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Assessing Residents' Views, Awareness Levels and Adoption of Solar Panel for Homes. Case Study: Taman Sinar Bukit and Sinar Baru, Kota Kinabalu, Sabah

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ABSTRACT

This article aims to assess the residents' views, level of awareness, and readiness to adopt and use solar energy, i.e., a renewable energy (RE) technology, within the case study area. The study collected residents' opinions regarding RE and what strategies are suitable for promoting the use of energy-efficient appliances in homes and neighbourhoods. We identified residents using a purposive sampling method to complete the questionnaire. The design of the queries includes a Likert-like scale of responses. Some patterns were found by describing the frequencies and cross-tabulating significant variables using the Chi-Square test of associations. The majority of the respondents have little knowledge or are unaware of RE. The variables of education level and level of awareness were not significant to the adoption of RE, i.e., the variables were not dependent. However, residents view the importance of RE in achieving energy independence and environmental protection as significantly associated and dependent upon each other. Those who view achieving energy independence as important are more ready to adopt RE than those who view it as unimportant. The majority of respondents view the financial costs of maintenance and installation as the major barriers to the adoption of RE. The significance of this paper lies in its contribution to insights of potential RE users' awareness, acceptance, and adoption of solar energy technology which is relevant to the education and outreach efforts towards the Sabah Energy Roadmap and Master Plan 2040Future research work on solar panel adoption in Malaysia should focus on understanding the factors influencing adoption, evaluating the effectiveness of policies, and exploring the potential of integrating solar with other energy-efficient technologies.

Keywords: Renewable Energy; Solar Panels Adoption; Residents' views of Solar Panels

INTRODUCTION

The transition to renewable energy has become a central focus for addressing the global challenges of climate change, urbanisation, and energy security. In urban contexts, where energy demands are rapidly increasing, renewable energy technologies offer significant potential to enhance sustainability while reducing environmental and economic vulnerabilities. Among these

technologies, rooftop solar systems have gained prominence due to their ability to harness solar energy in a decentralised and scalable way. In Sabah, particularly in urban areas like Kota Kinabalu, the adoption of renewable energy technologies is still in its early stages. Factors such as the region's high solar irradiance and increasing energy consumption present an opportunity to integrate rooftop solar installations into the urban energy landscape. However, successful implementation requires a thorough understanding of technical feasibility, environmental impacts, economic benefits, and the perceptions of the community. A limited understanding of the benefits and functionalities of solar systems may lead to resistance or apathy among potential users (Khoo et al., 2023). This limitation underscores the need for comprehensive education and outreach efforts to foster a more informed community that is supportive of renewable energy initiatives.

The aim of this article is to assess the level of awareness, readiness to adopt, and community use of solar energy technologies in the case study area. The research questions for this study are: What is the level of awareness, acceptance, and adoption of solar energy technology in the case study area? What are the residents' views regarding RE? And what strategies are suitable for promoting energy-efficient appliances in homes and neighbourhoods?

Renewable Energy (RE) technology - rooftop solar energy system

Sustainable urban energy involves a comprehensive approach to controlling energy systems in the city—environmental, economic, and social aspects should be considered. Cities should shift to green energy and use sustainable technologies to ensure that the residents they serve generate electricity in ways that will sufficiently meet today's and future energy needs with fewer adverse effects on the natural environment.

Residential systems can be described as small installations, usually for rooftops, or small ground-mounted systems (Moussa 2023). Installation of the panels on residential rooftops is set at a certain angle to the ground to ensure the most exposure to sunlight; in tracking systems, the position of the panels changes during the day, enabling them to produce more energy in total (Roshdan et al., 2024). Specifically, we can view photovoltaic (PV) systems as a crucial set of tools for harnessing solar energy. With the utilisation of solar power conversion from solar panels as well as the solar inverter, these systems offer a novel power generation alternative to replace fossil fuel energy sources and open the way for green energy solutions. Since the technology involved in the installation of PV systems is fast developing and the costs are becoming progressively cheaper, the use of PV systems also increases, thus promoting the use of renewable energy sources for power generation.

Sabah Energy roadmap and master plan 2040 target

The Sabah Energy Roadmap and Master Plan 2040, launched on September 19, 2023, is a 17-year-long program to formalise the energy system in Sabah, Malaysia. The following is a roadmap needed to provide a lasting solution for the state's perennial power supply challenges and, at the same time, promote efficiency in energy development. Key targets and initiatives outlined in the plan include:

Renewable Energy Goals: Goals have been proposed for renewable energy that at least 50% of the total energy capacity installed should be derived from renewable energy by 2035 and 80% by 2050 (MIDA, 2023; NST, 2023). Today, Sabah has only a little over 9% renewable power capacity.

Transition of Regulatory Authority: Starting January 3, 2024, the control of electricity supply and limited generators, as well as renewable energy, will be under state government regulation. This shift will enable Sabah to selectively decide on power issues, including energy policies and power infrastructure (MIDA, 2023). Energy Security and Affordability: SE-RAMP 2040 focuses on the availability and affordability of a reliable power supply together with energy security and sustainability in Malaysia (MIDA, 2023).

Establishment of the Sabah Energy Council Solar Energy: Solar power is being pushed hard because of its tremendous potential in Sabah. According to theoretical assessments, the potential

of SPECIFIC does not exceed 100,000 MW. The current installed capacity of large scale solar (LSS) plants generates almost 216 MW; the largest solar farm in the country is situated in Kudat and only has a rated capacity of 50 MW (Daily Express, 2024; Energy Commission of Sabah, 2024). In the recent past, the Sabah Energy Council endorsed the identification of 15 large-scale solar project developers for contract award for LSS Sabah 2024, managed by the Energy Commission of Sabah (ECoS), with a cumulative capacity of 199 MW (The Star, 2023). These are expected to be commissioned by the end of 2026, and they will contribute to the overall LSS capacity in Sabah to over 360 MW, which represents about 23% of Sabah's overall generation mix by 2027 (Sabah ECos 2024). Sabah has the best potential for solar harvesting in Malaysia. The roadmap indicated that utility-scale solar plants on virgin land in Sabah could generate approximately 99,400 MW (Malay Mail, 2024). However, to maintain the stability of the grid system, the connection of solar power with the electric grid is still restricted to approximately 220 MW or 22% of the total possible capacity (Malay Mail, 2024). In addition, suggestions on several district-level solar programmes to be planned in Beaufort, Kunak, Sandakan host plant, Tawau, and Labuan to increase capacity in the future shortly (Malay Mail 2024). In sum, Kota Kinabalu's solar energy prospects are to become even more important for the process of its shift towards the post-carbon future of Sabah.

Relevant factors for solar PV adoption

Solar PV adoption has various benefits for the environment, the economy, and society. However, there has been no comprehensive understanding of knowledge structure in solar PV adoption among households in the literature (Fauzi et al. 2023). In a study by Jager (2006), buyers' motives for solar panels were studied after a promotional campaign. It was discovered that financial support and general problem awareness were the most significant motivations, while other factors include social networks, technical and information meetings (Jager 2006). Schelly (2014) posits that environmental values alone are insufficient and not always necessary to motivate adoption, and a rational economic calculated return or payback period is less important than the particular timing of economic events within a household. Shakeel et al (2023) showed that eight categories – economic, environmental, personal, social, demographic, technical, market-related and regulatory factors were relevant for solar PV adoption.

Many incentives at the state and federal level exist for household adoption of renewable energy like solar photovoltaic (PV) panels, however, the adoption rate is low (Bauner & Crago, 2015). Cruz (2018) also suggests that adopting residential solar power has uncertain implications for renewable energy incentives and various actors are involved. Aside from economic and financial aspects, technological or design aspects of renewable energy adoption were considered relevant by Wilkinson & Morrison (2021). a deeper understanding of the technical and economic impacts of rooftop PV on wholesale energy markets.

Gajanayake et al. (2024) investigate how psychological determinants impact households' willingness to install solar photovoltaic (PV) systems and identify emerging themes about the factors leading to householders to adopt residential photovoltaic systems. They suggest that future orientation, values, and behavioural control are significant predictors of household willingness to install solar PV systems (Gajanayake et.al., 2024). A study by Mulyani et al. (2024) found that economic, environmental, social and technological motives and barriers are five themes to adopting residential photovoltaics (2024). They also found that knowledge, misconceptions, and scepticism; economically viable alternative PV technologies; and government regulations and policies were the main public discourse on PV adoption (Mulyani et al. 2024).

Site location

Kota Kinabalu is the state capital of Sabah and is situated on the north coast of Borneo with the South China Sea on its northern limit. This city has a high amount of light throughout the year due to the tropical nature of its climate, making it the best place to invoke the use of solar energy. Specifically, Taman Sinar Bukit and Taman Sinar Baru are two notable residential areas in Kota Kinabalu, Sabah, each offering distinct living environments and amenities. Taman Sinar Bukit, with

the postcode 88400, is characterised by its semi-detached houses and terrace homes, which cater to families seeking spacious living options. Properties in this area, such as the Damai CL999 semi-D houses, typically feature multiple bedrooms and bathrooms, with prices around RM1,600,000 for well-renovated units (EdgeProp, 2022). The neighbourhood is known for its peaceful atmosphere and access to local amenities, making it a desirable location for residents. In contrast, Taman Sinar Baru is a newer development that complements the urban landscape of Kota Kinabalu. Taman Sinar Baru is generally recognised for its modern housing designs and proximity to essential services, such as hospitals, commercial centres, and recreational facilities. Both areas reflect the growing demand for residential properties in Kota Kinabalu and contribute to the city's expanding urban fabric. As Kota Kinabalu continues to develop, neighbourhoods like Taman Sinar Bukit and Taman Sinar Baru play a vital role in accommodating the growing population while providing a range of housing options.

Current land use

The current land use in Taman Sinar Bukit and Taman Sinar Baru in Kota Kinabalu, Sabah, primarily consists of residential developments. Taman Sinar Bukit features a variety of landed properties, including semi-detached houses and terraced homes, with recent transactions indicating a median price of approximately RM1,020,000 and a range from RM720,000 to RM1,320,000 depending on property specifications and locations (Brickz.my, 2025). The area is equipped with essential amenities, such as schools, parks, and local shops, contributing to its appeal as a residential neighbourhood and enhancing the quality of life for residents.

Taman Sinar Baru is typically described as a neighbourhood with the same type of residential land use as the study site— Taman Sinar Bukit; the former comprised mostly terraced houses. In general, both Taman Sinar Bukit and Taman Sinar Baru are predominantly residential neighbourhoods of Kota Kinabalu in which residential properties coexist and are complemented by essential facilities to fulfil the needs of residents of a modern city.

METHODOLOGY

To answer the research question and meet the objectives of the study, the researchers gather and analyse the primary data and describe their findings. The data collection involves the use of a questionnaire to gather quantitative data. There are four main sections of the questionnaire: Respondents' Profile, Awareness and Perceptions of Renewable Energy, Current Energy Use, and Views on the Importance of RE. We design the responses for each question using a Likert-like scale. A final section of the questionnaire asks the respondents to provide their comments and recommendations. Through purposive sampling, questionnaires were distributed to the residents of Taman Sinar Bukit and Taman Sinar Baru, Kota Kinabalu, from November 2024 to January 2025. A total of 164 questionnaires were filled by the respondents and returned to the researchers. Purposive sampling, or selective sampling, is a non-probability sampling technique where researchers intentionally select participants based on specific characteristics relevant to answer the research question. The main criterion was that some landed residences in the neighbourhood have installed solar panels on their roofs.

Subsequently, a statistical descriptive analysis of the data will calculate frequencies, percentages, and means. The analysis helps researchers to understand the respondents' opinions or preferences. Using statistical software, we apply cross-tabulation to compare the variables and investigate the nature of the relationship between several relevant variables. The application of the chi-square test of association can reveal certain patterns of the selected variables, verify if they are dependent on each other, and help answer the research questions of the study.

ANALYSIS AND FINDINGS

The first section of the analysis is the respondents' household profile (Table 1). All respondents are over 18 years old, and their education levels are varied. Almost half of the respondents (48.8%)

have tertiary education, either a diploma or a degree. 77.5% of the respondents hold employment, while the remaining individuals are still studying or retired. The majority (80%) live in landed properties, while 20% of the respondents live in shop houses. Their primary sources of energy currently are electricity (32.3%), diesel (19.5%) and solar energy (48.2%). Almost half of the respondents reported that their energy or electricity bills are RM300 or less, while the others reported electricity bills of more than RM300. Respondents reported that appliances such as air conditioning (65.2%), computer devices (58.5%) and refrigerators use the most electricity energy (56.2%) (Figure 2).

Table 1. Demographic profile of respondents.

Gender	Number	Percentage (%)
Male	77	47
Female	87	53
Total	164	100

Age Categories	Number	Percentage (%)
18-25	24	14.6
26-35	38	23.2
36-45	40	24.4
46-55	42	25.6
56 and above	20	12.2
Total	164	100

Education Level	Number	Percentage (%)
Primary school	27	16.5
Secondary school	57	34.8
Diploma/Technical Certificate	47	28.7
Degree and above	33	20.1
Total	164	100

Occupation	Number	Percentage (%)
Student	23	14
Employed (Private sector)	47	28.7
Employed (Government sector)	47	28.7
Self-employed	33	20.1
Retired	14	8.5
Total	164	100

Residence Type	Number	Percentage (%)
Terrace house	30	18.3
Semi-detached	60	36.6
Detached	41	25
Shop House	33	20.1
Total	164	100

Primary Source Of Energy	Number	Percentage (%)
Electricity from the grid	53	32.3
Solar energy (rooftop panels)	79	48.2
Diesel generator	32	19.5
Total	164	100

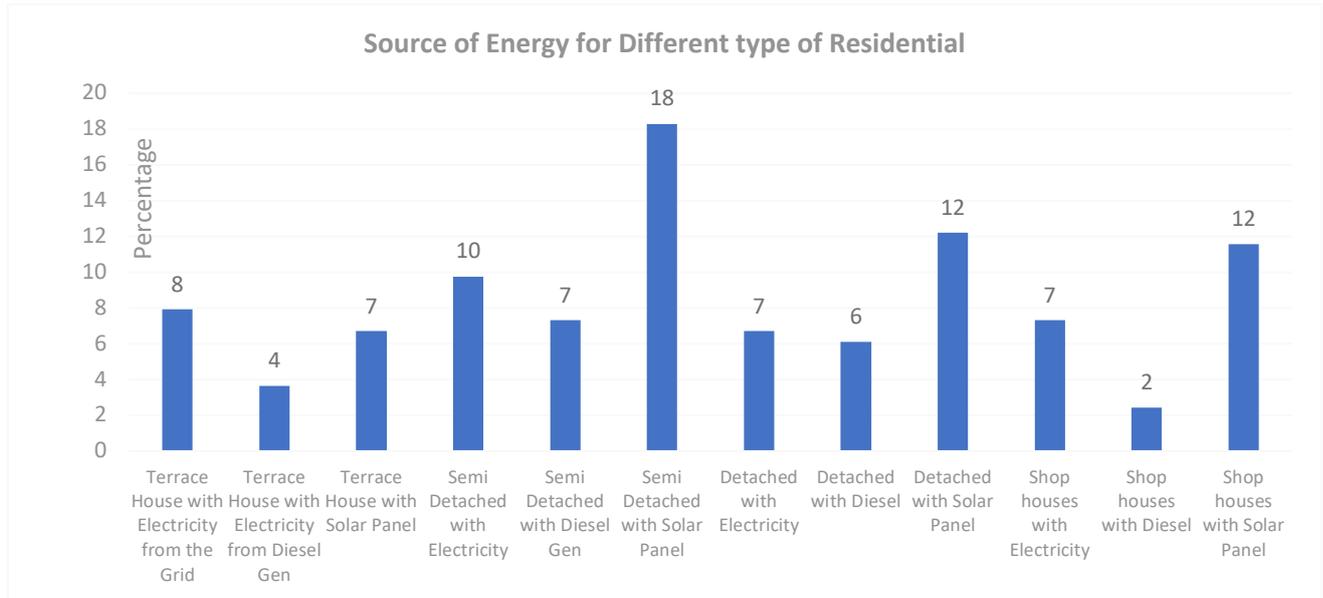| Monthly Electricity Bill	Number	Percentage (%)
Less than RM 100	34	20.7
RM 100–RM 300	49	29.9
RM 301–RM 400	60	36.6
Above RM400	21	12.8
Total	164	100

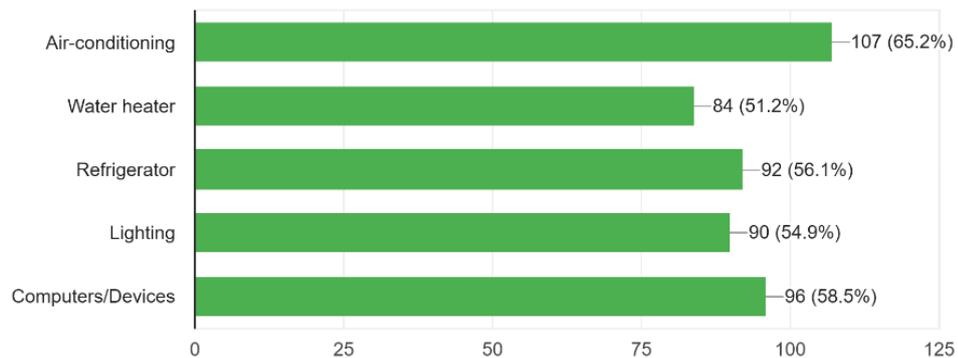Figure 1. Source of energy for different type of residential.

Figure 2. The major energy-consuming appliances used.

Level of awareness and readiness to adopt RE

Descriptive analysis can reveal the percentage of residents' awareness and views of renewable energy technology and the proportion of respondents' readiness to install rooftop solar panels. In addition, the chi-square test of association will indicate the level of association between the selected variables. Table 1 and Figure 1 show that despite almost half of the households reportedly having access to solar energy, i.e., being ready for RE (49%), the majority of the respondents in the study area (60.5%) reported having little knowledge and being unaware of RE technologies (Table 2). Only 39.1% of the respondents reported that they are aware of the details of RE. A chi-square test of association reveals no significant association between education level or the awareness level of respondents with the adoption of RE in this case study (Table 3(a) & 3(b)). This indicates that the adoption of RE technology is not dependent upon the level of knowledge or awareness about RE. The majority of respondents agree that RE technology offers many benefits, such as reducing electricity bills, creating job opportunities, and reducing environmental pollution (Table 2). Furthermore, the average analysis of respondents' readiness to adopt RE indicates that all respondents are only marginally prepared.

Table 2. Respondents' awareness of RE technology details.

Awareness of Renewable Energy Technologies	Number	Percentage (%)
Very unaware	16	9.8
Unaware	42	25.6
Little knowledge	42	25.6
Aware	47	28.7
Very Aware	17	10.4
Total	**164**	**100**
Readiness to Adopt Renewable Energy	**Number**	**Percentage (%)**
Very Ready	24	14.6
Ready	33	20.1
Neutral	42	25.6
Not Ready	50	30.5
Very Not Ready	15	9.1
Total	**164**	**100**
Main Benefits of Using Renewable Energy	**Number**	**Percentage (%)**
Reducing electricity bills	121	73.8
Reducing environmental pollution	98	59.8
Increasing energy security (less dependency on fossil fuels)	93	56.7
Creating job opportunities	120	73.2
Total	**432**	**263.5**

Table 3(a). Crosstabulation between variables education level and readiness to adopt renewable energy.

Variables	How ready are you to adopt renewable energy alternative such as installing solar panel?	*Very Unready* *1*	*Unready* *2*	*Slightly ready* *3*	*Ready* *4*	*Very Ready* *5*	Median
Education Level	Degree and above	3	8	10	6	6	3
	Diploma/Technical Certificate	5	17	10	10	5	3
	Secondary school	4	18	17	12	6	3
	Primary school	3	7	5	5	7	3
	Total	15	50	42	33	24	
Pearson Chi-Square	7.150a			0.848			

Note: The chi-square significance value is $p > 0.05$, thus there is **no significant association** between the variable Education and Readiness to adopt RE.

Table 3(b): Crosstabulation between variables awareness level and readiness to adopt renewable energy.

		Very Not Ready	*Not Ready*	*Neutral*	*Ready*	*Very Ready*	Total
Are you aware of renewable energy technologies?	Aware	4	20	10	6	7	47
	Little knowledge	7	11	8	6	10	42
	Unaware	3	14	12	10	3	42
	Very Aware	0	3	7	5	2	17
	Very unaware	1	2	5	6	2	16
	Total	15	50	42	33	24	164

Note: The chi-square significance value is $p > 0.05$ thus there is **no significant association** between variable Awareness and Readiness to adopt RE.

Residents' views regarding the importance of RE

The study further explored the importance of RE in four contexts: achieving energy independence, protecting the environment, cost reduction, and job opportunities. The Table 4 below highlights respondents' views regarding these aspects. The details also show that about a third of the respondents view RE as not important (32.3%), while 67.6% view RE as important in all four aspects of Importance of RE.

Table 4. The views on the importance of renewable energy (RE).

Importance of Renewable Energy (RE)	Number (1 = Extremely Not important, 2= Not Important, 3= Slightly Important, 4= Important, 5 = Extremely important)				
	1	**2**	**3**	**4**	**5**
Reducing energy costs	*29*	*35*	*39*	*37*	*24*
Percentage (%)	17.7	21.3	23.8	22.6	14.6
Protecting the environment	*24*	*39*	*37*	*45*	*19*
Percentage (%)	14.6	23.9	22.6	27.43	11.6
Achieving energy independence	*19*	*41*	*41*	*38*	*25*
Percentage (%)	11.6	25	25	23.2	15.2
Supporting job creation	*23*	*30*	*46*	*42*	*23*
Percentage (%)	14	18.3	28	25.6	14
Pearson Chi-Square	22.297[a]				

Note: The chi-square significance value is p> 0.05 for cross tabulation. Thus, there is no significant association between the variables.

The researchers cross-tabulated the variables "Important in Achieving Energy Independence" and "Readiness of Adopting RE". We applied the chi-square test of association analysis. The finding (Table 5) indicates a significant association between both variables, and both are dependent on each other. The implication is that those who view achieving energy independence as important are more ready to adopt RE than those who view achieving energy independence as not important.

Table 5. Crosstabulation between variable importance of RE achieving energy independence and adoption of RE.

How ready are you to adopt renewable energy alternative, such as installing solar panels?	Importance of renewable Energy (RE) achieving energy independence (1 = Extremely Not important, 2= Not Important, 3= Slightly Important, 4= Important, 5 = Extremely important)				
	1	*2*	*3*	*4*	*5*
Very not ready	1	9	0	1	4
Not ready	9	9	10	16	6
Slightly ready	5	8	10	13	6
Ready	3	7	12	7	4
Very ready	1	8	9	1	5
Total	19	41	41	38	25
Note: [Not ready and views RE Not important]	*10*	*18*			
Note: [Ready and views RE Important			*31*	*21*	*15*
Pearson Chi-Square 31.366a 0.038					

Note: The chi-square significance value is p< 0.05 thus there is **a significant association** between the variable Readiness to adopt RE and achieving energy independence

Residents' views regarding barriers to adopting rooftop solar energy

Table 6 below highlights the views of barriers towards adopting or installing rooftop solar energy. The majority of the respondents (70.7%) view that the biggest barriers are maintenance and durability, and the high installation costs. (70.1%). Financial constraints present a significant barrier to solar energy adoption, as the initial investment required for solar panels and associated infrastructure can be prohibitively high for many individuals and communities (Khoo et al., 2023). Solar panel installation typically costs between RM14,000 and RM46,000, depending on various specifications, e.g., roof size, type, material, and PV system (https://www.progressturesolar.com).

Despite the initial cost, however, the return on investment is approximately eight years, and the house owner can recoup the initial investment through electricity savings. In addition, there are several Malaysian government incentives for home solar panel purchases, such as the *Solar for Rakyat Incentive Scheme* (SolaRIS), which offers cash rebates for solar PV system installations,

and the Net Energy Metering (NEM) scheme, which allows for credits for excess energy sent to the grid (https://www.tnb.com.my/solar).

Table 6. Barriers to adopting rooftop solar energy.

Barriers to Adopting Rooftop Solar Energy	Number	Percentage (%)
Concerns about maintenance and durability	116	70.7
High installation costs	115	70.1
Lack of space or suitable rooftops	91	55.5
Limited government incentives or support	91	55.5
Lack of awareness about solar energy benefits	88	53.7

Residents' views regarding energy saving measures

The respondents also suggested several energy-saving measures, such as switching off unused lights and appliances (64.6%), installing solar panels (59.8%) and using more energy-efficient appliances such as inverter air conditioners (Figure 3).
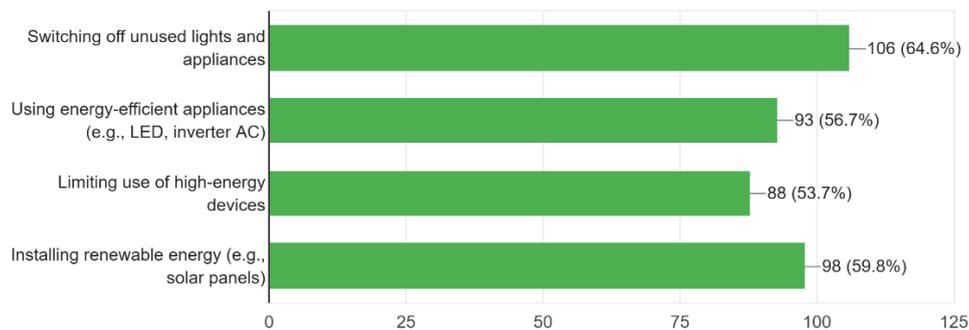

Figure 3. The energy-saving measures practiced.

Most respondents reported that one of the barriers to installing solar panels is due to financial aspects; however, 42% are willing to install solar panels if there is provision of monetary incentives, while 33.8% disagree and 23.2% are neutral. Currently, the Malaysian government announced that a cash rebate of up to RM4,000 will be given to residential customers who submit Net Energy Metering (NEM) applications to Sustainable Energy Development Authority (SEDA) Malaysia from April 1, 2024, onwards and successfully commission their solar PV system installations with TNB (https://www.tnb.com.my/solar).

DISCUSSION

Several obstacles hinder renewable energy systems implementation. Based on the data analysis, the substantial initial costs associated with solar panels and RE systems are barriers that prevent families from adopting renewable energy solutions. The high cost of solar energy installation at startup continues to be an obstacle for low- and middle-income families who want to benefit from long-term electricity savings. The lack of affordable financing options through subsidies and low-interest loans prevents residents from adopting solar energy because they need financial backing for their transition (Sarker et al. 2023; Jager 2006).

Technical or design-wise, some of the residence's rooftops are unsuitable for solar panel installation. Some are due to structural issues, inadequate space availability, and shading concerns. The uncertainty of solar energy reliability during periods of low sunlight causes people to doubt its performance (Roshdan et al. 2022). The uncertain nature of net metering policies and unclear investment returns create grid integration challenges (Cruz 2018), which prevent residents from knowing how their excess solar-generated electricity is managed.

Adopting renewable energy faces additional difficulties because of existing policies and regulatory hurdles. The combination of confusing government policies and slow bureaucratic permitting processes alongside insufficient incentives prevents residents from adopting solar power

systems (Cruz 2018). In addition, the low level of social acceptance and lack of public understanding of RE's importance can pose major obstacles to RE adoption. People in these communities lack knowledge of solar energy's advantages while holding incorrect beliefs about its pricing and operational effectiveness. People tend to resist new technologies because they need to see broad acceptance of these systems within their community before they will adopt them. The implementation of renewable energy faces obstacles because insufficient outreach activities allow misinformation to persist alongside public doubts about renewable energy systems. The elimination of these barriers needs financial support along with educational campaigns and improved policies and technological innovations. Government financial support through subsidies, low-interest loans and tax benefits may ease economic burdens, and informative workshops will increase residents' understanding of renewable energy systems and their importance. The adoption of renewable energy solutions by more households would increase when the adoption process becomes easier to access and when policies are simplified and the importance of RE towards energy independence is better understood. Overcoming these obstacles will enable more residences to advance sustainable energy adoption, thus supporting Sabah's renewable energy targets.

CONCLUSION

The study of renewable energy adoption in the case study area of Kota Kinabalu shows that almost half of the residents sampled have adopted rooftop solar panels in support of government policies of RE and show a good understanding of the importance of RE towards environmental protection. The majority of the respondents have little detailed knowledge or are unaware of RE., however, their education level and level of awareness were not significant to the adoption of RE, i.e., the variables were not dependent. They view that future maintenance and financial affordability for initial installation remain a constraint to most residents. People living in Taman Sinar Bukit and Taman Sinar Baru show high levels of understanding regarding renewable energy's environmental advantages, economic benefits, and social values. People understand solar energy's ability to decrease power expenses while fighting climate change and achieving energy self-sufficiency. The widespread implementation of renewable technologies faces challenges from expensive initial costs to insufficient knowledge about financial benefits and structural system limitations.

       Properly designed government initiatives are instruments to overcome adoption of RE barriers. The financial subsidies, e.g., the SolaRIS scheme tax rebates and low-interest loans, serve as tools to ease the financial burden for households during their initial investments. Marketing renewable energy depends heavily on local governments to simplify regulatory processes and clear renewable energy objectives. Policies which require solar ordinances and offer grants for green infrastructure projects can help speed up renewable energy adoption. Municipalities can demonstrate leadership by establishing renewable energy demonstration programs that prove the cost advantages, benefits, and return on investment of these systems. The significance of this paper lies in its contribution to insights of potential RE users' awareness, acceptance, and adoption of solar energy technology which is relevant to the education and outreach efforts towards the Sabah Energy Roadmap and Master Plan 2040. Future research on solar panel adoption in Malaysia should focus on understanding the factors influencing adoption, evaluating the effectiveness of policies, and exploring the potential of integrating solar with other energy-efficient technologies.

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CONFLICT OF INTERESTS

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

AUTHORS' CONTRIBUTIONS

Ferdy Brian Amigo wrote and carried out the research; he conceptualised the central research idea, analysed data and provided the theoretical framework.

Siti Mazwin Kamaruddin reviewed, designed the analysis, and supervised the research progress; she also anchored the review and ensured the article was approved for submission.

REFERENCES

Bauner, C., & Crago, C. L. (2015). Adoption of residential solar power under uncertainty: Implications for renewable energy incentives. *Energy Policy*, *86*, 27-35.

Chapman, A. J., McLellan, B., & Tezuka, T. (2016). Residential solar PV policy: An analysis of impacts, successes and failures in the Australian case. *Renewable Energy*, *86*, 1265-1279.

Cruz, R. B. (2018). The politics of land use for distributed renewable energy generation. *Urban Affairs Review*, *54*(3), 524-559.

Fauzi, M. A., Abidin, N. H. Z., Suki, N. M., & Budiea, A. M. A. (2023). Residential rooftop solar panel adoption behavior: Bibliometric analysis of the past and future trends. *Renewable Energy Focus*, *45*, 1-9.

Gajanayake, R., Johnson, L., Daronkola, H. K., & Perera, C. (2024). Impact of households' future orientation and values on their willingness to install solar photovoltaic systems. *Sustainability*, *16*(18), 8143.

Jager, W. (2006). Stimulating the diffusion of photovoltaic systems: A behavioural perspective. *Energy Policy*, *34*(14), 1935-1943.

Karasmanaki, E., Ioannou, K., Siakas, G., Galatsidas, S., & Tsantopoulos, G. (2025). A Qualitative Analysis of Factors Leading to the Adoption of Residential Photovoltaics. *Energies*, *18*(8), 2071.

Khoo, T. J., Chai, T. Q., & Ha, C. Y. (2023). Readiness of Malaysian on sustainable development in solar energy application. *International Journal of Sustainable Construction Engineering and Technology*, *14*(1), 189-201.

Moussa, R. K. (2023). Does solar home system promote entrepreneurship in off-grid areas?. *Heliyon*, *9*(1).

Mulyani, Y. P., Saifurrahman, A., Arini, H. M., Rizqiawan, A., Hartono, B., Utomo, D. S., … & Harefa, W. D. (2024). Analyzing public discourse on photovoltaic (PV) adoption in Indonesia: A topic-based sentiment analysis of news articles and social media. *Journal of Cleaner Production*, *434*, 140233.

Roshdan, W. N. A. W., Jarimi, H., Al-Waeli, A. H., Razak, T. R., Ahmad, E. Z., Syafiq, U., … & Sopian, K. (2024). Assessment of flat, symmetric, and asymmetric CPC photovoltaic thermal air solar collectors for building façades using artificial Neural Network Modelling. *Journal of Building Engineering*, *98*, 111221.

Roshdan, W. N. A. W., Jarimi, H., Al-Waeli, A. H., Ramadan, O., & Sopian, K. (2022). Performance enhancement of double pass photovoltaic/thermal solar collector using asymmetric compound parabolic concentrator (PV/T-ACPC) for façade application in different climates. *Case Studies in Thermal Engineering*, *34*, 101998.

Schelly, C. (2014). Residential solar electricity adoption: What motivates, and what matters? A case study of early adopters. *Energy Research & Social Science*, *2*, 183-191.

Wilkinson, S., John, M., & Morrison, G. M. (2021). Rooftop PV and the renewable energy transition; a review of driving forces and analytical frameworks. *Sustainability*, *13*(10), 5613.

Sabah Energy Roadmap and Master Plan 2040 (Sabah Energy RAMP 2040). Energy Commission of Sabah (EcoS) (2023).

Sarker, M. T., Haram, M. H. S. M., Ramasamy, G., Al Farid, F., & Mansor, S. (2023). Solar photovoltaic home systems in Malaysia: A comprehensive review and analysis. *Energies*, *16*(23), 7718.

Shakeel, S. R., Yousaf, H., Irfan, M., & Rajala, A. (2023). Solar PV adoption at household level: Insights based on a systematic literature review. *Energy Strategy Reviews*, *50*, 101178.

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