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DEVELOPMENT OF SOLAR ENERGY IN SABAH MALAYSIA: THE CASE OF TRUDGILL'S PERCEPTION

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ABSTRACT

Solar energy in Malaysia was first introduced as one of the five fuels in electricity generation through the Fifth Fuel Policy in 2001. However, the current real harnessing of available solar sources is still below its actual potential. This study examined the non-technical barriers towards solar energy implementation in Sabah located on the Borneo Island on eastern part of Malaysia. Following the theoretical framework, the proposed non-technical barriers are agreement, knowledge, technological, economic, social and political. The results of the study showed that awareness and economics are among the two significant barriers in solar energy implementation in Sabah. This necessitates more appropriate energy and financial policies to help public acceptance of solar energy sources for electricity generation in the region.

Keywords: Solar energy, Non-technical obstructions, Public perception, Awareness, Sabah, Malaysia.

Contribution/ Originality:

This is the first known study that examined the non-technical barriers towards solar energy implementation in Sabah Malaysia. Following Trudgill (1990) theroretical framework, it was established that among the non-technical barriers which includes aggrement, knowledge, technological, economic, social and political; economic and awareness are the two significant barriers towards solar energy implementation in Sabah.

1. INTRODUCTION

Malaysia's industrialization policy among other things has resulted high energy demand. Electricity consumption increased by approximately 200 percent from 20,867 gigawatt hours (GWh) in 1990 to 63,716 GWh in 2000. Malaysia again experienced significant growth after the recovery from global economic crisis of 2008. In 2010, the economy registered a growth of 7.2 percent and as a result of this strong growth, electricity demand experienced another high growth of 7 percent in 2010. It is expected that the electricity demand will increase by 4.7 percent

per annum by the year 2030 (Ali *et al*., 2012). Like many other developing countries in the region, electricity in Malaysia is still generated using fossil fuels such as coal, oil and gas. Fossil fuels are non-renewable but are unfortunately also a source of pollution, including CO_2 emissions and global warming. Government and policy makers have always faced serious problems regarding energy. Industrialization and continuous economic growth require more energy including electricity. However, fossil fuels, the main current sources of energy are not sustainable and have negative impact on the environment. To ensure the security and reliability of electricity supply for growth and development while minimizing the negative impacts to the environment many policies and projects have been implemented by the Malaysian government.

Renewable energy sources are plentiful, many still not fully exploited and are environmentally friendly and have high potential to contribute to the energy needs for both developed and developing countries (Oh *et al*., 2010). Some of these renewable energy sources include solar, wind, hydropower, biomass and geothermal energy. It is a challenge for the government and policy makers to decide on the most efficient, reliable and effective source to meet Malaysia's needs. Many policies and financial support schemes have been implemented to increase the consumption of renewable energy sources. One of the major significant policies was diversification of fuel mix used in electricity generation. Renewable energy was introduced as the fifth fuel after oil, gas, coal and hydro in electricity generation through Fifth Fuel Policy in 2001.

Malaysia's Third Industrial Master Plan was launch in 2006. Solar energy was introduced through this policy as a new growth path. In April 2009, the Malaysian government introduced a new policy which is the use of renewable energy sources in electricity generation. Besides these policies, an abundant number of key projects have been implemented such as the Malaysia Industrial Energy Efficiency Improvement Project, Small Renewable Energy Power Programme, Malaysia Building Integrated Photovoltaic, Building Energy Efficiency and Green Building Index (Muhammad-Sukki *et al*., 2011). To strengthen the country's long-term energy security needs and at the same time to mitigate and reduce the greenhouse gasses (GHG) emissions, the Malaysia Building Integrated Photovoltaic (MBIPV) Project was officially launched on 25th July 2005. The project purposed on market development for BIPV technology, and on building national capacities in three major areas: (a) policy and education; (b) technical skill and market implementation; and (c) technology development support (MBIPV, 2010).[1] The Malaysian government has confirmed the implementation of a new renewable energy policy in the 10th Malaysia plan (Chua and Oh, 2010). The new policy proposed the use of solar photovoltaic in electricity generation. Specifically, it focused on the generation of electricity by domestic users in their houses by using solar energy (Chua *et al*., 2011). Malaysia is made up of peninsular Malaysia and states of Sabah and Sarawak, which are located on the Borneo Island and is separated by the South China Sea. Given the locational constraints, there are three separate grids for electric

1The project ended on 31st December 2010. Some studies summarized the project findings and results Chua and Oh(2010). Muhammad-Sukki *et al*. (2011).

power distribution in the country, namely; the West Malaysia Grid, the Sarawak Grid and the Sabah Grid.

The Sabah Grid is a stand-alone and independent of the other two national grids. The electricity demand in Sabah has increased from 594 MW in 2006 to 779.7 MW in 2010, indicating an increase of 31 percent, which exceeded the estimated demand of 775 MW for 2010.[2] This growth in electricity demand is attributed to the growth of both the commercial and residential sectors. Currently, Sabah experienced about 4.2 percent increase in its daily electricity demand from 14.2 GWh in 2009 to 14.8 GWh in 2010. While with its maximum of 835 MW of total installed capacity in the region there is very small margin to spare (Koh and Lim, 2010). Among all the states in Malaysia, the highest number of interruptions per month in 2009 was in Sabah, with 1,759 average monthly electric interruptions reported in 2009.[3] This was mainly due to the low availability and reliability of oil/diesel power generation plants.

Malaysia is well endowed with different sources of renewable energies. Table 1 shows the potential of renewable energy sources in Malaysia.

Table-1. Renewable energy resource potential in Malaysia (Jaafar *et al.*, 2002).

Renewable energy	Energy value (RM million per annum)
Forest residues	11,984
Oil palm biomass	6,379
Solar thermal & PV	3401
Mill residues	836
Hydro	506
Municipal waste	190
Rice Husk	77
Landfill gas	4

Among the renewable energy sources, solar energy has many advantages over the others. First, its limitless potential and a free source from the sun (Jaafar *et al.*, 2002). Second, it does not need extra land and lastly, it generates electricity at the point of consumption thus decreasing electricity transmission losses (Ali *et al.*, 2012). The tropical weather in Malaysia is favourable for the development of solar energy. Malaysia with an average of 8-12 hours of sunshine daily, is receiving an average of around 5.5 kilowatt hours per square meter (kwh/m^2) solar radiation daily (Ali *et al.*, 2012). This much is equivalent to 15 mj/m^2 PV generated electricity (Oh *et al.*, 2010).

About 20 percent of the national energy demand can be satisfied only with the lower solar capacity (Ali *et al.*, 2012). Malaysia is targeting 5.5% of electricity generation from renewable sources including solar energy by 2015. However, recently the real harnessing of available solar sources is below its actual potential. Solar energy only contributes a mere 0.007% of the total electricity generated in Peninsular Malaysia. Shifting energy mix from conventional sources to renewable sources is always accompanied by difficulties and barriers (Dagher and Ruble, 2011).

2 Electricity supply industry in Malaysia performance and statistical information (2010).

3 Energy (2009).

There are some technical and non-technical barriers and obstacles which delay and hinder the process of renewable energy implementation. The barriers to renewable energy implementation are different across technologies and countries (Painuly, 2001). Therefore there is a serious need in examining the attributed barriers to renewable energy implementation in each country and region separately.

(Trudgill, 1990) applied a theoretical framework to explain a broad range of obstacles to environmental problem solutions. He applied this framework for Amazonian deforestation. Trudgill (1990) theoretical framework is based on the concept that all environmental problems and their potential solutions can be explained by one or more of the following barriers: agreement, knowledge, technology, economic, social, or political. Rösch and Kaltschmitt (1999) analysed some certain non-technical barriers towards solid bio fuels within Europe. They concentrated on financial, administrative, organisational, infrastructure and perceptual challenges. Painuly (2001) developed a framework to identify the barriers to renewable energy technologies. He categorized the major barriers as follows; market, economic, financial, institutional, technical, social, cultural and behavioural barriers. Similarly, in other studies Brown (2001) and Owen (2006) described a range of market failures and institutional barriers to clean energy development.

Richards *et al.* (2011) examined the most important barriers to investment in renewable energy in Canada. The study concludes that barriers to renewable energy cannot be explained solely by technological, social, political, or economic factors in isolation, and that a multidimensional approach is necessary. In his study, stakeholders' perception and understanding of the barriers to renewable energy development in Canada was examined by employing Trudgill (1990) framework. They concluded that the most significant barriers to renewable energy investment can be explained mostly by knowledge and agreement. Solar energy and attributed barriers to its development has received attentions from scholars (Cabraal *et al.*, 1996; Oliver and Jackson, 1999; Painuly, 2001). Haw *et al.* (2009) conducted a survey in urban areas of Kuala Lumpur to examine the barriers to PV application in Malaysia. Employing Trudgill (1990) methodology, they conclude that people awareness is still one of the main barriers in consumption of renewable energy in electricity generation especially solar PV in Malaysia. This paper will investigate and examine the non-technical barriers of solar energy development in Sabah using the Trudgill (1990) framework. Finding different barriers to renewable energy and specifically solar energy is essential for effective policy development.

Section 2 provides the theoretical framework, research method and Data. Section 3 explains the results and the last section discusses the results and concludes the paper.

2. THEORETICAL FRAMEWORK AND DATA

Following recent studies by Richards *et al.* (2011) and Haw *et al.* (2009), hence this study is based on a method which was driven by Trudgill (1990). He developed a generalized model in which major non-technical barriers and obstacles to environmental problems solution are classified in six main categories, namely agreement, knowledge, technological, economic, social

and political (the so called AKTESP barriers) [4]. In Trudgill (1990) framework, barrier over agreement of a problem is the major obstacle. If there was not a serious problem in agreement, next is the question regarding knowledge and awareness about the issue.

Lack of suitable and affordable technology may be the next barrier. On the other hand, the price of the technology must be cheap enough to encourage the public to invest. Lastly, there may not be appropriate socially or lack of political motivation. Based on Trudgill (1990), these six major barriers can operate at any level within the sequence. However in reality, knowledge and agreement seems to be the major barriers followed by social, political and economic considerations (Ling *et al.*, 2000). This framework for analysis helps us to have a better understanding of public perceptions and opinion towards implementation of solar energy in Sabah, a state in Malaysia. Furthermore it helps us to find the barriers and obstacles towards solar energy development and to implement solutions for each group barriers, if any.

To understand the public perception of solar energy in Sabah state, a survey was conducted over 9th November 2012 to 20th November 2012. A total of 309 respondents were interviewed in this survey. The following Table shows the detail of collected data from different district in rural and urban areas of Sabah.

Table-2. Details of the collected data

Area	District	Population	No. of Questionnaires Collected
Urban	Sandakan	396290	38
	Tawau	397673	38
	LahadDatu	199830	20
	Semporna	133164	14
	Kota Kinabalu	452058	42
Rural	Kudat	83140	42
	Kota Marudu	66374	34
	Sipitang	34862	20
	Tenom	55553	29
	Beaufort	64350	32
Total			**309**

3. RESULT

In order to examine barriers and obstacles towards solar energy implementation in the Sabah state in Malaysia, a total of 309 respondents were interviewed. Following Trudgill (1990) framework, barriers and obstacles to solar energy implementation in six main categories, namely; Agreement, Knowledge, Technological, Economic, Social and Political were examined.

The examination process began with first, a brief description concerning the consumption of fossil fuels such as coal, petroleum, crude and natural gas as the main sources of electricity generation was explained. Then, the respondents were asked if they agree to continue using fossil fuels for electricity generation.

4 Detailed explanations for each group barriers are available in Haw *et al.* (2009).

The findings indicated that about 66 percent of the respondents agreed on not using the fossil fuels for future electricity generation. Next, the respondents were asked that if they agree to use renewable energy as an alternative source of electricity generation. About 81.5 percent of the respondents agreed and strongly agreed that renewable energy should be implemented in Sabah. In contrast, only 11.3 percent of respondents disagree and strongly disagree that renewable energy should be implemented in the region. Next, the respondents' agreement towards solar energy consumption in the region was asked. Around 93 percent of the respondents agreed in the use of solar energy in Sabah. The same number of respondents also agreed that solar energy consumption has advantages for the environment.

Under the 10th Malaysia Plan, the Malaysian government is targeting 5.5 percent consumption of renewable energy sources in electricity generation by 2015. However, the current contribution from renewable sources for electricity generation is still very low. For example, solar energy only contributes about 0.007 percent of the total generated electricity in Peninsular Malaysia.

One of the main obstacles of solar energy implementation is the lack of awareness among Malaysians. In order to find the level of people's knowledge about solar energy in the area, the respondents were asked on their knowledge about implementation of solar energy for electricity generation. The public awareness about policies to replace fossil fuels in electricity generations by solar energy is shown in Table 3. About 58 percent of the respondents revealed that they are aware of new policies by government in solar energy consumption for electrification.

Table-3. Public awareness about solar energy

Options	**Frequency**	**Percentage (%)**	
Yes	178	57.6	
No	131	42.4	
Total	309	100	
Descriptive statistics			
Minimum	Maximum	Mean	Standard Deviation
0	1	0.58	0.495

Table 4 compares public awareness towards solar energy with other sources of renewable energy. It is apparent that the public knowledge about solar energy is relatively high after knowledge about biogas and it is followed by knowledge about hydro, nuclear, biomass and other renewable sources.

Next, the respondents were asked about the sources of information regarding solar energy. They were allowed to choose from more than one source. Television and radio are the main sources of solar energy information sources (67.2 percent) followed by newspapers and magazines, internet friends and other sources such as schools and living near solar development canters.

Table-4. Comparing public awareness about solar energy with other renewable sources

Type of renewable energy	Option	Percentage (%)	Level of awareness
Biogas	Yes	86.9	1
	No	13.1	
Solar	Yes	46.9	2
	No	53.1	
Hydro	Yes	28.7	3
	No	71.3	
Nuclear	Yes	24.4	4
	No	75.6	
Biomass	Yes	23.1	5
	No	76.9	
Others	Yes	8.8	6
	No	91.2	

Table-5. Sources of solar energy information

Sources	Percentage (%)	Ranking
Television and radio	67.2	1
Newspaper and magazine	35.6	2
Internet	30.5	3
Friends	16.9	4
Others	6.7	5

High cost and low efficiency of solar panels or photovoltaic (PV) cells are other barriers towards solar energy consumption. Although Malaysia is the world's fourth largest PV modules producer, solar technology is not widely adopted here. One reason is the cost of installing PV systems in Malaysia is expensive. For example, in 2005 the cost of PV system per kW peak was RM31,410. Although the cost has fallen at a rate of more than 10 percent per year from RM24,970 in 2007 to RM20,439 in 2009, it is still unaffordable to most Malaysians.

To further encourage the adoption of solar energy, the Malaysian government introduced the Feeds in Tariff (FIT) scheme in 2012. FIT enables solar energy users to sell electricity they generated to the government. For example household can get Malaysian Ringgit (RM) 1.2 to 1.23 Malaysia (RM) for every one kWh electricity generated and sold. Respondents were explained that if they generate as much as 3.3 kWh of electricity every month, they can gain up to RM400 per month. Then they were asked whether they are willing to invest in solar energy. About 47 percent of the respondents answered that they are willing to invest in solar energy compared to the 78 percent of the respondents who are willing to use solar energy. More than 55 percent of the respondents revealed that their decision towards using solar energy highly depends on the equipment cost. About 90 percent of the respondents agreed and strongly agreed to buy the renewable products from market if they are affordable.

One of the social barriers towards solar implementation is public opinion towards environmental sustainability. Respondents' ideas about the environment and natural resources and whether they agree to save the environment for next generation is a key factor in solar energy progress. The respondents were asked if the usage of solar energy will help to sustain the

environment. More than 80 percent of the respondents believed that solar energy implantation will help to sustain environment for the next generations. Furthermore, the respondents were asked if they will change their electricity consumption pattern after solar implantation. Around 67 percent of the respondents revealed that they will not increase the use of electrical equipment frequencies even after solar energy implementation.

In order to assess the political barriers towards solar energy consumption, respondents were asked about government incentives towards solar implication. More than 90 percent of the respondents agreed and strongly agreed that government role in electricity production from solar energy is a vital factor in success of renewable energy implementation and more than 80 percent of the total respondents answered that government should increase public awareness in consumption of renewable energy sources for environmental sustainability. Specifically, 64.5 percent of the total respondents expect financial help from government to implement solar energy, while 42 and 41.8 percent of the total respondents also expect government helps in purchase of the solar equipment and reduction of income tax, respectively.

4. DISCUSSION AND CONCLUSION

Most of the electricity in Malaysia is still generated using fossil fuels sources such as coal, oil and gas. These sources of energy are depletable and pollution intensive sources for electricity generation. Thus the consumption of fossil fuels is associated with a significant increase of CO_2 emissions and global warming.

The Malaysian government has proposed number of policies and financial supports to increase the consumption of renewable energy sources in order to meet the electricity demand in the country, to solve the problem of natural resources depletion and to minimize the negative impacts of electricity generation on the environment.

Solar energy was introduced first as one of the fifth fuel in electricity generation through Fifth Fuel Policy in 2001. Around 20 percent of national energy demand can be satisfied only with lower solar capacity (Ali *et al.*, 2012). However, recently the real harnessing of available solar sources is very below its actual potential. Solar energy only contributed 0.007 percent of the total generated electricity in Peninsular Malaysia.

This study examined non-technical barriers towards solar energy implementation in Sabah state of Malaysia. Following Trudgill (1990) theoretical framework, proposed non-technical barriers are classified into six main categories namely; agreement, knowledge, technological, economic, social and political. The results of the study showed that awareness and economic are among the two most barriers in solar energy implementation in Sabah. This necessitates more appropriate policies and financial help to increase public awareness to implement solar energy sources in electricity generation. Similar results were also found by other studies such as Muhammad-Sukki *et al.* (2012), Yuan *et al.* (2011) and Haw *et al.* (2009) who found that the public awareness is still one of the main hindrances to development of renewable energy consumption. The results revealed that mass media sources of information such as television, radio and newspaper play significant role in public acceptance of solar energy consumption. Thus,

government, policy makers and non-governmental organizations should promote public awareness and education in solar energy consumption through these sources.

Renewable technologies seem to be more expensive and less price competitive due to the subsidies and efforts that go to conventional energy sources (Ahmad *et al.*, 2011). This is also reflected in this study that more than half of the respondents revealed that their decision towards using solar energy depends highly on the equipment cost. It is not surprising as for example, in 2005 the cost of PV system per kW peak was RM31,410. Although the cost has fallen at a rate of more than 10 percent per year from RM24,970 in 2007 to RM20,439 in 2009, it is still a big share of household expenditures.

Moreover, government should also undertake some other plans and programmes such as 1) reduction of imported solar technologies taxes and tariffs. 2) Serious actions in running feeds in tariff (FIT) scheme which was implemented in 2012. 3) Implementation of suitable policies for each region and state separately. 4) Grant loans and credits for purchasing solar equipments. 5) Reduction of fossil fuels subsidies and shift to solar technologies. 6) Increase public acceptance and support through cooperation between government and non-governmental organizations (NGOs)

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