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EXPLORING THE POTENTIAL OF SOLAR POWER FOR RESIDENTIAL USE IN MALAYSIA: INSIGHTS FROM SOLAR COMPANIES AND LOCAL AUTHORITIES

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Abstract

With extremely strong solar radiation during the year, Malaysia has the greatest potential for solar-energy implementation. However, despite the widespread interest in the country, solar energy is still not widely utilized in residential buildings. Thus, this research aimed to identify the implementation and challenges of implementing solar energy in residential buildings and strategies to promote solar energy in Malaysia. Thirteen responses from representatives of solar companies in Malaysia were obtained through interviews. Through the research results, the implementation and challenges faced in implementing solar technologies were identified, together with strategies to promote solar technology. High installation costs, lack of awareness, and lack of incentive schemes are the barriers that prevent people from installing solar technology, as revealed by the interviews. Therefore, the government should make greater efforts to promote solar energy to the public. Interviewees suggested successful financial incentive schemes, personal tax exemptions, and public awareness programs to attract consumer interest as ways to increase solar adoption. The findings of this research may be used to help the government develop policies to promote solar energy for electricity consumption in residential buildings.

Keywords: Solar energy, potential, residential buildings, companies, local authorities

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INTRODUCTION

Solar energy, often known as solar power, is produced by converting renewable energy from sunshine to electricity by using photovoltaics (PVs) or concentrated solar power, or by collecting heat from the sun (Kamaruzzaman et al., 2012). The year-round availability of sufficient sunlight in Malaysia is conducive to the development of solar energy (Mekhilef et al., 2012). Northern Malaysia and a few eastern regions have the highest potential for solar energy deployment owing to their year-round exposure to high levels of solar radiation (Kamaruzzaman et al., 2012). However, most of Malaysia's energy production continues to depend on limited fossil fuel resources, such as oil, coal, and natural gas, and only a minor amount of electricity is generated from renewable sources (Alam et al., 2016). Fossil fuels are non-renewable resources that emit greenhouse gases, which are highly polluting. Large amounts of carbon dioxide, also known as greenhouse gases, are released into the atmosphere when fossil fuels are burned, causing global warming. Global warming will cause the global average temperature to exceed 1.5°C, thereby causing increased sea level rise and extreme weather, which will lead to poor health, food shortages, and poverty for millions of people around the world (Schleussner et al., 2016).

Approximately 7.5 million of Malaysia’s total energy users are residential consumers (Abdullah et al., 2019). It may reduce greenhouse gas emissions by nearly 20% and avoid the use of fossil fuels by increasing the use of solar energy in the residential sector (Basri et al., 2015). Solar energy has seen tremendous growth amid growing concerns about climate change, but its implementation of solar energy is still in an early stage in Malaysia (Mekhilef et al., 2012). In order to support the use of solar energy, the Malaysian Government has implemented several incentives, programs, and strategies, including National Renewable Energy Policy, SURIA 1000 program, Feed-in Tariff (FiT) mechanism and Net Metering (NEM) Scheme (Kamaruzzaman et al., 2012). The FiT mechanism was introduced in 2011 but ended in 2017 and was replaced with NEM (Lau et al., 2022). With plentiful solar radiation and government initiatives, Malaysia still relies primarily on non-renewable resources for its energy needs despite the country's abundance of solar energy (Abdullah et al., 2019).

Thus, this research aimed to determine the implementation and challenges of solar energy technology, as well as the strategies to promote solar energy in Malaysian residential buildings. Owing to insufficient policy incentives and the absence of rules and regulations, the development of solar technology in Malaysia is trailing behind (Lau et al., 2022). To support the use of solar energy, it is necessary to understand how solar technology is implemented in residential buildings, and the Malaysian Government should take necessary action by promoting solar technology to the publics (Ho Soon Min et al., 2019).

LITERATURE REVIEW

Solar energy is a clean, renewable energy source that can power the world indefinitely and keep it habitable. In fact, the sun supplies our planet with more energy in one hour than the entire human population of the globe consumes in one year (Kabir et al., 2018). Malaysia has one of the highest solar utilization potentials because of its strategic location near the equator, which creates climatic conditions with sufficient sunshine throughout the year. Malaysia's monthly sun irradiation is predicted to be 4 kWh/m^2–5 kWh/m^2, which is suitable for the development of solar energy (Abdullah et al., 2019; Sahid et al., 2021). The hot and sunny climate of Malaysia offers a great opportunity for solar power (Kamaruzzaman et al., 2012).

The three primary methods for collecting solar energy are the Photovoltaic Energy System, which directly transforms sunlight into usable power: the utilization of the sun's thermal energy to power massive electrical turbines, known as Concentrated Solar Power (CSP); and hot water can be provided via a Solar Water Heating System, which collects thermal energy from the sun (Nadarajah Kannan & Divagar Vakeesan, 2016). Solar energy is regarded as a non-polluting, sustainable, and renewable source of energy (Hui & Kock, 2017). Solar energy has a favorable influence on the environment primarily by reducing carbon emissions and greenhouse gases, as it relies primarily on the sun (Kabir et al., 2018). In addition, solar energy is obtained for free, and anywhere can be used as long as sunlight shines (Shafie et al., 2011). With solar power, electricity bills can be significantly reduced (Khalil et al., 2017).

There are several limitations associated with solar technology, although it is very reliable. Previous research has established that high costs, lack of awareness, insufficient government incentives are the barriers that prevent people from installing solar technology (Florez-Perez & Ghazali, 2020; Kamaruzzaman et al., 2012; Mohd Zainal Abidin Ab Kadir et al., 2010; Muhammad-Sukki et al., 2011; Sen & Ganguly, 2017). The main barrier for the implementation of solar technologies that is seen in a vast majority of the literature reviews is the installation cost of these systems. Residents may be reluctant to invest in PV systems because of their high initial costs and the complexity of the technology required to operate them (Kamaruzzaman et al., 2012; Mekhilef et al., 2012). A study conducted by Florez-Perez and Ghazali (2020) found that most of the respondents agreed they would be interested in installing one if the government would subsidize the cost. Cost reduction is vital for solar energy technologies to become widely accepted. Therefore, more financial incentives are crucial for increase implementation of solar technologies among the residents.

Another barrier that must be overcome when implementing solar technology is the lack of interest and awareness among the residents. Muhammad-Sukki et al. (2011) indicated that residents in Malaysia have

inadequate knowledge and awareness of solar technology and government programs, particularly the benefits of installing solar panels and the long-term investments involved. The public generally ignores environmental and energy issues, because they assume that the government seek solutions when problems occur. Therefore, the government should take initiatives to ensure that customers are aware of renewable technologies and their benefits. As many consumers become more aware of environmental issues related to fossil fuels use, they become more willing to switch to green energy technologies.

High costs and lack of awareness can be concluded to be due to insufficient incentives and awareness programs. There is a strong push for solar power by the Malaysian Government and incentives are still lacking. The existing government programs do not have a high level of support to encourage users to shift to renewable energy (Florez-Perez & Ghazali, 2020). To ensure the successful implementation of solar projects, financial supports are essential to solar adopters. Similar net metering schemes exist in many countries, notably in the United States and several European countries, such as Italy, Belgium, Denmark, Greece and the Netherlands, to provide incentives for solar technology (Shahsavari & Akbari, 2018). Policy mechanisms such as FiT subsidies in Germany, Spain, Italy, France, Japan, China, the United States and other countries have played a considerable role in the promotion of solar technology (Shahsavari & Akbari, 2018). FiT can easily be associated with other support programs like tax credits or capital subsidies. Consequently, the government have to formulate a series of policies on solar energy development or introducing a significant support program in promoting solar energy adoption.

METHODOLOGY

To achieve the research objectives of this study, a qualitative research method was utilized. This approach is widely employed in social sciences to allow researchers to gain profound insights and knowledge about a topic (Edwards & Holland, 2013). Interviews, in particular, are commonly used in qualitative research, enabling researchers to engage in discussions with participants. This often results in a deeper understanding of the interviewees' opinions and experiences regarding specific issues.

The research gathered two types of data: primary and secondary. As noted by Sospeter (2020), primary data is derived from direct evidence. Therefore, interviews were chosen as the method for collecting data. The respondents included registered PV service providers and local authorities in Malaysia, ensuring a comprehensive perspective on the implementation of solar energy technologies in residential buildings. Additionally, Goundar (2012) mentioned that secondary data comes from existing documents and literature, also referred to as second-hand data. The researcher examined previous studies

and various sources like journals, websites, and government records to gather relevant information for this research (Sospeter, 2020).

For the primary data collection, two professional categories were targeted: local authorities and industry players. These professionals were selected to gain a comprehensive understanding of the development of the solar industry and its policies in Malaysia. A semi-structured interview method was employed to obtain more profound and insightful outcomes. Invitations for interviews were sent via the respondents' emails, sourced from their company's official websites. Out of 30 invitations, 13 received responses. The interviews were conducted using Google Meet, facilitating quicker and more convenient scheduling. With the participants' consent, the interviews were audio-recorded and transcribed. The entire conversation content was manually transcribed into text. The interview responses were then analyzed and organized according to various themes, with a summary of the responses presented in Table 2.

ANALYSIS AND DISCUSSION

Semi-structured interviews were conducted to better understand opinions of the implementations and challenges of implementing solar energy technology, as well as the strategies to promote solar energy in Malaysian residential buildings. The interview invitation was sent via the respondent's email, which was available on the official website of the respondent's company. A total of 30 invitations were sent out, of which 13 were replied. Table 1 indicates the respondents profession and classified into two categories: local authorities and PV service providers registered with SEDA. Every individual of the respondents has been given their own unique identifier in the form of an R number, where R stands for "respondent." Among all the respondents, six respondents have five years of working experience in the solar industry. The remaining respondents have 5 years of work experience. All respondents had sufficient experience and knowledge to participate in this research. The summary of the responses is portrayed in Table 2.

Table 1. Summary of the respondent profile (source: author)

Respondent	Position of Respondent	Service years	Department
R1	Assistant Director	6	Department of Strategic Communications
R2	Authorized Business Partner	2	Private Company
R3	Consultant	4	Private Company
R4	Director	10	Private Company
R5	Information Technology Manager	4	Private Company

Respondent	Position of Respondent	Service years	Department
R6	Head of sales coverage	4	Private Company
R7	General Manager	6	Department of Renewables
R8	Sales engineer	2	Private Company
R9	Assistant Director	1	Regional Office
R10	Analyst	2	Greenhouse Gas Advisory & Consultancy in Climate Action Group
R11	Director	9	Private Company
R12	Technical Specialist	8	Department of Energy Efficiency & Renewable Energy
R13	Analyst	7	Department of Energy Efficiency & Renewable Energy

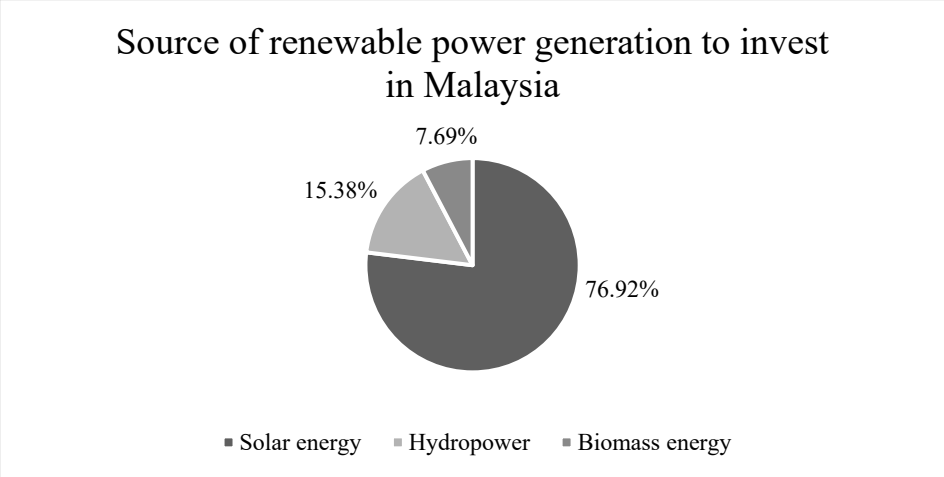

Figure 1. Source of renewable power generation to invest in Malaysia
Source: Author

Table 2. The summary of the responses

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13
Motivation to invest in a renewable energy technology													
Environment protection by reduce the carbon footprint			√	√	√	√	√			√	√	√	
Affordable and efficient		√						√					√
Free and unlimited sources	√		√						√		√		
Better ROI	√	√											
Benefits of installing solar energy technology													
Reduce electricity bills	√		√	√				√	√	√	√		√
Reduce electricity consumption					√		√					√	
Environment friendly		√		√		√					√	√	
Free and unlimited sources						√		√					
Factors encouraging people towards solar technology installation													
Low installation cost	√		√	√	√	√			√				
Incentive and scheme		√							√	√	√		√
Saving in electricity bills	√						√	√				√	
Main barriers preventing people from supporting solar technology													
High installation cost	√		√	√		√			√	√	√		
Lack of knowledge and awareness		√							√	√			√
High capital investment					√		√					√	
Tariffs and installation rules						√					√		
Lack of government initiatives			√	√				√		√			
Strategies promoting solar energy technology to households													
Through social media										√			
More incentive scheme	√	√	√			√	√		√	√	√	√	√
Awareness programs	√			√									
Tax exemption on individual					√			√	√				

Source: Author

The responses presented in Figure 1 indicated that solar energy might be the field in which to make the best investments in Malaysia. Because of its geographical location, Malaysia is well-suited for the generation of electricity from solar sources. The climate in Malaysia is one of the most favorable in the world for the creation of solar electricity. On average, it receives between six and eight hours of sunshine every day, contributing to its high solar radiation potential. This statement is supported by Kabir et al. (2018), who stated that Malaysia is located in the equatorial region, with daily average solar radiation as high as 4,500 kWh/m^2, as well as sufficient solar radiation; about 10 hours per day is most suitable for harnessing solar energy and developing solar technology. Thus, while comparing to the others source of renewable power generation, solar energy is the most suitable source of renewable power generation to invest in Malaysia based on the geographical location and climatic conditions with sufficient sunshine throughout the year for harnessing solar energy.

Most respondents indicated that their motivation to invest in renewable energy technologies was to protect the environment. The consumption of energy has a direct impact to the climate change. The burning of fossil fuels to generate electricity, such as coal and oil, will release large amounts of carbon dioxide which can causes climate change and global warming. By replacing or reducing the use of other energy sources that have a negative impact on the environment, solar energy can indirectly have a good effect on the environment. According to Shahsavari and Akbari (2018), solar energy contributes the least to global warming emissions and creates little to no pollution. Their findings confirmed this assertion. In conjunction with other renewable sources, it can help reduce carbon dioxide emissions from residential buildings, thereby reducing the severity of climate change.

The respondents stated that the number of solar installations has increased significantly over the past five years based on their experience. It is impressive to observe an increase in the use of solar technology. People are becoming aware of and implementing solar energy technology. Florez-Perez and Ghazali (2020) mentioned that if there is high awareness among the public, there is a push to implement solar technology and eliminate carbon emissions. It is encouraging to see that more individuals are becoming aware of environmental pollution and solar technology are putting it into practice. Kabir et al. (2018) stated that the use of solar energy can virtually eliminate all these environmental hazards. People are aware of the problems associated with global warming, and as a result, renewable energy technology is gaining attention. By increasing the use of solar power among the publics, the country is one step closer to achieving net-zero greenhouse gas emissions. Three to four tons of carbon dioxide emissions per year can be avoided by installing a standard solar panel system at a home (Khalil et al., 2017). The effects of global warming can be mitigated by

the reduction of carbon footprints, which in turn will contribute to the protection of the ecosystem.

Installing solar technology not only can protect the environment, but also reduce electricity bills. According to a study conducted by Kabir et al. (2018), homeowners and business owners no longer need to rely solely on electricity from utility companies when they install solar technology. Generating own electrical power will reduce the dependency on the utility company and result in instant savings on the cost of electricity. If the solar system produces more energy than the home or business actually consumes, excess power enters the utility grid. This excess energy can be sold to a local power company, thus making a profit.

However, high installation costs are the most highlighted main barriers identified by the interviewees. Many authors also have identified the high cost and low efficiency of solar energy technologies as the most significant barrier in relation to solar energy utilization (Florez-Perez & Ghazali, 2020; Kamaruzzaman et al., 2012; Mohd Zainal Abidin Ab Kadir et al., 2010; Muhammad-Sukki et al., 2011; Sen & Ganguly, 2017). In comparison to the high costs of solar technology, the affordable cost of fossil fuels has proven becoming more popular to residents. If the price of fossil fuels were about the same as the price of solar energy, residents would be willing to install solar technology rather than use fossil fuels to generate electricity. This study's findings found that the interviewees most frequently emphasized low installation cost as a key factor that could encourage individuals to adopt solar technology. Therefore, receiving financial support from the government is an effective way to increase the use of solar energy. Besides, lack of knowledge and awareness also one of main barrier preventing people from supporting solar technology. This scenario contributed to the slow adoption of solar technology. Interviewees also claimed that the current government policies are insufficient in promoting public understanding and acceptance of solar energy. This statement is supported by Sen and Ganguly (2017), which stated that there are no effective awareness programs in place, and that the government has not done enough to increase the public awareness. Currently, there are awareness initiatives like the Annual Malaysian Photovoltaic Industry Association National Solar Roadshow, which focus on teaching and promoting the installation of solar PV on commercial and industrial rooftops, rather than residential residences (Lau et al., 2022). During the 10th Malaysia Plan (2006–2010), incentives like Green Investment Tax Allowance (GITA) and Green Income Tax Exemption (GITE) were introduced to encourage firms to adopt renewable energy technologies (Lau et al., 2022). However, households have not gained any advantages from these incentives. This demonstrated that the government's efforts to promote solar technology have thus far failed to garner popular interest. The government should organize more awareness and education

campaigns for the public, emphasizing all government incentives and policies that might positively impact the economy, community welfare and the environment.

Most interviewees expressed their belief that the use of solar energy may be encouraged through the implementation of policies such as incentives and tax exemptions. The findings suggested the possibility of policymakers introducing more incentive schemes to residents to increase the installation of solar technology. Similar to the findings of a study conducted by Kamaruzzaman et al. (2012), residents claimed that they lacked the financial resources necessary to purchase solar technology owing to the high installation cost of solar technology. According to the results of their study, more than 80% of the respondents said that receiving financial support from the government is an effective way to increase the use of solar energy. Hence, the government should develop subsidy or incentive programs to decrease the payback period and initial expenses of solar technology, in order to motivate residents to adopt the technology. The Malaysian Government can utilize the practical knowledge of other governments to create appropriate support programs for solar PV adoption. For example, Australia offers solar incentive schemes from both the State and Federal Government to promote the adoption of solar PV systems in households (Lau et al., 2022). The results indicated a lack of public awareness about government-introduced solar schemes and the environmental advantages of solar energy. Public awareness and education efforts should be initiated to inform households about government solar projects and the significance of adopting solar technology to reduce pollution. The government can collaborate through mass media and social media to deliver information to the public regarding solar projects and their advantages. The people should get education on renewable energy and engage in related activities starting at a young age in schools. The course familiarises students with various forms of energy and their environmental effects. In short, educating the public is a crucial strategy for the government to promote the use of solar technology.

CONCLUSION

This study investigated various existing solar technologies, gaining an understanding of each solar technology and its related issues, which will serve as a good foundation for assessing the strengths and limitations of solar implementation in Malaysia. The findings indicated that solar energy is the most suitable power generation source to invest in Malaysia because of its strategic location near the equator, which causes climatic conditions with sufficient sunshine throughout the year. A series of barriers to solar technology implementation were identified and examined by using a combination of literature review and interviews. High installation costs, lack of awareness and

insufficient government incentives are the main barriers that prevents people from installing solar technology. Currently, residents are reluctant to install solar technology because the cost of installation is too high and there are limited financial incentives from the government. Over the decades, the government has introduced a number of incentives or policies related to solar energy, including the National Renewable Energy Policy, SURIA 1000 scheme and NEM scheme. This indicates that the general public has little awareness of the numerous incentives and programs related to solar technology. This needs to be seriously addressed not only by the government but also by the private sector. Educational programs on solar technology should be implemented at all levels of educational institutions, from primary to tertiary education, to enhance awareness and knowledge. The mass media should allocate certain sections for promoting solar technologies. By providing sufficient awareness through mass media, it is possible to break through this barrier and see the successful penetration of renewable energy in Malaysia. However, without proper public awareness, the solar program may not reach its full potential. Thus, the government should make more efforts to promote the benefits of implementing solar energy by increasing financial incentives or awareness campaign among the publics. When the publics are aware of government's effort related to solar energy, they will be interest to use renewable energy as power generation, thus can increase the implementation of solar energy while achieving low-carbon footprint goals in the future.

In future research, a larger sample size or a mixed research approach, combining qualitative and quantitative research methods, could be considered to gain a deeper understanding of the strengths and weaknesses of solar energy policies in Malaysia. Additional comparative research may be conducted among developing countries to examine the effectiveness of their current solar-related policies. Such research could probably provide important lessons for the developing countries in refining their solar policies, and hence enhancing the use of solar energy. Furthermore, future research could also examine the energy sectors of other developing countries and make comparisons across these countries with renewable energy technology that has been adopted. In addition to the use of solar technology, there are other renewable energy sources that may be effective to use available resources to minimize the environmental impact of power generation systems.

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