

# Usage of Renewable Energy in Malaysia Household for Sustainable Environment

Moe Shwe Sin<sup>1</sup> & Abraham A/L Methews<sup>1</sup>

<sup>1</sup>Faculty of Business, Economics and Social Development, Universiti Malaysia, Terengganu, 21030 Kuala Nerus, Terengganu, Malaysia

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## ABSTRACT

This study investigates the adoption of renewable energy in Malaysian households, emphasizing its role in fostering a sustainable environment amidst the challenges posed by the depletion of non-renewable energy resources. Malaysia's continued reliance on fossil fuels such as coal, petroleum, and natural gas has resulted in significant environmental degradation, including greenhouse gas emissions, climate change, and ecosystem damage. The research examines how scarcity of non-renewable resources influences household decisions, the environmental consequences of current energy consumption patterns, and the low awareness levels surrounding renewable energy alternatives. Using a mixed-method approach, data were collected through surveys from 150 households across urban and rural areas, with key variables including education, income, age, and gender used to analyze willingness to pay (WTP) for renewable energy solutions. The findings indicate a strong correlation between awareness levels, socioeconomic status, and the readiness to adopt sustainable energy practices. However, barriers such as limited knowledge, financial constraints, and infrastructure issues persist. The study concludes that addressing these challenges through targeted awareness campaigns, educational programs, and policy incentives is critical to promoting household-level adoption. By evaluating these factors, the research contributes valuable insights for policymakers aiming to transition Malaysia's energy landscape toward sustainability, enhance energy security, and meet global environmental commitments. The outcome supports future research and real-world applications in developing effective strategies for renewable energy integration.

**Keywords:** Energy Adoption, Sustainable Environment, Non-renewable Resource Depletion, Willingness to Pay (WTP).

## INTRODUCTION

**Background and Context:** Renewable energy refers to natural energy sources such as sunlight, wind, hydro, biomass, and geothermal that replenish over time. Unlike fossil fuels—which are finite and harmful to the environment—renewable energy is sustainable and eco-friendly. As the world faces increasing energy demands and the urgent threat of climate change, renewable energy offers a solution to reduce greenhouse gas emissions, protect ecosystems, and improve energy security. Economically, it fosters innovation, creates job opportunities, and supports local development. Therefore, raising awareness about renewable energy is not just important but a moral responsibility for a healthier planet.

Malaysia is rich in renewable energy sources that align with its sustainability goals. Solar, biomass, hydropower, and wind are key contributors to its green energy potential. Malaysia's tropical climate offers consistent solar radiation, making solar energy particularly viable. Solar farms like those in Sepang produce clean electricity. Biomass, especially from palm oil and rice husks, is also promising due to Malaysia's strong agricultural base. Hydropower is effective in high-rainfall areas like Sarawak, with major projects like the Bakun Hydroelectric Dam generating up to 2,400 MW of electricity. Wind energy, though less developed, is being explored in coastal areas.

In contrast, Malaysia's heavy use of non-renewable energy such as coal, petroleum, and natural gas has caused major environmental issues. Burning fossil fuels releases significant amounts of CO<sub>2</sub>, contributing to global warming and environmental degradation. The extraction of these fuels leads to habitat loss, pollution, and ecological damage, especially from offshore oil spills and coal waste. Recognizing these dangers, Malaysia has introduced policies like the Renewable Energy Act 2011 and the Feed-in - Tariff (FiT) system to increase renewable energy adoption.

The Bakun Hydroelectric Dam, located on the Balui River in Sarawak, is a crucial site in Malaysia's renewable energy landscape. Its high rainfall and river systems make it ideal for hydropower. The dam powers cities like Kuching and Bintulu and supports industries such as aluminum smelting. It also offers export opportunities to neighboring countries. Sarawak is also beginning to develop solar power in remote and rural areas that are off the national grid. Solar PV systems supply electricity to homes, schools, and clinics, often in combination with biomass or micro-hydro systems.

**Problem Statement:** Malaysia continues to depend on non-renewable energy sources to meet industrial and household needs. These finite resources are depleting, resulting in increased costs and dependence on imports, raising energy security concerns. The study seeks to understand whether this scarcity encourages Malaysian households to shift to renewable energy alternatives such as solar and wind power. Additionally, non-renewable energy has caused significant environmental degradation—air pollution, greenhouse gas emissions, and habitat destruction. Identifying these specific environmental impacts and assessing how renewable energy like solar or bio-mass can reduce the household environmental footprint is a key aim of this research.

Despite global efforts and government incentives, many Malaysian households remain unaware of the benefits and technologies associated with renewable energy. This lack of awareness limits adoption. The study explores the causes of this knowledge gap—limited access to information, poor education, and cultural resistance—and suggests solutions such as awareness campaigns and education programs.

**Purpose of the Study:** The goal of this research is to analyze how the scarcity of non-renewable energy, environmental impacts, and low awareness levels influence the adoption of renewable energy in Malaysian households. It aims to: Understand the barriers and motivators of renewable energy adoption; Examine the environmental benefits of switching to sustainable sources; Recommend effective strategies to improve awareness and promote clean energy practices for a more sustainable and secure energy future in Malaysia.

### Research Questions and Objectives:

1. How does the scarcity of non-renewable energy resources affect the adoption of renewable energy in Malaysian households?
2. What are the environmental consequences of relying on non-renewable energy, and how can household renewable energy adoption mitigate these effects?
3. What factors contribute to the lack of awareness about renewable energy among Malaysian households, and how can this be improved?

Based on the research questions encountered, the study objectives are as follow:

1. To investigate how non-renewable resource scarcity influences renewable energy adoption.
2. To evaluate environmental consequences of fossil fuel usage and how renewable can reduce these impacts.
3. To identify awareness barriers and propose strategies to increase renewable energy adoption in Malaysian households.

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## LITERATURE REVIEW

The literature review provides a comprehensive understanding of past studies related to renewable energy adoption in Malaysia. It highlights the potential of renewable sources, especially solar energy, in addressing environmental challenges and promoting sustainability. By reviewing previous research, this chapter establishes the theoretical framework, identifies knowledge gaps, and supports the methodological approach of the study.

**Overview of Renewable and Non-Renewable Energy Resources:** Renewable energy sources like solar, wind, hydro, tidal, and geothermal use natural processes that regenerate over time. They offer sustainable alternatives to finite fossil fuels. Solar energy is particularly suitable for Malaysia due to its tropical climate, which provides consistent sunlight. Solar PV systems—ranging from rooftop panels to large solar farms—can reduce greenhouse gas emissions, ensure energy independence, and enhance resilience. Malaysia's increasing energy demand, driven by industrialization and urbanization, underscores the urgency of shifting to clean energy. Solar energy stands out as a highly viable solution for Malaysian households, promoting sustainability and reducing fossil fuel dependency.

Malaysia receives approximately 400–600 MJ/m<sup>2</sup> of solar energy monthly. With a solar potential of about 6,500 MW, Malaysia introduced the Feed-in Tariff (FiT) policy in 2011 to encourage adoption. Despite this, solar utilization remains low. This policy aims to accelerate the shift from fossil fuels and reduce environmental impact. Malaysia is also a top biodiesel producer, especially from palm oil. Biodiesel can reduce carbon emissions by up to 78%, offering an alternative for the transportation sector. Solar PV systems are increasingly encouraged, but low awareness and affordability, especially among the B40 group (low-income households), hinder adoption. Environmental concerns also drive the need for change. Burning fossil fuels is the largest contributor to greenhouse gas emissions in Malaysia. Research supports that solar and biomass energy can replace fossil fuel use in rural areas, promoting sustainable development.

Awareness remains a critical issue. Although some groups show basic understanding, most Malaysian households lack detailed knowledge about the environmental and economic benefits of renewable energy. Educational programs and government incentives are essential to address this gap. Additionally, coastal areas such as Alor Setar have strong solar energy potential. Integration of solar technologies like heliostat fields and storage systems can enhance energy reliability, reduce carbon emissions, and contribute to industrial processes such as hydrogen liquefaction.

**Environmental Impact of Energy Choices:** Malaysia has made policy advancements through the Renewable Energy Act 2011 and FiT system. These policies support the national goal of reaching 20% renewable energy by 2025. Despite this, high installation costs and poor education still challenge public awareness and adoption. The reliance on fossil fuels continues to worsen climate change and air pollution. Solar energy, particularly in rural and coastal areas, can help reduce Malaysia's carbon footprint. Research shows that integrating solar PV with thermal energy storage can mitigate emissions and align with global sustainability targets.

For instance, Nur Atirah Ibrahim et al. (2024) highlight the need for resilient infrastructure and technical readiness for large-scale solar systems. Malaysia's climate allows for average monthly solar radiation between 400–600 MJ/m<sup>2</sup>, suitable for widespread solar deployment. Other studies emphasize that renewable energy, including hydrogen production through solar processes, is vital for long-term sustainability. These methods contribute to Malaysia's aim to become carbon neutral by 2050. Wei et al. (2024) emphasize the importance of increasing awareness and overcoming technological barriers such as high costs. They propose public education campaigns and financial incentives to boost household-level solar and hydrogen system adoption.

**Awareness and Adoption of Renewable Energy:** Salman Ahmad and Razman Mat Tahar used the Analytic Hierarchy Process (AHP) to rank renewable energy options based on technical, economic, social, and environmental criteria. Their study found solar energy to be the most favorable, followed by biomass. Hydropower and wind were ranked lower due to technical and environmental limitations. This prioritization is valuable for guiding national energy planning. Similarly, Ahmad and Tahar (2014) found that solar energy's high economic viability and shorter lead times make it an ideal choice. Their study supports the need for diversifying Malaysia's energy mix and reducing reliance on fossil fuels.

Tóth et al. (2018) studied soil CO<sub>2</sub> emissions and highlighted how sustainable agricultural practices like no-tillage can mitigate environmental degradation. Though not directly linked to energy, the study reinforces the broader benefits of sustainable practices in reducing carbon emissions. Zen et al. (2021) examined carbon footprints of households in Iskandar Malaysia. Urban households were found to emit more CO<sub>2</sub> due to higher income and energy use. This study calls for policy interventions to promote low-carbon lifestyles, especially in urban areas.

Lastly, Hamed et al. (2023) explored solar-driven pyrolysis of palm oil biomass in Sabah. Tawau, with its high solar irradiance and palm plantations, was identified as a strategic location. This innovation could reduce waste and support energy transition using existing natural resources. This literature review demonstrates the immense potential of solar and biomass energy in Malaysia and the importance of education, policy, and innovation in accelerating their adoption. It provides a strong foundation for your study on household-level renewable energy adoption for environmental sustainability.

## DATA AND METHODOLOGY

This chapter presents the results of the descriptive analysis conducted using data collected from 150 Malaysian households through a structured Google Form survey. The analysis focuses on understanding respondents' awareness, perception, and attitudes toward renewable energy, the scarcity of non-renewable resources, environmental impacts, and their willingness to adopt clean energy alternatives. This study emphasizes interpreting the frequency distributions, percentages, and visual insights provided by pie charts and bar graphs in the survey results.

**Overview of the Survey Method:** The data were gathered from 150 respondents representing various age groups, genders, income levels, and educational backgrounds. The structured questionnaire was divided into four sections: 1. Demographic Information; 2. Scarcity of Non-Renewable Energy Resources; 3. Environmental Consequences of Non-Renewable Energy; and 4. Awareness and Adoption of Renewable Energy. Each section was designed to assess participants' levels of understanding, perception, and behavior toward Malaysia's current energy scenario and renewable energy alternatives. Responses were recorded in percentage formats and analyzed using descriptive tools such as pie charts and bar graphs generated via Google Forms. The respondents' information and perception of the respondents upon the renewable energy use in Malaysia are evaluated with the structured questionnaire with the following format.

### Section A: Demographic Profile of Respondents

Understanding the gender balance is important, as different demographic groups may respond differently to renewable energy awareness and implementation strategies. For example, from the gender distribution chart, 63.3% of respondents were female and 36.7% male. This shows that more women participated in the survey, possibly indicating a greater concern or interest in environmental and household energy matters among female participants.

### Section B: Scarcity of Non-Renewable Energy Resources

In Section B, respondents were asked about their perception of fossil fuel scarcity. A majority agreed that non-renewable energy sources such as coal, petroleum, and natural gas are running out. This strong

response indicates an overall public awareness that fossil fuels are finite. Furthermore, most respondents acknowledged that overreliance on these sources would negatively affect future generations, highlighting an intergenerational perspective on sustainability.

When asked whether rising fossil fuel costs have affected their daily lives, many respondents responded affirmatively, indicating that households are beginning to feel the financial pressure caused by global energy price fluctuations. This awareness creates a potential motivation to explore cheaper and more stable energy alternatives like solar power. Similarly, when asked if Malaysia relies too much on fossil fuels, the majority said yes, reflecting a public understanding of the country's current energy dependency and the need for diversification. Finally, when questioned if fossil fuel scarcity would encourage them to adopt renewable energy, the majority again responded positively. This indicates that resource depletion acts as a strong psychological and practical motivator towards renewable energy adoption.

### **Section C: Environmental Consequences of Non-Renewable Energy**

Section C explored environmental concerns tied to fossil fuel usage. The results show that most respondents were well aware of the environmental impacts caused by burning fossil fuels. A majority acknowledged that fossil fuels contribute significantly to climate change, air and water pollution. These responses reflect a strong baseline of knowledge about the environmental degradation linked to conventional energy use.

Interestingly, when asked whether they had noticed environmental degradation in their own areas, the responses were mixed. Some reported visible environmental harm, while others did not. This variation could be due to geographic factors of urban or industrial areas may face more pollution than rural zones. Regardless, a majority believe that Malaysia's current energy practices are harming the environment.

Most significantly, an overwhelming number of respondents believed that switching to renewable energy sources could help reduce environmental damage. This finding reveals an optimistic, and solution-focused mindset among the public. It suggests that Malaysians are not only aware of the problem but they are also open to cleaner solutions when presented with viable options.

### **Section D: Awareness and Adoption of Renewable Energy and Willingness to Pay (WTP) for maintaining Environment**

Section D focused on assessing the public's awareness of and readiness to adopt renewable energy. Most respondents confirmed that they had heard of renewable energy, particularly solar and wind energy, indicating that public exposure to the concept is widespread. However, when asked about knowledge of specific government incentives like Feed-in Tariff (FiT), most respondents said they were unaware. This shows a gap in communication between policy initiatives and public outreach, which needs to be addressed to encourage adoption.

When asked if they would consider installing solar panels or similar clean energy systems at home, a majority responded positively. This reveals a high willingness to adopt renewable technologies. However, when asked what prevents them from doing so, common barriers included the high cost of installation, lack of technical knowledge, and insufficient government support. These findings show that although the public is interested, practical challenges prevent widespread adoption. Educational influence was also examined. Respondents overwhelmingly agreed that schools should teach more about renewable energy. This indicates a strong belief that environmental values should be nurtured from a young age. It also emphasizes the long-term importance of education in achieving national sustainability goals.

When asked if they believed renewable energy could replace fossil fuels in the future, the majority responded positively, expressing optimism in the potential of clean energy technologies. Lastly, nearly

all respondents stated that they would support national policies promoting renewable energy. This indicates strong public backing for clean energy reforms and shows that the population is ready to align with future sustainability initiatives if policies are inclusive and well-communicated.

### Descriptive Analysis on the Respondents information and Perceptions on Renewable Energy Use and Environmental Impact.

The descriptive analysis of this survey reveals that Malaysian households have a considerable level of awareness regarding the depletion of non-renewable resources and the environmental damage caused by their usage. Respondents also show a generally positive attitude toward renewable energy, expressing both interest and support for its adoption. However, cost, lack of technical knowledge, and weak policy outreach remain major barriers. The findings strongly suggest that government and institutional efforts should focus on improving awareness, reducing financial barriers, and integrating renewable energy education into schools and communities. This can create a more informed and motivated public ready to transition toward a cleaner and more sustainable energy future.

## RESULTS AND DISCUSSION

### Section A: Respondent Information

The majority of respondents fall into the 21–30 age group, indicating that young adults are more actively participating in topics related to energy and sustainability. This age group is often more exposed to education and media awareness on environmental issues. A smaller number of respondents come from older age groups (41+), which may reflect generational gaps in renewable energy awareness and technology adoption. The majority of the respondents are female (63.3%), while males make up 36.7% of the sample. This gender distribution may influence the perspectives and responses in the study, especially when gender is one of the variables analyzed in relation to awareness or willingness to adopt renewable energy.

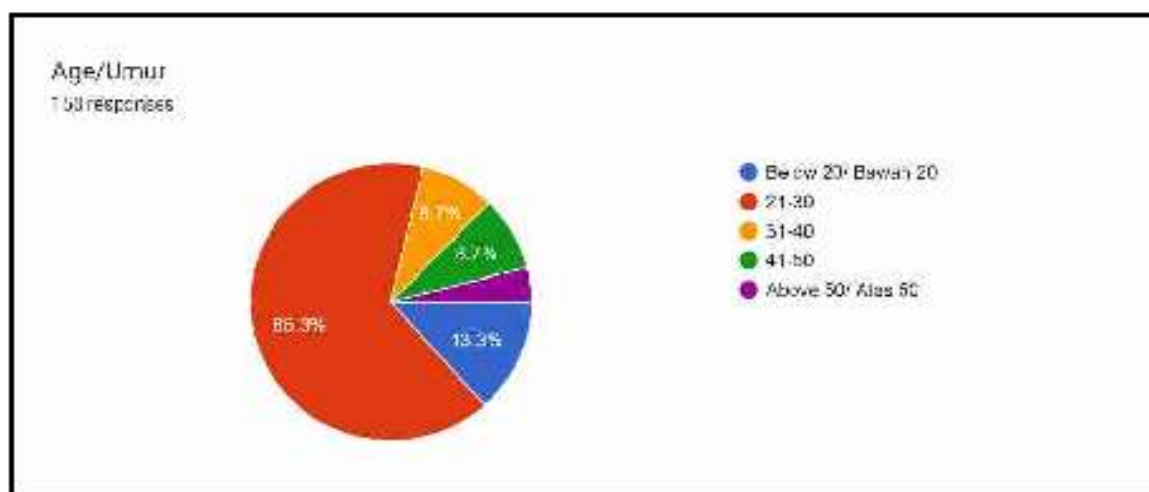


Figure 1: Age Distribution of respondent

Most respondents likely hold a bachelor's degree or higher, which suggests a more educated sample that may have better understanding of renewable energy concepts. This could influence their awareness and willingness to adopt renewable energy technologies. Fewer respondents with only primary or secondary education may imply a knowledge gap that needs to be addressed in awareness campaigns. If the largest portion is in the RM 3001–6000 range, this represents the middle-income group, which is a crucial demographic for renewable energy adoption. They may have moderate purchasing power but still face cost concerns, especially regarding the initial investment in technologies like solar panels. Lower-

income households may be more concerned about immediate costs, while higher-income groups could be more flexible in adopting green technologies. If most respondents are from urban areas, it suggests greater access to information, infrastructure, and renewable energy solutions. Suburban and rural areas might face more logistical and infrastructural challenges, but also represent key areas for targeted government incentives and off-grid solutions such as solar PV systems.



Figure 2: Education levels of the respondents

## Section B: Scarcity of Non-Renewable Energy Resources

The majority of respondents indicated that they are aware of the limited availability of fossil fuels in Malaysia, highlighting a strong public consciousness of energy issues. This awareness suggests a foundation for future educational or policy efforts to promote renewable alternatives, as most participants recognize the country's dependency on finite energy sources.

Most respondents acknowledged experiencing a rise in electricity costs linked to fossil fuel depletion, though some reported only slight increases. This perception indicates a public sensitivity to cost implications of non-renewable energy reliance, which can be a powerful motivator for adopting cost-stable renewable energy sources

The responses were largely in agreement, with many either strongly agreeing or agreeing that the scarcity of non-renewable energy promotes the use of renewable alternatives. This implies that public understanding connects energy scarcity with the urgency of transitioning to sustainable sources, reinforcing support for renewable energy adoption.

The most common concerns expressed were rising electricity costs and environmental degradation, followed by energy insecurity. These concerns reflect a multifaceted awareness of the risks associated with over-reliance on fossil fuels, emphasizing both economic and ecological consequences. Among the 150 of respondents, the respondents answered on the question of "4.

What are your concerns regarding the depletion of non-renewable energy resources?" and most of the Malaysian people are facing the consequences of (i) Rising electricity costs (67.3% of respondents), (ii) Energy insecurity (49.3% of respondents) and (iii) Environment degradation (51.3%). And, concerning with the policy matter, a strong majority indicated that government incentives would motivate them to adopt renewable energy. This response underscores the critical role of policy interventions and financial support in driving household-level transitions to cleaner energy sources.

Table 1: People’s Perception on Scarcity of Renewable Energy Resources and Consequences

| Items                                                                                                             | Responses on Scarcity of Non-renewable Energy Resources |              |             |                |       |         |          |                   |
|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|--------------|-------------|----------------|-------|---------|----------|-------------------|
|                                                                                                                   | Strongly Yes                                            | Slightly Yes | Not Sure/No | Strongly Agree | Agree | Neutral | Disagree | Strongly disagree |
| 1. Are you aware the limited availability of fossil fuel (coals, oil, natural gas) in Malaysia?                   | 90.7%                                                   | 9.3%         | -           |                |       |         |          |                   |
| 2. Have you experienced any increases in electricity costs due to the decreasing of fossil fuel?                  | 39.3%                                                   | 49.3%        | 11.3%       |                |       |         |          |                   |
| 3. Do you believe the scarcity of non-renewable energy resources encourage the use of renewable energy resources? |                                                         |              |             | 36%            | 39.3% | 20%     | 3%       | 2%                |
| 3. Would government incentives encourages you to adopt renewable energy usage?                                    | 60.7%                                                   | 26.7%        | 12.7%       |                |       |         |          |                   |

### Section C : Environmental Consequences of Non-Renewable Energy

Most respondents either agreed or strongly agreed that fossil fuel use contributes significantly to environmental problems in Malaysia. This reflects high public awareness of the environmental impact of energy sources and aligns with global concerns regarding carbon emissions and climate change. Air pollution and climate change were the top concerns, followed by biodiversity loss and water contamination. These results highlight that the public perceives fossil fuel use as a major driver of various environmental threats, particularly those affecting air quality and climate stability.

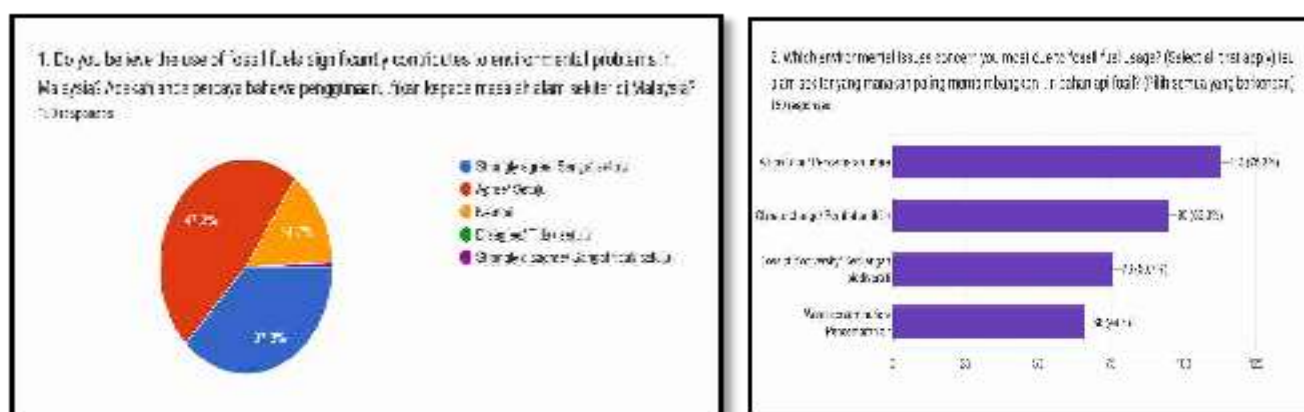


Figure 3: Awareness of local environmental degradation and Perceived environmental issues caused by fossil fuels

A majority of participants believe that renewable energy can help mitigate environmental degradation. This indicates a strong public association between clean energy and environmental restoration, reinforcing the need for educational campaigns and infrastructure investment. Responses were mixed, with many indicating they had not observed renewable energy solutions in their community. This

suggests a potential gap between awareness and implementation, pointing to the need for visible, community-based renewable energy projects.

Lowering greenhouse gas emissions was identified as the most effective benefit of renewable energy, followed by conserving water and reducing deforestation. This illustrates that respondents understand the broad environmental advantages of renewable adoption, especially in terms of climate impact

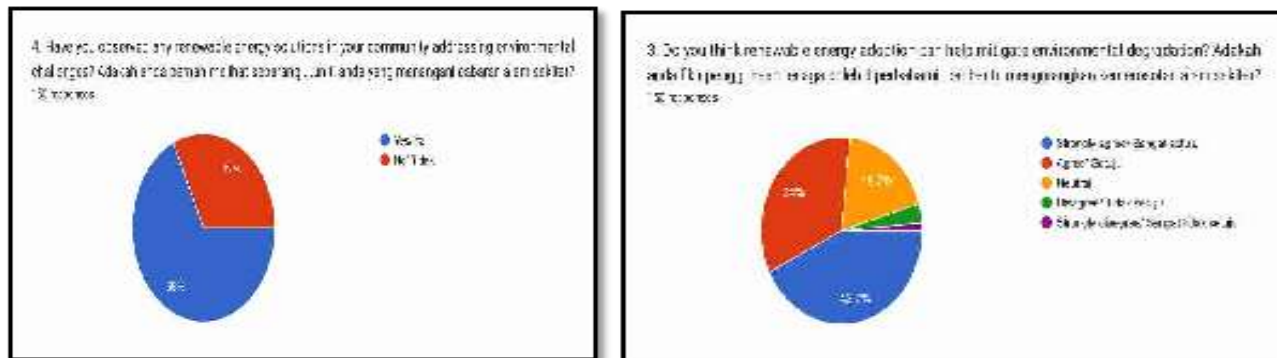


Figure 4: Roles of renewable energy and Visibility of solutions in local communities

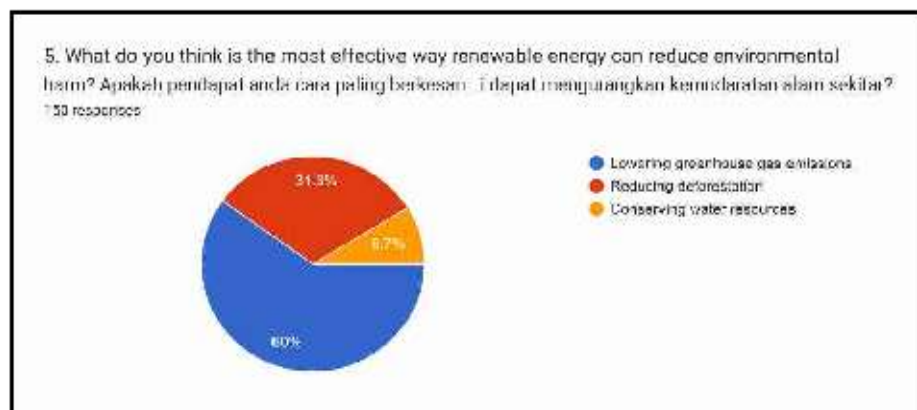


Figure 5: Perceived environmental benefits of renewable energy

## Section D: Awareness and Adoption of Renewable Energy

Most respondents reported being familiar with renewable energy options, indicating successful public dissemination of information, although there is still room for improving knowledge among less-informed groups. Government campaigns and social media were the most cited sources of initial awareness, followed by schools/universities and family/friends. This highlights the influential role of media and educational institutions in shaping renewable energy perceptions.

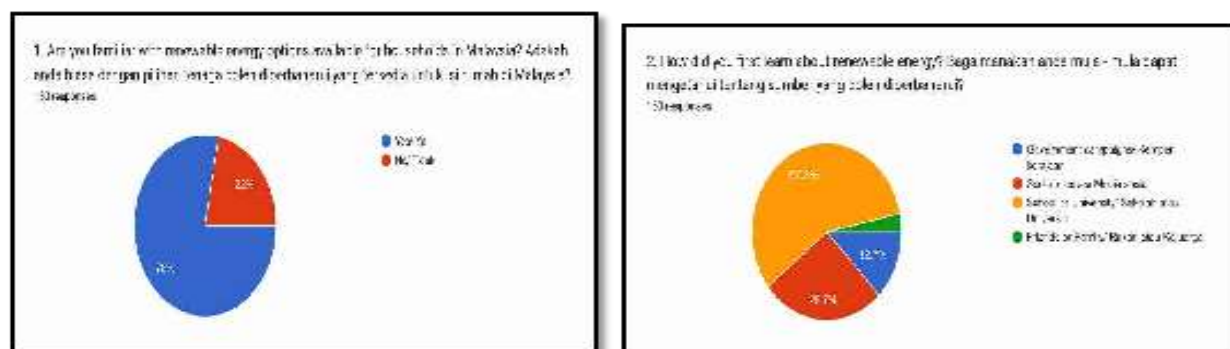


Figure 6 : General awareness on Sources and Types of renewable energy information

High initial costs and lack of knowledge were the most significant barriers, with limited availability and lack of government support also noted. These findings emphasize the need for financial incentives, awareness programs, and infrastructure development to enhance renewable energy uptake.

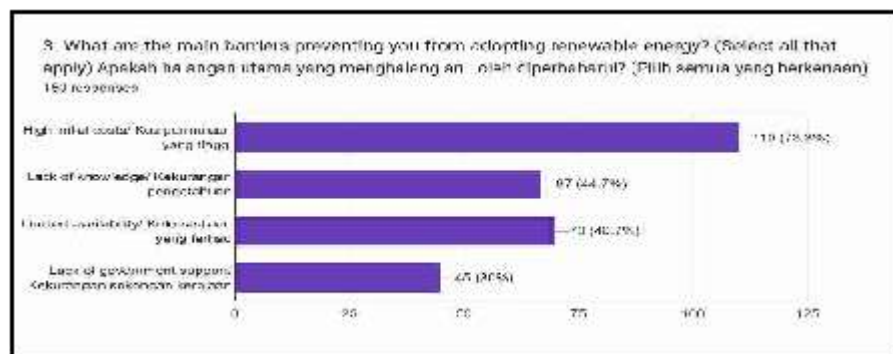


Figure7 : Barriers to adopting renewable energy at household level

Financial incentives and media campaigns were identified as the most effective strategies to improve awareness. Respondents believe that both economic motivation and consistent messaging can encourage broader public interest and adoption. All 150 respondents expressed willingness to invest in renewable energy technologies if better information and support were provided. This shows that increasing educational efforts and technical support could lead to greater public investment. Most participants indicated a readiness to be involved in clean energy initiatives, reflecting a proactive attitude toward environmental responsibility and energy sustainability. Among those willing to participate, RM30 and RM45 were the most common preferred payment ranges, suggesting a moderate willingness to contribute financially to renewable efforts, provided the costs are reasonable and justifiable.

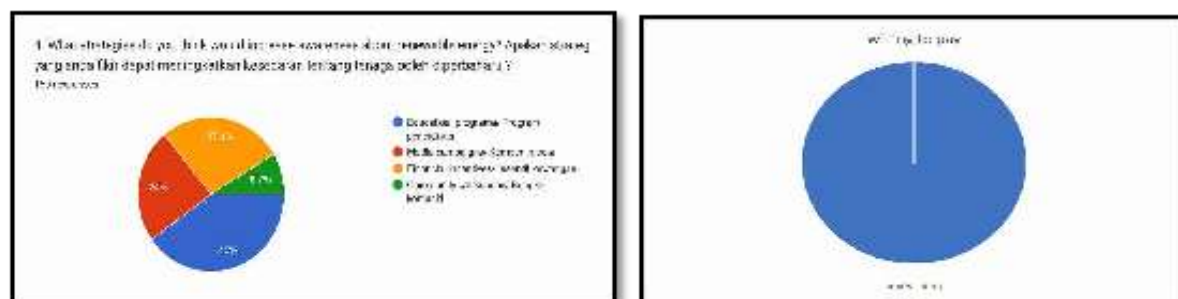


Figure 8: Suggested Strategies to improve awareness and Willingness to invest in renewable energy systems

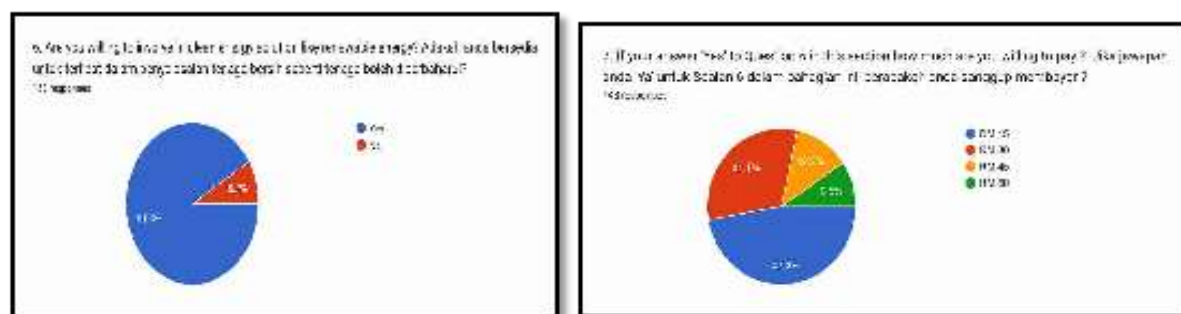


Figure 10: Readiness to participate in clean energy programs and Willingness to pay (WTP) range for renewable energy solutions

## CONCLUSION

This study explored the adoption of renewable energy in Malaysian households within the context of resource scarcity and environmental sustainability. The findings revealed that the majority of respondents are aware of the limited availability of fossil fuels in Malaysia and recognize the negative consequences of overdependence on these non-renewable sources. Respondents expressed concern over rising electricity costs and the environmental degradation resulting from fossil fuel usage, including air pollution, climate change, and biodiversity loss. This general awareness forms a solid foundation for encouraging a shift toward renewable energy adoption at the household level.

However, despite this awareness, actual implementation and use of renewable energy technologies remain low. Key barriers include high initial investment costs, insufficient infrastructure, and a lack of comprehensive understanding of renewable energy benefits and technologies. Many households, especially in lower-income and rural groups, struggle with affordability and access to accurate information. These obstacles hinder the transition to clean energy, despite growing public concern and environmental consciousness.

The study also found that demographic factors such as education, income, age, and gender significantly influence willingness to pay (WTP) for renewable energy solutions. Households with higher education and income levels showed greater readiness to invest in sustainable technologies. This highlights the importance of tailoring awareness campaigns and support systems to different socioeconomic groups, ensuring that no community is left behind in Malaysia's energy transition.

Government incentives were identified as a crucial motivator for renewable energy adoption. Respondents indicated that financial support, along with educational programs and media campaigns, would significantly increase their likelihood of adopting renewable energy systems. Moreover, while most respondents are aware of renewable options and express a desire to participate in clean energy initiatives, many have not observed such solutions within their communities, indicating a gap between policy intent and visible local implementation.

In conclusion, this study underscores the urgent need for integrated strategies that combine public education, financial assistance, and policy support to promote household-level adoption of renewable energy in Malaysia. Addressing the barriers identified especially those related to cost and information will be essential for building a more sustainable and secure energy future. The insights provided can guide policymakers and stakeholders in designing targeted interventions to enhance renewable energy integration, reduce environmental harm, and meet national and global sustainability goals.

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