Malaysian Journal of Sustainable Environment
Vol.13.No.1 (2026) 145-164
doi: 10.24191/gc2cj973

EMPOWERING HOMES: AN ANALYSIS OF THE SOCIOECONOMIC AND ENVIRONMENTAL BENEFITS OF RESIDENTIAL SOLAR ENERGY IN MALAYSIA

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Received: 11 September 2025
Accepted: 24October 2025
Published: 31 March 2026

ABSTRACT

This study examines the socioeconomic and environmental advantages of adopting home solar energy in Malaysia. The research is driven by the increasing global focus on renewable energy sources to address climate change and diminish reliance on fossil fuels. Notwithstanding Malaysia's potential for solar energy, the adoption of household solar systems remains constrained. The study examines the issue of insufficient solar energy utilisation in Malaysian households, which impedes economic savings for families and broader environmental objectives. This study aims to analyse the effects of home solar systems on household energy expenses, gauge public awareness of the benefits of solar energy, and examine the environmental advantages associated with solar energy utilization. A mixed-methods approach was employed to collect data via surveys and interviews with homeowners who have installed solar panels. The results indicate substantial decreases in electricity expenses, a high degree of

user satisfaction, and large reductions in carbon emissions. The report advocates for enhanced government incentives, public awareness initiatives, and optimised installation procedures to promote broader adoption of solar technology in residential sectors. These strategies are essential for improving energy sustainability and securing enduring socioeconomic and environmental advantages for Malaysian communities.

Keywords: *Solar power, Residential solar users, Benefits, Experiences.*

INTRODUCTION

Malaysia, a tropical nation close to the equator, is a prime location for solar energy use because it receives plenty of sunlight all year round. The nation has historically depended on fossil fuels, including coal, natural gas, and oil, to satisfy its energy requirements. Nonetheless, escalating apprehensions regarding climate change, surging energy expenses, and the exhaustion of non-renewable resources have catalysed a transition towards more sustainable and renewable energy alternatives. Solar energy is distinguished among available alternatives for its accessibility, environmental advantages, and swiftly declining installation expenses.

The worldwide movement towards clean energy transitions has impacted Malaysia's energy policies and development objectives. The Malaysian government has implemented various policies and frameworks to promote renewable energy, including the Renewable Energy Act 2011, the Sustainable Energy Development Authority (SEDA), and incentive programs such as the Feed-in Tariff (FiT) and the current Net Energy Metering (NEM) initiative. These projects seek to motivate individuals, businesses, and industries to participate in solar energy by allowing them to reduce electricity expenses and supply excess power to the national grid.

The Malaysia Renewable Energy Roadmap (MyRER) 2021–2035 reinforces these initiatives by establishing ambitious targets for renewable energy to constitute 31% of the national energy mix by 2025 and 40% by 2035. This plan prioritises solar photovoltaic (PV) technology in Malaysia's energy revolution, emphasising its critical role in enhancing energy resilience, decreasing carbon emissions, and fostering economic growth

through green technology.

Notwithstanding these favorable policies and Malaysia's extensive solar potential, the uptake of solar energy in residential settings remains very limited. A multitude of variables contribute to this disparity, including the substantial initial installation cost, inadequate public information, restricted access to funding, and apprehensions regarding system upkeep. Moreover, variations in adoption rates among urban, suburban, and rural regions illustrate wider socioeconomic issues that must be tackled to provide equitable access to sustainable energy.

This study aims to comprehend the practical experiences of existing home solar users in Malaysia, evaluate the concrete benefits they gain, and identify obstacles that hinder broader adoption. The research focuses on actual users to underscore the socioeconomic and environmental benefits of residential solar systems, assess public awareness levels, and provide recommendations for increasing future adoption. The report provides significant insights for policymakers, energy providers, and the public, facilitating Malaysia's transition to a more sustainable and inclusive energy future.

LITERATURE REVIEW

Reducing greenhouse gas emissions is one of the most widely cited advantages of solar panels. According to the International Energy Agency (IEA, 2020), solar photovoltaic (PV) technology plays a vital role in mitigating climate change by offering a clean alternative to fossil fuel-based power generation. A study by Kılkış and Kılkış (2021) also found that switching to solar energy significantly reduces carbon emissions and local air pollutants, particularly in urban areas.

Furthermore, research conducted by Habib et al. (2021) demonstrated that solar panels have substantially lower life-cycle emissions compared to traditional energy sources. The authors emphasized that even after accounting for production and end-of-life processes, solar PV remains one of the cleanest available energy technologies. Recent studies also highlight the economic viability of solar energy. Research by Sahu et al. (2022) and

Majid et al. (2020) indicates that the levelized cost of electricity (LCOE) for solar PV has decreased dramatically, making it competitive with, or even cheaper than, coal and gas in many regions, including Southeast Asia. In Malaysia, for example, the expansion of Net Energy Metering (NEM) initiatives has enabled businesses and households to reduce electricity costs, often achieving payback periods of under ten years (Musa et al., 2021).

Moreover, the solar sector contributes to job creation. Ramli et al. (2020) reported that Malaysia's solar industry has generated thousands of new jobs, particularly in the manufacturing, installation, and maintenance sectors. By reducing dependence on imported fuels and mitigating supply disruptions, solar panels also enhance energy security at both national and household levels. Farid et al. (2021) found that decentralized solar systems provide resilience during natural disasters and energy shortages. Rooftop PV systems, in particular, offer reliability and autonomy to rural or remote areas where grid access may be limited or unstable.

Malaysia is currently experiencing a rapid increase in electricity demand, primarily driven by continuous economic development and the expansion of national power infrastructure. This rising demand is placing significant pressure on the country's energy supply, which remains largely reliant on finite fossil fuel resources. In response, renewable energy (RE) has emerged as a viable and strategic solution for addressing the nation's energy challenges (Mohd & Faizal, 2024). Recognising the urgency of this transition, the Malaysian government has introduced a comprehensive range of policies and regulatory frameworks aimed at promoting the integration and development of RE technologies. These efforts signal a broader commitment to reducing carbon emissions, improving energy security, and aligning with global climate and sustainability goals.

In keeping with these findings, a recent study by Umme and Kasim (2024) highlights how urgent it is to reduce reliance on fossil fuels and hasten the switch to renewable energy sources. Their findings indicate that shifting to cleaner and more sustainable energy options is crucial for tackling environmental issues such as climate change and air pollution, as well as for securing long-term energy stability and economic resilience. The research highlights the significance of policy endorsement, public consciousness, and technology advancement as essential catalysts for this energy transition.

Advancements in solar PV technology have led to greater efficiency and extended lifespans. A recent study by Zhang et al. (2022) has explored the performance improvements offered by bifacial panels, perovskite materials, and integrated storage systems, all of which enhance the overall viability and appeal of solar solutions. These innovations are making solar energy more adaptable across various sectors, including agriculture and transportation. Emerging research has also highlighted the social benefits of solar energy- an improved quality of life and access to education in underserved regions. For instance, Ismail et al. (2020) found that solar-powered schools in rural Malaysia enabled longer study hours and enhanced digital learning opportunities.

To sum up, solar energy is a catalyst for socio-economic growth and energy independence, as well as, clean and reasonably priced power source. Especially in developing countries like Malaysia, these benefits make it a crucial element of sustainable development plans.

METHODOLOGY

This study utilised a mixed-method research methodology, primarily focusing on quantitative data gathering, supplemented with qualitative insights to achieve a thorough understanding of household solar energy uptake in Malaysia. The primary objectives were to analyse user experiences, evaluate quantifiable advantages, and identify significant obstacles to adoption within Malaysian families.

A systematic questionnaire was created and distributed to household solar energy customers in several locations in Malaysia. The poll had closed-ended and Likert-scale questions regarding system usage duration, monthly electricity savings, perceived advantages, installation expenses, and maintenance issues. Furthermore, open-ended questions were incorporated to collect anecdotal information and elucidate more nuanced user experiences.

A purposive sample method was employed to choose participants who had installed solar photovoltaic (PV) systems in their residences. Participants were enlisted via partnerships with solar installation firms,

energy-focused forums, and homeowner associations. A total of 109 valid replies were obtained, encompassing a diverse array of geographic regions, professional backgrounds, and income brackets. This sampling technique guaranteed the participation of individuals with pertinent and firsthand expertise in domestic solar energy utilisation.

Data collection occurred over a two-month duration utilising online platforms like Google Forms, enabling extensive dissemination and convenience of participation. For the qualitative method, ten household solar PV users were chosen through purposive sampling to participate in semi-structured interviews to record a range of experiences. Each session was conducted over the phone or online, lasted 30 to 45 minutes, and was audio recorded with permission. The recordings were verbatim transcribed and subjected to thematic analysis, which coded and categorized recurrent concepts such as installation difficulties and cost-saving motivation into major themes.

RESULTS & DISCUSSION

The distribution of residential solar users based on location, as shown in Table 1, indicates a relatively balanced adoption between urban and suburban areas. A total of 49.5% of respondents reside in urban areas, while 44% are from suburban regions. This suggests that the adoption of residential solar energy systems is not limited to densely populated urban centres but is also gaining traction in suburban neighbourhoods. The small difference in percentage points highlights a growing awareness and acceptance of solar energy technology across different residential settings. This trend may be attributed to increased accessibility of solar installation services, supportive government incentives, and rising public interest in energy cost savings and environmental sustainability. The relatively even distribution also implies that efforts to promote solar adoption are reaching a wide demographic, potentially paving the way for broader implementation across the country.

Nonetheless, it is important to highlight that rural participation is quite low at 6.4%. This may result from infrastructural obstacles, reduced income levels, and restricted promotional efforts in these regions. Rural areas may gain the most from decentralised energy sources such as solar; nevertheless,

obstacles include inadequate financial alternatives, restricted technical support, and diminished exposure to awareness efforts that may impede adoption. Addressing this disparity would necessitate focused activities, including community solar programs, rural subsidies, and collaborations with local cooperatives and NGOs. including community solar initiatives, rural subsidies, and collaborations with local cooperatives and NGOs.

Table 1. Residential Area

Area	Frequencies (%)
Urban	54 (49.5%)
Suburban	48 (44%)
Rural	7 (6.4%)

Source: Author

The data in Table 2 illustrates the employment backgrounds of residential solar users, revealing important insights into the demographic characteristics of adopters. The majority of respondents, 45.4%, are employed in the private sector, followed by self-employed individuals at 37%, and those in the government sector, comprising only 17.6%. This distribution suggests that individuals in the private sector and those who are self-employed are more likely to invest in residential solar installations, possibly due to greater flexibility in financial decision-making or a stronger motivation to reduce long-term operational costs. The relatively lower participation from government sector employees might reflect differences in income stability, access to housing types suitable for solar installations, or varying levels of awareness and engagement with renewable energy initiatives. These findings imply that targeted outreach and financial incentives may be needed to encourage broader adoption across all employment groups, especially within the public sector.

Table 2. Employment Sector

Sector	Frequencies (%)
Private sector	49 (45.4%)
Self-employed	40 (37%)
Government sector	19 (17.6%)

Source: Author

Table 3 presents the monthly income distribution of residential solar energy users, highlighting the economic profile of individuals who have adopted solar technology. A significant portion of users, 38.5%, reported earnings above RM20,000 per month, followed closely by 36.7% with a monthly income between RM15,000 and RM20,000. Meanwhile, 19.3% fall within the RM10,000 to RM15,000 range, and only 5.5% earn between RM5,000 and RM10,000. This distribution indicates that residential solar adoption in Malaysia is currently more prevalent among higher-income households. The upfront cost of installation and the long-term investment mindset required for solar adoption may be more accessible to individuals with greater financial capacity. The relatively low representation of middle- and lower-income earners suggests potential financial barriers to entry, underlining the need for more inclusive financing options, subsidies, or awareness programs to make solar energy more accessible to a broader socioeconomic group.

Table 3. Monthly Income of Solar User

Income	Frequencies (%)
Above RM20,000	42 (38.5%)
RM15,000 to RM20,000	40 (36.7%)
RM10,000 to RM15,000	21 (19.3)
RM5,000 to RM10,000	6 (5.5%)

Source: Author

Table 4 analyses the representation of income groups among residential solar energy users in Malaysia. The purpose is to assess whether the adoption of solar energy is equitably distributed across socio-economic strata, thereby contributing to an understanding of affordability and inclusiveness within the national renewable energy transition. Respondents were categorized according to Malaysia's official household income classification (Department of Statistics Malaysia, Household Income and Basic Amenities Survey Report 2022). The result indicated an extreme concentration of solar users within the T20 group, with almost no representation from lower-income households.

The dominance of the T20 group suggests that residential solar adoption is economically stratified, favoring high-income earners with greater financial capability and access to credit. High-income households

are more financially ready to pay for up-front installation costs that often range from RM15,000 to RM30,000 and qualify for bank-backed green loan schemes. In contrast, the near absence of B40 respondents and the marginal inclusion of M40 participants highlight systematic barriers to equitable participation, including limited access to financing, insufficient information on long-term savings, and perceived cost burdens. This is supported by the survey conducted among non-solar users by S. M. Nurudin et al. (2025), which reveals that the hindrances of residential solar installation are high installation costs as the main barrier, followed by respondents' lack of awareness of available government incentives and their high monthly financial commitments.

Table 4. Residential Solar User Income Group Distribution

Income Group	Frequency (%)
T20 (>RM10,971)	103 (94.5)
B20 (RM4851-RM10,970)	6 (5.5)
B40 (<RM4,850)	0 (0.0)

Source: Author

Table 5 provides an overview of the monthly savings experienced by residential solar users. A significant proportion of respondents, 33.9%, report saving RM500 and above each month, followed by 29.4% who save between RM400 and RM500. Additionally, 22.9% of users save between RM300 and RM400, while 8.3% save between RM200 and RM300. A small minority, 0.9%, save RM100 or less. These findings suggest that residential solar energy users are generally experiencing substantial financial benefits, with over 60% of respondents saving between RM400 and RM500 or more each month. The potential for cost savings may be a key motivating factor for adopting solar technology, as users appear to recover their initial investment through monthly savings on energy bills. However, the small percentage of users saving less than RM100 may indicate that some households, perhaps with smaller systems or lower energy consumption, may not experience as significant savings. This variation underscores the importance of system size, energy usage, and local electricity tariffs in determining the financial benefits of solar adoption.

Table 5. Monthly Savings for the Solar User

Savings	Frequencies (%)
RM500 and above	37(33.9%)
RM400 to RM500	32(29.4%)
RM300 to RM400	25(22.9%)
RM200 to RM300	9(8.3%)
RM100 and below	1(0.9%)

Source: Author

A Pearson correlation was conducted to assess the relationship between respondents' monthly income and their estimated monthly savings from residential solar energy usage. The result in Table 6 revealed a moderate positive correlation, r= 0.32, p= 0.48, indicating a statistically significant linear relationship at the 0.05 level. This finding suggests that respondents with higher monthly income tend to record greater monthly savings, potentially reflecting larger system capabilities or higher efficiency in energy use. This outcome also reflects socioeconomic inequality in the diffusion of green technologies. As higher-income groups have more consistent financial benefits from solar adoption, policy interventions are essential to ensure equitable access and inclusive participation in Malaysia's solar transition agenda.

Table 6. Relationship between Residential Solar User Monthly Income & Monthly Savings

Relationship	Pearson	P-value
Monthly Income & Monthly Savings	0.322	0.048

Source: Author

A second analysis was conducted to examine the association between the duration of residential solar usage (in years) and the monthly savings achieved from solar energy. The Pearson correlation revealed a moderate positive correlation, r= 0.30, p= 0.066. Although the correlation result was not statistically significant at the level of 0.05 level, the positive coefficients suggest that households with longer durations of solar usage tend to report higher savings. The non-significance of these findings may be attributed to several contextual factors, including variations in household energy consumption, system efficiency, and maintenance practice.

Table 7. Relationship between Years of Solar Energy Usage & Monthly Usage

Relationship	Pearson	P-value
Years of Solar Energy Usage & Monthly Usage	0.302	0.066

Source: Author

Table 8 illustrates the duration of residential solar energy usage among respondents. The largest proportion, 48.6%, has been using solar energy for a period ranging from 1 to 5 years, while 33.9% have utilized it for 6 to 10 years. A smaller percentage, 9.2%, have been using solar energy for less than a year, and 7.3% have utilized it for 11 to 15 years. Only 0.9% of respondents have had solar installations for 15 years or more. These findings suggest that residential solar energy adoption is relatively recent for most users, with the majority having installed solar systems within the past decade. The relatively low percentage of long-term users (11 years and above) may indicate that the technology is still in its early stages of widespread adoption in residential settings. However, the significant number of users in the 1 to 10-year range suggests a steady increase in confidence and long-term commitment to solar energy. This also highlights that, despite the initial barriers to adoption, users tend to stick with their solar systems once installed, likely due to the perceived financial and environmental benefits.

Table 8. The Utilization Years of Residential Solar Energy

Utilization years	Frequencies (%)
Below a year	10 (9.2%)
1 year to 5 years	53 (48.6%)
6 years to 10 years	37 (33.9%)
11 years to 15 years	8 (7.3%)
15 years and above	1 (0.9%)

Source: Author

The bar chart in Figure 2 illustrates the benefits enjoyed by the residential solar installation. The findings reveal that residential solar users in Malaysia widely acknowledge a range of benefits associated with solar energy installations. The most strongly agreed-upon benefits include monthly electricity bill savings (109 respondents), the perception of solar as a safe and environmentally friendly energy source (108), its contribution

to the country's energy savings (108), and its support for Malaysia's green energy policy (107). These results indicate that economic advantages and alignment with environmental and national sustainability goals are highly influential factors in the adoption of residential solar systems. Similarly, solar energy is recognized for its durability (101 responses) and as a clean and long-lasting energy source (106), further emphasizing users' confidence in its long-term reliability and sustainability.

However, responses regarding other aspects, such as the ability to control electrical disruptions and perceptions of low maintenance costs, were more mixed. For instance, while 58 respondents agreed that solar installations help control electrical disruptions, a notable number (39) disagreed, and 12 were uncertain. Likewise, although 67 respondents acknowledged the benefit of low maintenance costs, 29 disagreed, and 18 were uncertain. These mixed perceptions suggest that while core benefits related to cost savings and environmental impact are well understood and experienced, there may still be gaps in user awareness or varied experiences concerning technical performance and maintenance requirements. Addressing these uncertainties through targeted education, improved service quality, and technical support could further enhance the adoption and satisfaction levels among residential solar users.

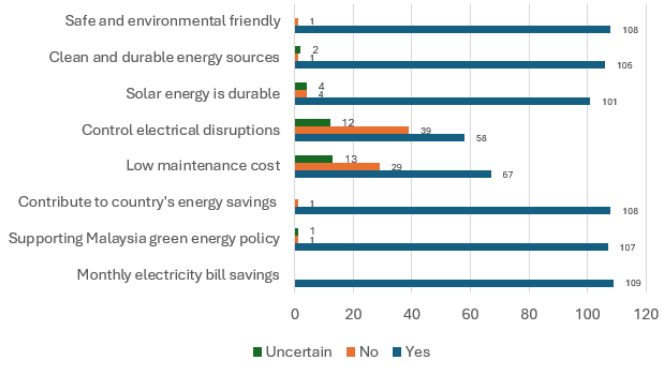

Figure 1. Benefits Enjoyed by the Residential Solar Installation
Source: Author

The annual Return on Investment (ROI) of residential solar users was estimated at approximately 24.9%, indicating strong short-term financial viability. Over the entire loan tenure, the cumulative ROI reached

approximately 125%, demonstrating that most households effectively double their investment within five years. This finding highlights that solar investments are both environmentally beneficial and economically profitable under Malaysia's Net Energy Metering (NEM) and Green Financing Schemes (Energy Commission, 2023).

The ROI of residential solar energy is supported by the data in Figure 2, which shows the analysis of the informant's residential solar energy billing data which demonstrates the dual economic and environmental benefits of solar adoption under Malaysia's Net Energy Metering (NEM) scheme. The household generated 822 kWh of excess energy, valued at RM451.58, leading to a significant reduction in the monthly electricity bill to RM173.11 after NEM offsets and government subsidies. Variations in monthly charges, ranging from RM33.95 to RM326.50, suggest seasonal fluctuations in solar generation and household consumption. Cumulative earnings of RM23,276.23 highlight the system's long-term financial viability and illustrate its positive environmental impact. Overall, the findings affirm that residential solar adoption under the NEM framework effectively promotes both household energy savings and national sustainability objectives.

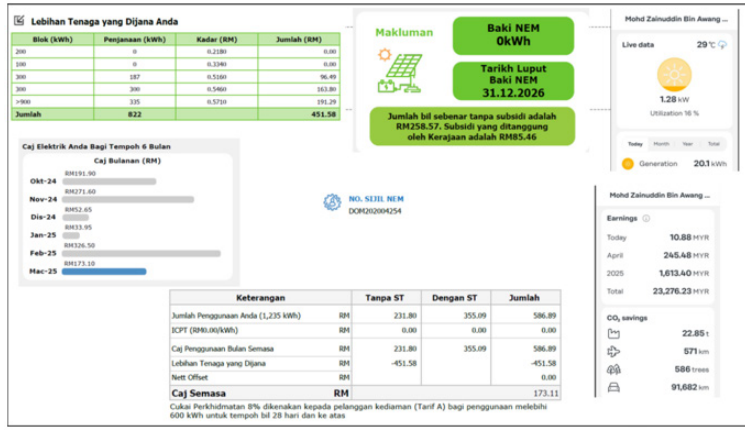

Figure 2. Residential Solar User Experience from Informant)

Source: Author

Collectively, the findings highlight that the household income and duration of solar usage are key determinants of financial outcomes in residential solar adoption. Policy makers should focus on expanding low-interest green financing, enhancing public awareness of solar economics,

and ensuring standardized performance monitoring. Future research should also use continuous quantitative measures (installation cost, capacity, and actual energy output) and longitudinal data to provide stronger empirical validation.

For the qualitative result, based on the interview with the informant, most of the installers' motivation and decision to install the solar PV system were cost savings and to support the renewable energy initiative introduced by the government. In addition, the government incentives to finance the solar PV installation also contribute to the intention to install. Most of the informants who had installed the solar PV experienced a reduction in the electricity bill from RM500+ to RM1000+. This supports the findings on the estimation of the ROI, where the installation may save about 25% of annual cost, which is a good investment since the payback is within five years.

For the challenges, the informants agree on these 3 common issues and the delays in solar PV installation due to waiting time for the solar panels to be received by the contractor. In addition, the changes in the capacity and plan for NEM scheme also pose problems to the installer. For example, the capacity for NEM1.0 differs from NEM2.0 and NEM3.0. Those who install NEM2.0 can't upgrade their capacity under NEM3.0, and may affect their bills due to the amendment of the electricity tariff as proposed by the government. In addition, the plan for the scheme also differs, such as the tax exemption benefits.

Table 9. The Responses by the Informants on the Intention and Challenges to Install a Solar PV System

	1	2	3	4	5	6	7	8	9	10
Factors in in-stallation Cost saving	/	/	/	/	/		/	/	/	
Renewable energy	/		/		/	/			/	/
Incentives by the gov	/	/		/	/	/	/	/		/
Short term pay-back	/		/	/		/	/	/	/	
Challenges of installing Delay for installation	/	/		/		/		/		/
Differentcapacity for NEM scheme	/			/	/		/		/	/
Different plans on NEM scheme		/		/	/	/		/		/

CONCLUSION & RECOMMENDATION

This study's findings indicate a considerable unexploited potential for household solar energy adoption in Malaysia. Notwithstanding the country's advantageous tropical environment, characterized by year-round ample sunlight, and the existence of strong government regulations designed to promote solar energy, the adoption rates among Malaysian families remain very low. This discovery corresponds with prior research that identifies structural and perceptual obstacles to renewable energy adoption in developing nations (Teoh et al., 2020; Zaidi, 2020). The obstacles encompass budgetary limitations, insufficient awareness, and issues relating to infrastructure and policy.

A significant element identified in the study is the disparity in public understanding and preparedness to embrace solar technology. Despite initiatives like the Net Energy Metering (NEM) program and the comprehensive Malaysia Renewable Energy Roadmap (MyRER) 2021–2035 outlining a definitive national vision, a disjunction exists between these policy aims and the public's comprehension of how to engage with them. The research reveals that numerous people lack access to clear, simplified, and practical information regarding the installation process of residential solar systems. This includes ambiguity regarding initial expenses, financial incentives, installation protocols, technical specifications, and anticipated returns on investment.

This information imbalance greatly diminishes public trust, especially among individuals with restricted technical understanding or financial resources. Despite governmental initiatives to popularise it, solar technology remains perceived as difficult, inaccessible, or hazardous by numerous households. This deficiency in awareness diminishes the perceived viability of solar systems and serves as a significant impediment to their implementation. This reflects global research indicating that informational and psychological hurdles are as significant as economic obstacles in the adoption of renewable energy (International Renewable Energy Agency, 2019).

Nonetheless, the study's results provide promising evidence from current users, whose experiences depict a far more favourable perspective.

Numerous respondents indicated concrete, quantifiable advantages from solar adoption, such as markedly reduced monthly electricity expenses, enduring financial savings, and the fulfilment derived from promoting environmental sustainability. These results align with the objectives of Malaysia's solar energy regulations and illustrate the tangible benefits of solar technology when effectively executed. Such testimonials can significantly impact public image. The impact of peer influence—where prospective users are influenced by the experiences of existing adopters—should not be overlooked. User tales function as informal yet effective means of public education, elucidating solar technology and fostering trust.

Nonetheless, the evidence clearly indicates that the advantages of solar energy use are not uniformly allocated. The predominant solar users found in the survey were from higher-income brackets, indicating that the initial financial outlay constitutes a significant obstacle for middle- and lower-income households. This corroborates the assertions made by Musa et al. (2021), who contended that in the absence of equitable finance channels, solar technology will continue to be disproportionately accessible to affluent demographics. To achieve a more equal energy transition, the government could contemplate specific financial tools, like subsidies, low-interest loans, leasing arrangements, or pay-as-you-save initiatives. These tools would facilitate the democratisation of solar energy access and extend its availability to a wider populace.

The study revealed varied experiences among users, especially concerning system reliability, maintenance, and technical assistance. Although the majority of customers were content, a few had apprehensions over continuous maintenance, system deterioration, and sporadic electrical issues. These variations indicate inconsistencies in installation quality and after-sales service, perhaps resulting from a deficiency in industry standards. This underscores the necessity for the establishment and implementation of explicit national standards and quality assurance methods for solar system installation and service provision. Guaranteeing user pleasure and the enduring viability of the system is essential for preserving public trust and promoting additional adoption.

To properly tackle these complex concerns, enhanced participation from both governmental and industrial parties is needed. Strategic public

education initiatives should be prioritised to enhance awareness, rectify misconceptions, and deliver comprehensible facts. These initiatives should have a multi-channel approach, employing traditional media (print, radio, television), digital platforms (social media, internet), and grassroots community involvement to optimise impact. Public communication must emphasise not just the environmental advantages of solar energy but also the financial savings, financing alternatives, maintenance simplicity, and testimonials from existing users.

Additionally, collaborations with local governments, NGOs, and educational institutions can be utilised to establish community-oriented awareness projects, especially in rural and marginalised regions. Localised initiatives will guarantee that solar energy education is accessible to all societal sectors, particularly those requiring financial support and empowerment.

In conclusion, although Malaysia has made significant strides in establishing the policy framework for a smooth transition to domestic solar energy, our study indicates that increased focus is necessary to address the implementation gap. This encompasses improving public education, establishing inclusive finance systems, and guaranteeing consistent service quality. The experiences of existing users underscore the enduring benefits of solar systems and can act as significant spurs for widespread adoption. To realise the lofty objectives stated in its renewable energy roadmap and to comply with its climate obligations, Malaysia must incorporate these essential elements into its national energy policies. Malaysia can only realise the full promise of solar energy for a sustainable and fair future by overcoming the highlighted systemic and perceptual limitations.

ACKNOWLEDGMENT & FUNDING

This study was supported by the FSPPP Internal Research Grant (FIRG), Faculty of Administrative Science and Policy Studies, Universiti Teknologi Mara (UiTM), Malaysia with the collaboration of Universitas Indonesia & PETRONAS (600-TNCPI 5/3/DDF (FSPPP) (003/2024). The study also has been granted approval from the UiTM Research Ethics Committee (REC/10/2024 (ST/MR/220) and the innovation project registered for

MyIPO (IP/CR/07915).

DECLARATION OF AI-GENERATED CONTENT

AI tools (e.g, ChatGPT, Grammarly) were used for drafting, assistance, paraphrasing and grammar checking. All content was critically reviewed and edited by researcher.

AUTHOR CONTRIBUTIONS

All authors participated in the research design, the online survey, and the manuscript preparation. the researchers undertook the extraction and analysis of information. all authors have reviewed and endorsed the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Arnulf, J. W. (2007). Photovoltaics and renewable energies in Europe. *Renewable and Sustainable Energy Reviews, 11*(7), 1414–1437.

Energy Commission Malaysia. (2022). *Net energy metering (NEM) programme*. https://www.st.gov.my/.

Energy Commission. (2023). *Malaysia renewable energy roadmap (MyRER) 2023–2050.* Putrajaya: Suruhanjaya Tenaga Malaysia.

Farid, S. M., Bakar, N. A., & Rashid, M. H. A. (2021). Enhancing energy security in Malaysia through distributed solar generation. *Renewable Energy Focus, 39*, 48–55. https://doi.org/10.1016/j.ref.2021.01.005.

Habib, H., Khan, M. R., & Rafiq, M. (2021). Comparative life cycle assessment of electricity generation from solar PV and fossil fuels.

Journal of Cleaner Production, 278, 123867.https://doi.org/10.1016/j.jclepro.2020.123867

Humayara Manni, U., & Md. Mansur, K. H. (2024). Sustainable energy transition challenges in selected ASEAN countries: A 4A framework data envelopment analysis perspective. *Malaysian Journal of Sustainable Environment, 11*(1), 1–24. https://doi.org/10.24191/myse.v11i1.981.

IEA. (2020). *World energy outlook 2020.* International Energy Agency. https://www.iea.org/.

Majid, M. S. A., Zainuddin, H., & Sapuan, S. M. (2020). Economic performance of solar PV in Southeast Asia. *Renewable Energy, 147,* 1106–1115. https://doi.org/10.1016/j.renene.2019.09.019.

Mohd Haniff Hazmin, & Mustapha, F. (2024). An outlook on hydropower in Malaysia: Policies, conditions, and the potential of small hydropower in Malaysian rivers as a new norm in renewable energy. *Malaysian Journal of Sustainable Environment, 11*(1), 1–24. https://doi.org/10.24191/myse.v11i1.981.

Musa, M. F., Rahman, H. A., & Ahmad, N. (2021). Impact of Net Energy Metering policy on solar PV adoption in Malaysia. *Energy Policy, 155*, 112334. https://doi.org/10.1016/j.enpol.2021.112334.

Nor Suhana Yusof. (2022). *Relevankah pemasangan solar di kediaman? Penyelidik Kluster Alam Sekitar, Sumber Asli dan Asas Tani Terengganu Strategic Integrity Institute (TSIS).*

Norazlinda Binti Mohamed, Irdayanti Binti Mat Nashir, & Nurul Fazura Abdul Hamid. (2019). Kajian keperluan alat latihan sistem solar fotovolta bagi memenuhi keperluan industri di Malaysia. *International Journal of Humanities Technology and Civilization (IJHTC), 6*(1), 40–48.

Ramli, M. A. M., Twaha, S., & Al-Turki, Y. (2020). Green jobs in the Malaysian solar industry: Potential and strategies. *Renewable and Sustainable Energy Reviews, 134,* 110320. https://doi.org/10.1016/j.rser.2020.110320.

Razak, I. (2021). *Pemeteran tenaga bersih atau Net Energy Metering (NEM) merupakan insentif solar bagi meningkatkan penggunaan tenaga solar dalam kalangan pengguna di Malaysia,* 1–5.

Roland, C. (2007). Climate change and energy policy: The importance of sustainability arguments. *Energy, 32*(4), 262–268.

Sahu, B. K., Yadav, N. S., & Purohit, I. (2022). Cost competitiveness of solar PV in Asia-Pacific: Trends and projections. *Energy Economics, 106*, 105799. https://doi.org/10.1016/j.eneco.2021.105799.

SEDA Malaysia. (2021). *Laporan tahunan 2020*. https://www.parlimen.gov.my/ipms/eps/2021-12-16/ST.200.2021 - ST 200.2021.pdf

.

Seribu Ombak. (2019). *Malaysia perlu pergiat penggunaan tenaga solar dalam negara*. 16–17. https://seribuombak.wordpress.com/2019/01/09/malaysia-perlupergiat-penggunaan-tenaga-solar-dalam-negara/

Suzei Mat Nurudin, Zarina Mohd Zain, Farihah Hassan, Reza Fathurrahman and Mohd Zainuddin Awang Ahmad (2025). Transitioning to Solar Energy in Malaysia: A Study of Residential Solar Users and Non-Residential Solar Users, *Proceedings of the 9th Terengganu International Business and Economics Conference 2025* (TiBEC IX 2025), ISSN 2352-5428, Atlantis Press -Advances in Economics, Business and Management Research (AEBMR), https://doi.org/10.2991/978-94-6463-801-1_5

Teoh, A. N., Go, Y. I., & Yap, T. C. (2020). Is Malaysia ready for sustainable energy? Exploring the attitudes toward solar energy and energy behaviors in Malaysia. *World, 1*(2), 90–103. https://doi.org/10.3390/world1020008.

Utusan Malaysia. (2021). *Solar Rakyat: Jimat elektrik, mesra alam.*

Zaidi, A. (2020). *Berbaloikah pemasangan sistem solar panel (PV) di rumah?* Terengganu Strategic Integrity Institute, pp. 4–9.

Zhang, X., Li, Y., & Tan, Y. (2022). Emerging trends in solar PV technologies: Efficiency, cost, and deployment. *Renewable Energy, 182*, 670–684. https://doi.org/10.1016/j.renene.2021.10.095.