpelainen & Yoon, 2015). India's private entrepreneurship-based models outperform subsidy-based ones (Borah et al., 2014).

Bangladesh, heavily reliant on fossil fuels, has seen 1.4% of energy generated from renewable sources, notably solar and water power (World data, 2022). Solar home systems have been crucial in providing basic electricity access, with studies exploring various motivators, obstacles, and effects (Imran, 2020). The Infrastructure Development Company Limited (IDCOL) launched the solar home systems program in 2003 to bring basic electricity access to rural households by 2021 (Imran, 2019).

Research on solar home systems in Bangladesh delves into its social, economic, and environmental effects. Studies show improved comfort levels, living standards, and indirect income from solar home systems adoption (Kabir et al., 2017; Rahman & Ahmad, 2013; Sharif & Mithila, 2013). Diffusion of Innovation (DOI) and the Technology Acceptance Model (TAM) theories minimally impact solar home systems adoption (Saim & Khan, 2021). Non-income factors, including household income, mobile phone usage, rechargeable batteries, and kerosene consumption, influence solar home systemsadoption in rural Bangladesh (Komatsu et al., 2013).

Government policies, global influence, and decreasing solar panel costs are significant drivers of solar technology adoption in Bangladesh (Marzia et al., 2018). Financing studies reveal that microcredit plays a crucial role, with factors like age, location, and solar home systemssize impacting payment methods (Tahsina et al., 2019). Obstacles in socio-technical, management, economic, and policy aspects hinder solar home systemsadoption (Karakaya & Sriwannawit, 2015).

Repair and upkeep challenges underscore the disparity between solar project goals and actual outcomes (Kumar et al., 2019). In 2021, renewable sources contributed to 1.4% of Bangladesh's energy, with solar and water power accounting for 0.6% and 0.8%, respectively, while 98.6% came from fossil fuels (Worlddata, 2022). Electrification through solar home systems remains an effective means of ensuring basic electricity access in developing nations like Bangladesh, with ongoing research exploring various facets of solar home systems (Imran, 2020).

3. Methodology

3.1 Study Area

We have selected Kazipur Upazila under Sirajganj district as our study area. The Upazila has a total of 281,429 people, with the majority residing in villages and riverine island areas (BBS, 2022). Several key factors, including researchers' personal experiences, abundant sunlight throughout the day in the area, and being among the worst victims of climate change, were pivotal in choosing this area.

3.2 Sampling and Data Collection Strategies

The households in this area, who were adopters and non-adopters of solar home systems among riverine island dwellers for not less than one year, including households with and without access to grid electricity within each category, comprised the study population. Both qualitative and quantitative methods were used to carry out this study. This research is based on both primary and secondary data. Secondary data were collected from the Bangladesh Bureau of Statistics (BBS) from different years. To collect primary data, a stratified random sampling system was followed, but respondents were stratified based on their adoption and non-adoption of solar home systems. After a preliminary visit, five islands named Natuarpara Union, Chargirish Union, Tekani Union, Nischintapur Union, and Khasrajbari Union from Kazipur Upazila were selected.

Primary data were collected from households of 105 early adopters of solar home systems and from households of 102 non-adopting neighborhoods between August and October 2023 by using the structured questionnaire. These were administered through face-to-face interviews by trained enumerators using the "Jotform Mobile Forms & Survey" app. A total of 207 households were randomly selected across the five unions, ensuring almost equal representation from each. After cleaning the data for missing variables, 201 households were identified as suitable for empirical analysis. To ensure a statistically balanced representation between adopters and non-adopters, one adopter household was randomly excluded, resulting in a final sample size of 200 households (100 adopters and 100 non-adopters).

3.3 Empirical Modeling of Solar Home Systems Adoption

The empirical model utilizes the logit model due to the binary nature of the dependent variable, indicating whether a household adopts solar home systems or not. The logit model, along with the probit model, is commonly used for dichotomous response models. While both models yield similar predicted probabilities, the logit model is preferred for its computational simplicity and ease of interpretation (Gujarati & Porter, 2009). Previous studies, such as those conducted by Smith & Urpelainen (2014) in Tanzania, Guta (2018) in Ethiopia, and Etongo & Naidu (2022) in Seychelles, have utilized logistic regression. Additionally, Rahut et al. (2018) in Sub-Saharan region of Africa employed the probit model for similar analyses.

The logit model assumes a logistic distribution function and utilizes maximum likelihood estimation after transforming the response variable into logit (Gould & Carson, 2008). This approach allows for the calculation of odds ratios pertaining to households adopting solar home systems. Contrarily, the linear probability model (LPM) presents limitations such as fitted probabilities that can exceed 1 or be negative, and constant partial effects of explanatory variables(Wooldridge, 2008).

Once the dependent variable is transformed into the natural log of odds (logit), the equation isexpressed as:

$$ln\left(\frac{P_i}{1-P_i}\right) = X_i\,\beta \tag{1}$$

$$P_i = \frac{e^{x_i\beta}}{1+e^{x_i\beta}} \tag{2}$$

Here, P_i denotes the probability of a specific event, such as a household adopting solar home systems. *Xi* represents a collection of explanatory variables, which include monthly household income, access to credit, age, gender, schooling years of the household head, and family size. The natural logarithm base is indicated by *'e'*, and b represents the vector of unknown parameters to be estimated from the model. Consistent with the methodologies proposed in earlier studies (Aldrich & Nelson, 1984; Garson, 2008), the model can be expressed as:

$$P_i = \frac{1}{1+e^{-x_i\beta}} \tag{3}$$

We utilized a dummy variable to distinguish between sampled households as users or non-users of solar home systems. Y represents a dichotomous dependent variable, where a value of 1 signifies a household using solar home systems, and 0 indicates otherwise. Finally, Xirepresents the independent variables detailed in (Table 1) that could potentially influence the household's decision to adopt. The reduced form is as follows:

Table 1.

Factors Influencing Household Adoption of Solar Home Systems and their Potential Effects

Variables	Description	Expected Sign
Access_Credit	Credit access for Households (1=Yes, 0=No)	+
Income_H	Monthly Income of household (BDT)	+
Schooling_HH	Years of schooling of the household head (Number)	+
Gender_HH	Sex of the household head (1=Male, 2=Female, and 0=Others)	±
Age_HH	Age of the household head (Year)	±
Family_Size	Number of family members (Number)	±

Source: Authors developed.

$$Y_i = log\left(odd(event)\right) = log\left(\frac{prob(event)}{prob(nonevent)}\right) = Y_i = \beta_0 + \Sigma_{i=1}^{n} X i\beta + \varepsilon_i \tag{4}$$

Here, the error term is denoted by ε_i.

4. Results and Discussion

4.1 Analysis of Descriptive Statistics

The descriptive statistics revealed clear patterns in the factors influencing the adoption of solar home systems among riverine island dwellers in the Sirajganj district of Bangladesh. A comprehensive analysis of various key variables highlighted several intriguing findings in Table 2.

Table 2.

Descriptive Statistics of Variables and Mean differences between Adopters and Non-adopters

Descriptive Statistics						
Variables	Whole Sample		Adopters		Non-Adopters	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
respnd_typ	.50	.501	1.00	.000	.00	.000
Gender_HH	1.15	.353	1.09	.288	1.20	.402
Age_HH	50.94	9.492	49.00	9.760	52.88	8.846
Family_Size	5.40	1.553	5.67	1.798	5.14	1.215
Access_Credit	.52	.501	.12	.327	.91	.288
Schooling_HH	5.59	4.305	9.08	2.770	2.09	2.216
LnIncome_H	9.5264	.47385	9.9282	.18545	9.1245	.30124

Source: Developed by Authors

Initially, the overall response type across the entire sample exhibited a balanced distribution with a mean of 0.50. However, notably, adopters showcased an exclusive manifestation of a response type scoring at 1.00, indicating a definitive inclination towards solar home systems adoption within this subgroup (Table 2).

Delving into socio-demographic factors, the gender of the household head exhibited a slight skew towards one gender within the overall sample, with a mean score of 1.15. This trend persisted among adopters (1.09) and non-adopters (1.20), indicating varied gender distributions among participants. Further examination of the age of heads of the household uncovered a subtle yet noteworthy difference between adopters and non-adopters. Adopters tended to have a slightly younger demographic, averaging at 49.00 years, whereas non-adopters skewed slightly older with a mean age of 52.88, hinting at a potential correlation between age and solar home systems adoption tendencies (Table 2).

The family size dynamics also differed between the two groups, with adopters indicating a larger mean family size (5.67) compared to non-adopters (5.14). Moreover, access to credit emerged as a significant factor, where adopters reported notably lower access (mean = 0.12) compared to non-adopters (mean = 0.91). This discrepancy implies a potential financial influence on adoption decisions (Table 2).

Education played a vital role, as indicated by the schooling years of the heads of the household. Years in school revealed a higher mean among adopters (9.08) compared to non-adopters (2.09), suggesting a positive correlation between schooling years of the household head and solar home systems adoption tendencies. Lastly, examining monthly household income unveiled a subtle aspect: adopters displayed a slightly lower mean of the natural logarithm of monthly household income (9.9282) compared to non-adopters (9.1245), highlighting intricate financial dynamics that may contribute to adoption behaviour (Table 2).

4.2 Motivations and Barriers toward Solar Home Systems Adoption

The study employed qualitative questions strategically to gather insights into the drivers and barriers toward solar home systems adoption. Among the adopters, diverse motivations emerged, reflecting the reasons driving their choice. Notably, a substantial 67% of households pointed to the absence of electricity access as a primary inspiration, emphasizing the pivotal role solar systems play in bridging energy gaps (Figure 1). Furthermore, 60% expressed a motivation based on energy security, underscoring the reliability and autonomy offered by solar home systems (Figure 1). Financial considerations also played a significant role, with 33% citing cost savings as a compelling factor, and 48% noting the influence of financial options like loans or installments (Figure 1). Additionally, community connections proved influential, as 29% mentioned the sway of neighbors, friends, or sellers in their decision-making process, showcasing the impact of social networks on solar adoption (Figure 1). Some of these findings align with prior research, which indicates that the motivation for adopting solar home systems is generally influenced by socioeconomic factors (Etongo & Naidu, 2022; Qureshi et al., 2017). These factors include the desire for energy security (Etongo & Naidu, 2022; Ford et al., 2017), cost savings from reduced electricity bills (Etongo & Naidu, 2022; Fikru, 2020), and the impact of peer effects (Etongo & Naidu, 2022; Graziano et al., 2019). Peer effects, for instance, play a crucial role in generating interest and expediting the decision-making process, as direct contact with both adopters and non-adopters can shorten the time between consideration and adoption.

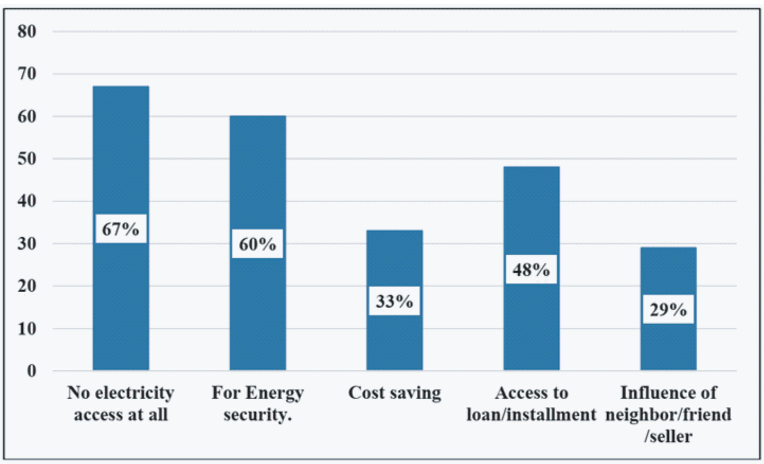

Figure 1.

The Motivations for Adopting Solar Home Systems Among the 100 Surveyed Households, which had Adopted Solar Home Systems (totaling more than 100% due to multiple responses).

Source: Developed by Authors

Conversely, for households that did not adopt solar systems, barriers were identified as major barriers. Foremost among these challenges was the perceived high initial cost of solar purchase and installation, cited by a leading 79% (Figure 2). The absence of installment facilities emerged as a significant barrier for 47%, highlighting the importance of flexible payment options in overcoming financial barriers (Figure 2). Furthermore, 28% cited a lack of awareness about the benefits of solar systems, pointing to a critical need for education and outreach efforts to dispel misconceptions and promote informed decision-making (Figure 2). This perspective finds support in several other studies as well (Etongo & Naidu, 2022; Ford et al., 2017; Karjalainen & Ahvenniemi, 2019; Qureshi et al., 2017; Rai et al., 2016; Zander, 2020).

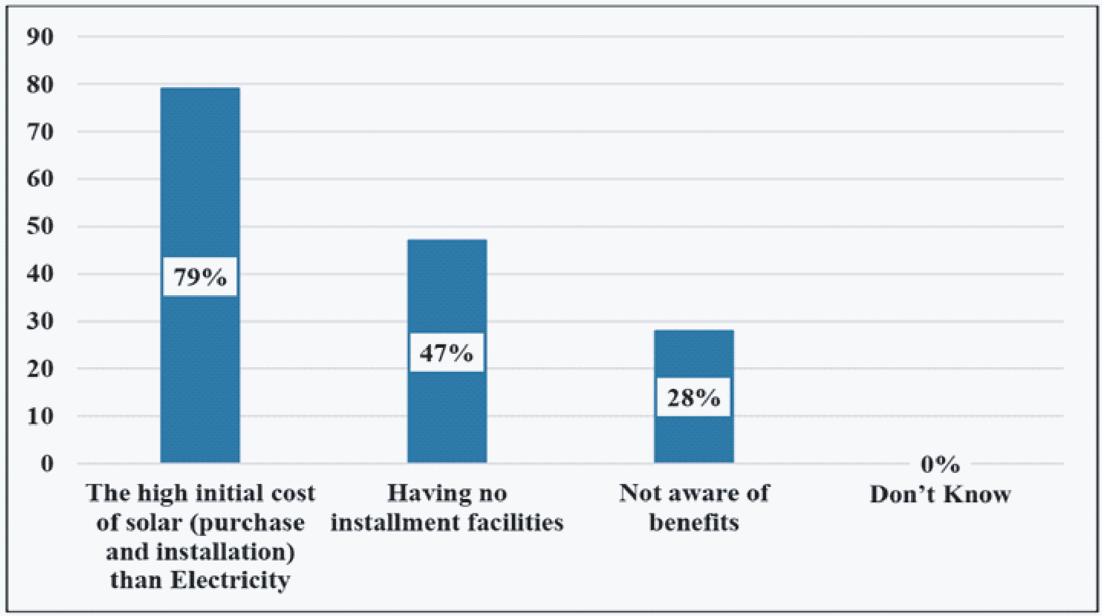

Figure 2.
The barriers mentioned for not adopting solar home systems among the 100 surveyed households, which had not adopted solar home systems (totaling more than 100% due to multiple responses).
Source: Developed by Authors

4.3 Econometric Results

The findings from the logistic regression offer insights into the factors influencing household adoption of solar home systems, incorporating six predictor variables: access to credit, gender, age, monthly household income, family size, and schooling years of the household head. The model collectively accounted for approximately 72.4% (Cox and Snell R Squared) to 96.5% (Nagelkerke R Squared) of the variance in solar home systems adoption status.

Table 3.
Analysis of Logistic Regression for Solar Home Systems Adoption

Variables in the Equation								
	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Gender_HH(1)	-1.577	1.929	.668	1	.414	.207	.005	9.062
Age_HH	.069	.079	.771	1	.380	1.072	.918	1.252
Family_Size	.391	.326	1.436	1	.231	1.479	.780	2.804

Access_Credit(1)	3.577	1.655	4.672	1	0.031**	35.751	1.396	915.821
Schooling_HH	1.945	.672	8.389	1	.004***	6.996	1.876	26.097
LnIncome_H	3.899	1.606	5.892	1	.015**	49.349	2.119	1149.436
Constant	-54.002	19.675	7.533	1	.006	.000		

Source: Developed by Authors

The regression result revealed that the coefficient for Gender_HH in assessing solar home systems adoption was -1.577, indicating statistical insignificance ($p = 0.414$). In this model, gender does not appear to significantly influence the likelihood of solar home systems adoption among riverine island dwellers in Sirajganj. Interestingly, previous research suggests that women generally exhibit a greater willingness to pay for or support renewable energy technologies (Akeyo et al., 2020; Guta, 2018). The unique scenario on these islands, characterized by economic hardship and distinct gender roles, contrasts with typical situations in most developing countries. Mainly in such marginalized and poverty-stricken areas of Bangladesh, where education rates are relatively low and the household are headed by male and female's decisions are always given less importance. This result reflects that image.

Moving on to the coefficient for Age_HH (0.069, $p = 0.380$), it implies that age does not play a significant role in influencing the likelihood of solar home systems adoption in these islands. While prior studies indicate that younger individuals tend to be more willing to pay for renewable energy due to heightened environmental awareness (Aini & Ling, 2011; Olivier et al., 2016), an alternative previous findings suggests that older heads of households, potentially wealthier due to productive resource ownership, may also invest in renewable energy technologies (Guta, 2018). In this context, age does not appear to significantly determine the probability of solar home systems adoption in this specific community.

Exploring the coefficient for Family_Size (0.391, $p = 0.231$), it is not statistically significant, indicating that family size does not seem to have a substantial impact on the likelihood of adopting solar home systems in this specific community context. Electricity bills are subsidized in Bangladesh to ensure that even relatively poor families can afford it. Our findings contradict two previous studies suggesting that larger households tend to opt for solar energy technology for domestic purposes compared to smaller family sizes (Guta, 2018; Rahut et al., 2018).

Conversely, the coefficient for Access_Credit (3.577, $p = 0.031$**) is statistically significant, highlighting that access to credit significantly drives the chance of adopting solar home systems in this community. This outcome aligns with previous studies emphasizing the importance of credit access in renewable energy adoption (Etongo & Naidu, 2022; Hadush & Bhagwat, 2018; Tahsina et al., 2019).

Similarly, the coefficient for Schooling_HH (1.945, $p = 0.004$***) is highly significant, indicating that education levels significantly improve the likelihood of solar home systems adoption among river island dwellers in Sirajganj. This finding is consistent with previous research emphasizing the profound influence of education on decisions about adopting solar energy solutions (Guta, 2018; Rahut et al., 2018; Smith & Urpelainen, 2014).

Lastly, the coefficient for LnIncome_H (3.899, $p = 0.017$**) is statistically significant, suggesting that higher monthly household income significantly increase the probability of solar home systems adoption. In these areas, sellers offer installment plans. Otherwise, the p-value would have been even lower in these economically fragile areas. This result also line up with prior research findings (Etongo & Naidu, 2022; Guta, 2018; Komatsu et al., 2013; Rahut et al., 2018; Smith & Urpelainen, 2014).

5. Conclusion, Recommendations, and Future Research Directions

Bangladesh faces severe climate change impacts like rising sea levels and coastal flooding due to its low-lying geography. Riverine islands are especially vulnerable, leading to community displacement. Moreover, soaring oil prices worsen energy insecurity. To combat these issues, the government is promoting solar energy adoption.This study aims to explore the determinants of solar home systems adoption among riverine island dwellers, focusing on the case study of Sirajganj district in Bangladesh. This study presents significant fresh insights about how to support sustainable energy projects in comparable situations. Lack of access to electricity, an emphasis on energy security, cost savings, availability of loans or installment plans, and ties to the community were among the factors driving acceptance. Conversely, non-adopters encountered obstacles such a lack of instalment options, a perception of a large initial cost, and inadequate knowledge. Regression result shows that the likelihood of adopting solar home systems is highly influenced by the household head's education level, monthly household income, and credit availability. Remarkably, this study does not find any significant impact of gender, age, and family size on solar home systems adoption although these characteristics are frequently significant in other studies.

Considering these insights, we propose targeted interventions. Firstly, improving credit accessibility through initiatives like microfinance programs or partnerships with financial institutions can economically empower individuals for solar home systems adoption. Secondly, tailored educational initiatives, such as workshops, can provide riverine island communities with the knowledge needed for informed decisions. Lastly, addressing economic disparities through empowerment programs and subsidies can make solar technologies accessible across income levels. These interventions aim to accelerate solar solution adoption within riverine island communities and advance sustainable energy practices.

The study's limitations include its small sample size and the challenges of collecting data in the riverine area, as well as potential regional variations. Being a cross-sectional study, it provides an understanding of the situation at a particular point in time. Further research is recommended to validate and extend these findings across diverse geographical settings. Future studies could adopt a longitudinal approach, allowing for the examination of trends and patterns in solar home systems adoption over time. Additionally, expanding the sample size and incorporating comprehensive data collection methods that address the unique challenges of riverine areas and it enhance the robustness and generalizability of the findings. This holistic approach to future research will provide comprehensive insights and practical recommendations for sustainable energy adoption and resilience-building efforts in Bangladesh and beyond.

References

Ahmed, Z., Guha, G. S., Shew, A. M., & Alam, G. M. M. (2021). Climate change risk perceptions and agricultural adaptation strategies in vulnerable riverine char islands of Bangladesh. *Land Use Policy, 103,* 105295.

Aini, M. S., & Ling, M. G. M. (2011). *Factors Affecting the Willingness to Pay for Renewable Energy amongst Eastern Malaysian Households: A Case Study. 21,* 147-164.

Akeyo, O. M., Patrick, A., & Ionel, D. M. (2020). Study of Renewable Energy Penetration on a Benchmark Generation and Transmission System. *Energies, 14*(1),169

Albadi, M. H., & Saadany, E. F. E. (2008). A summary of demand response in electricity markets. *Electric Power Systems Research, 78*(11), 1989-1996.

Aldrich, J. H., & Nelson, F. D. (1984). Linear Probability, Logit, and Probit Models. *SAGE Publication, 45,* 10-96.

Azimoh, C. L., Klintenberg, P., Wallin, F., & Karlsson, B. (2015). Illuminated but not electrified: An assessment of the impact of Solar Home System on rural households in South Africa. *Applied Energy, 155,* 354-364.

Azimoh, C. L., Klintenberg, P., Wallin, F., Karlsson, B., & Mbohwa, C. (2016). Electricity for development: Mini-grid solution for rural electrification in South Africa. *Energy Conversion and Management, 110,* 268-277.

Babul, H., Shi, G., Ajiang, C., Sarker, M. N. I., Sohel, M. S., Sun, Z., & Hamza, A. (2022). Impact of climate change on human health: Evidence from riverine island dwellers of Bangladesh. *International Journal of Environmental Health Research, 32*(11), 2359-2375.

BBS. (2022). *Upazila Statistics Office, Kazipur, Sirajganj.* retrieved from http://bbs.kazipur.sirajganj.gov.bd/en

Borah, R. R., Palit, D., & Mahapatra, S. (2014). Comparative Analysis of Solar Photovoltaic Lighting Systems in India. *Energy Procedia, 54*, 680-689.

Cai, J., & Jiang, Z. (2008). Changing of energy consumption patterns from rural households to urban households in China: An example from Shaanxi Province, China. *Renewable and Sustainable Energy Reviews, 12*(6),1667-1680.

Cozzi, L., Wetzel, D., & Tonolo, G. (2022). For the first time in decades, the number of people without access to electricity is set to increase in 2022. *IEA, 50*, 5-7.

CPI, (2017, October 20). *The Solar Home Systems initiative in Bangladesh.* Retrieved from https://www.centreforpublicimpact.org/case-study/solar-home-systems-bangladesh

Dias, R. A., Rios De Paula, M., Silva Rocha Rizol, P. M., Matelli, J. A., Rodrigues De Mattos, C., & Perrella Balestieri, J. A. (2021). Energy education: Reflections over the last fifteen years. *Renewable and Sustainable Energy Reviews, 141,* 110845.

Eckstein, D., Künzel, V., & Schäfer, L. (2021). Global Climate Risk Index 2021. *German Watch, 16,* 52.

Enerdata. (2023). *Electricity production.* Retrieved from https://yearbook.enerdata.net/electricity/world-electricity-production-statistics.html

Etongo, D., & Naidu, H. (2022). Determinants of household adoption of solar energy technology in Seychelles in a context of 100% access to electricity. *Discover Sustainability, 3*(1), 38.

Fikru, M. G. (2020). Determinants of electricity bill savings for residential solar panel adopters in the U.S.: A multilevel modeling approach. *Energy Policy, 139*(C),111351.

Ford, Walton, & Stephenson. (2017). Emerging energy transitions: PV uptake beyond subsidies. IDEAS. Retrieved from https://ideas.repec.org/a/eee/tefoso/v117y2017icp138-150.html

Garson, G. D. (2008). Garson Logistic Regression. *North Carolina State University*, 1-33.

Gould, D., & Carson, S. (2008). Life skills development through sport: Current status and future directions. *International Review of Sport and Exercise Psychology, 1*(1), 58-78.

Graziano, Marcello, Adoption of Diffused Renewable Energy Technologies: Patterns and Drivers of Residential Photovoltaic (PV) Systems in Connecticut, 2005-2013, Doctoral Dissertations. 386.

Graziano, M., Fiaschetti, M., & Atkinson-Palombo, C. (2019). Peer effects in the adoption of solar energy technologies in the United States: An urban case study. *Energy Research & Social Science, 48,* 75-84.

Grieve, C., Lawson, R., & Henry, J. (2012). Understanding the non-adoption of energy efficient hot water systems in New Zealand. *Energy Policy, 48,* 369-373.

Gujarati, D. N., & Porter, D. C. (2009). *Basic econometrics* (5. ed). McGraw-Hill Irwin.

Guta, D. D. (2018). Determinants of household adoption of solar energy technology in rural Ethiopia. *Journal of Cleaner Production, 204,* 193-204.

Hadush, S. Y., & Bhagwat, S. R. K. (2018). *A comparative study of renewable energy and electricity access policies and regulatory frameworks in the Indian Ocean Islands: The case of Mauritius, Seychelles, Madagascar and Comoros.* (1st ed., pp. 1-63). European University Institute.

Halder, A. (2023, August 27). Rising sea levels and the lessons to learn. *The Daily Star.* Retrieved from https://www.thedailystar.net

Hansen, U. E., Pedersen, M. B., & Nygaard, I. (2015). Review of solar PV policies, interventions and diffusion in East Africa. *Renewable and Sustainable Energy Reviews, 46,* 236-248.

Hasanuzzaman, M., Al-Amin, A. Q., Khanam, S., & Hosenuzzaman, M. (2015). Photovoltaic power generation and its economic and environmental future in Bangladesh. *Journal of Renewable and Sustainable Energy, 7*(1), 013108.

Herter, K. (2007). Residential implementation of critical-peak pricing of electricity. *Energy Policy, 35*(4), 2121-2130

Hirmer, S., & Guthrie, P. (2017). The benefits of energy appliances in the off-grid energy sector based on seven off-grid initiatives in rural Uganda. *Renewable and Sustainable Energy Reviews, 79,* 924-934.

Hossain, M. F., Hossain, S., & Uddin, M. J. (2017). Renewable energy: Prospects and trends in Bangladesh. *Renewable and Sustainable Energy Reviews, 70,* 44-49.

Hossain, M. S., & Rahman, M. H. (2021). Challenges for Char Dwellers from Riverine Floods Due to Climate Change: *A Case Study from Northern Bangladesh* (pp. 391-419). Springer International Publishing.

Imran, K. (2019). Power generation expansion plan and sustainability in a developing country: A multi-criteria decision analysis. *Journal of Cleaner Production, 220*, 707-720.

Imran, K. (2020). Impacts of energy decentralization viewed through the lens of the energy cultures framework: Solar home systems in the developing economies. *Renewable and Sustainable Energy Reviews, 119*, 109576.

Irfan, M., Yadav, S., & Shaw, K. (2021). The adoption of solar photovoltaic technology among Indian households: Examining the influence of entrepreneurship. *Technological Forecasting and Social Change, 169,* 120815.

Islam, M. A., Hossain, M. S., & Murshed, S. (2015). Assessment of Coastal Vulnerability Due to Sea Level Change at Bhola Island, Bangladesh: Using Geospatial Techniques. *Journal of the Indian Society of Remote Sensing, 43*(3), 625-637.

Jakariya, M. (2016). Vulnerability Analysis of the Cyclone <i>Aila</i> Affected Community in the South-West Belt of Bangladesh. *Journal of Health and Environmental Research, 2*(2), 5.

Jibran, K., & Arsalan, M. H. (2016). Solar power technologies for sustainable electricity generation - A review. *Renewable and Sustainable Energy Reviews, 55,* 414-425.

Kabir, E., Kim, K.-H., & Szulejko, J. (2017). Social Impacts of Solar Home Systems in Rural Areas: A Case Study in Bangladesh. *Energies, 10*(10), 1615

Kang, K. H., Stein, L., Heo, C. Y., & Lee, S. (2012). Consumers' willingness to pay for green initiatives of the hotel industry. *International Journal of Hospitality Management, 3*1(2), 564-572.

Karakaya, E., & Sriwannawit, P. (2015). Barriers to the adoption of photovoltaic systems: The state of the art. *Renewable and Sustainable Energy Reviews, 49*, 60-66.

Karjalainen, S., & Ahvenniemi, H. (2019). Pleasure is the profit-The adoption of solar PV systems by households in Finland. *Renewable Energy, 133,* 44-52.

Komatsu, S., Kaneko, S., & Ghosh, P. P. (2011). Are micro-benefits negligible? The implications of the rapid expansion of Solar Home Systems (SHS) in rural Bangladesh for sustainable development. *Energy Policy, 39*(7), 4022-4031.

Komatsu, S., Kaneko, S., Ghosh, P. P., & Morinaga, A. (2013). Determinants of user satisfaction with solar home systems in rural Bangladesh. *Energy, 61*, 52-58.

Kumar, A., Ferdous, R., Luque-Ayala, A., McEwan, C., Power, M., Turner, B., & Bulkeley, H. (2019). Solar energy for all? Understanding the successes and shortfalls through a critical comparative assessment of Bangladesh, Brazil, India, Mozambique, Sri Lanka and South Africa. *Energy Research & Social Science, 48,* 166-176.

Laufer, D., & Schäfer, M. (2011). The implementation of Solar Home Systems as a poverty reduction strategy-A case study in Sri Lanka. *Energy for Sustainable Development, 15*(3), 330-336.

Marzia, K., Hasan, M. F., Miyazaki, T., Saha, B. B., & Koyama, S. (2018). Key Factors of Solar Energy Progress in Bangladesh until 2017. *Evergreen, 5*(2), 78-85.

Mizobuchi, K., & Tanizaki, H. (2018). *The power-saving behavior of households: How should we encourage power saving?* (pp. 1-166). Nova Science Publishers, Inc.

Mondal, M. A. H., & Denich, M. (2010). Assessment of renewable energy resources potential for electricity generation in Bangladesh. *Renewable and Sustainable Energy Reviews, 14*(8), 2401-2413.

Mondal, M. A. H., Kamp, L. M., & Pachova, N. I. (2010). Drivers, barriers, and strategies for implementation of renewable energy technologies in rural areas in Bangladesh-An innovation system analysis. *Energy Policy, 38*(8), 4626-4634.

Monyei, C. G., Adewumi, A. O., & Jenkins, K. E. H. (2018). Energy (in)justice in off-grid rural electrification policy: South Africa in focus. *Energy Research & Social Science, 44,* 152-171.

Mundaca, L., Samahita, M., Sonnenschein, J., & Seidl, R. (2020). Behavioural economics for energy and climate change policies and the transition to a sustainable energy use-A Scandinavian perspective. *In Energy and Behaviour* (pp. 45-87). Elsevier.

Murtagh, N., Gatersleben, B., & Uzzell, D. (2014). 20?60:20-Differences in Energy Behaviour and Conservation between and within Households with Electricity Monitors. *PLoS ONE, 9*(3), e92019

Olivier, D. G., Pepermans, G., & Verboven, F. (2016). Heterogeneity in the adoption of photovoltaic systems in Flanders. *Energy Economics, 59,* 45-57.

Ondraczek, J. (2013). The sun rises in the east (of Africa): A comparison of the development and status of solar energy markets in Kenya and Tanzania. *Energy Policy, 56*, 407-417.

Opiyo, N. N. (2019). Impacts of neighbourhood influence on social acceptance of small solar home systems in rural western Kenya. E*nergy Research & Social Science, 52,* 91-98.

Pachauri, S., & Jiang, L. (2008). The household energy transition in India and China. *Energy Policy, 36*(11), 4022-4035.

Palit, D. (2013). Solar energy programs for rural electrification: Experiences and lessons from South Asia. *Energy for Sustainable Development, 17*(3), 270-279.

Pode, R. (2013). Financing LED solar home systems in developing countries. *Renewable and Sustainable Energy Reviews, 25,* 596-629.

Quansah, D. A., Adaramola, M. S., & Mensah, L. D. (2016). Solar Photovoltaics in Sub-Saharan Africa - Addressing Barriers, Unlocking Potential. *Energy Procedia, 106,* 97-110.

Qureshi, T. M., Ullah, K., & Arentsen, M. J. (2017). Factors responsible for solar PV adoption at household level: A case of Lahore, Pakistan. *Renewable and Sustainable Energy Reviews, 78*, 754-763.

Rahman, S. M., & Ahmad, M. M. (2013). Solar Home System (SHS) in rural Bangladesh: Ornamentation or fact of development? *Energy Policy, 63,* 348-354.

Rahut, D. B., Mottaleb, K. A., Ali, A., & Aryal, J. (2018). The use and determinants of solar energy by Sub-Saharan African households. Int*ernational Journal of Sustainable Energy, 37*(8), 718-735.

Rai, V., Reeves, D. C., & Margolis, R. (2016). Overcoming barriers and uncertainties in the adoption of residential solar PV. *Renewable Energy, 89,* 498-505.

Roche, O. M., & Blanchard, R. E. (2018). Design of a solar energy centre for providing lighting and income-generating activities for off-grid rural communities in Kenya. *Renewable Energy, 118,* 685-694.

Saim, M. A., & Khan, I. (2021). Problematizing solar energy in Bangladesh: Benefits, burdens, and electricity access through solar home systems in remote islands. *Energy Research & Social Science, 74,* 101969.

Sarker, M. H., Huque, I., Alam, M., & Koudstaal, R. (2003). Rivers, chars and char dwellers of Bangladesh. *International Journal of River Basin Management, 1*(1), 61-80.

Sharif, I., & Mithila, M. (2013). Rural Electrification using PV: The Success Story of Bangladesh. *Energy Procedia, 33,* 343-354.

Smith, M. G., & Urpelainen, J. (2014). Early Adopters of Solar Panels in Developing Countries: Evidence from Tanzania: Early Adopters of Solar Panels in Developing Countries. *Review of Policy Research, 31*(1), 17-37.

Steg, L. (2008). Promoting household energy conservation. *Energy Policy, 36*(12), 4449-4453.

Sunny, F. A., Fu, L., Rahman, M. S., & Huang, Z. (2022). Determinants and Impact of Solar Irrigation Facility (SIF) Adoption: A Case Study in Northern Bangladesh. *Energies, 15*(7), 2460.

Tahsina, K., Khanam, S. N., Rahman, M. H., & Rahman, S. M. (2019). Determinants of microfinance facility for installing solar home system (SHS) in rural Bangladesh. *Energy Policy, 132,* 299-308.

Ueno, T., Sano, F., Saeki, O., & Tsuji, K. (2006). Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data. *Applied Energy, 83*(2), 166-183.

Urban, J., & Ščasný, M. (2012). Exploring domestic energy-saving: The role of environmental concern and background variables. *Energy Policy, 47,* 69-80.

Urpelainen, J., & Yoon, S. (2015). Solar home systems for rural India: Survey evidence on awareness and willingness to pay from Uttar Pradesh. *Energy for Sustainable Development, 24,* 70-78.

Vine, D., Buys, L., & Morris, P. (2013). The Effectiveness of Energy Feedback for Conservation and Peak Demand: A Literature Review. *Open Journal of Energy Efficiency, 02*(01), 7-15.

Walton, S., & Ford, R. (2020). Easy or arduous? Practices, perceptions and networks driving lighting transitions from kerosene to solar in Vanuatu. En*ergy Research & Social Science, 65,* 101449.

Wang, F., Deng, R., Wang, J., Wang, Q., Han, Y., Zhu, H., Chen, X., & Liu, X. (2011). Tuning upconversion through energy migration in core-shell nanoparticles. *Nature Materials, 10*(12), 968-973.

Wijayatunga, P. D. C., & Attalage, R. A. (2005). Socio-economic impact of solar home systems in rural Sri Lanka: A case-study. *Energy for Sustainable Development, 9*(2), 5-9.

Wooldridge, J. M. (2008). Econometrics: Panel Data Methods. *The MIT Press,* 1-741.

Worlddata. (2022). Energy consumption in Bangladesh [dataset]. https://www.worlddata.info/asia/bangladesh/energy-consumption.php

Zander, K. K. (2020). Unrealised opportunities for residential solar panels in Australia. *Energy Policy, 142,* 111508.