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Research article

Understanding perception and interpretation of Malaysian university students on renewable energy

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Abstract: Contribution of renewable energy (RE) in current Malaysian energy mix is limited despite of the abundant biomass from its agriculture and sufficient sunshine and rainfall throughout the year. As future leaders, the acceptance of young generation towards RE reflects the most important public decision and policy especially in reducing dependency on fossil fuels. In order to optimise the successful of an awareness program, a set of questionnaire has been used to examine the perception and interpretation of university students towards RE. A total of 2,863 completed questionnaire were analysed according to educational background (science and non-science) and family economic status classified as Bottom 40 (B40), Middle 40 (M40) and Top 20 (T20). The results revealed that most of them have positive perception and optimistic on the usage of RE. Unfortunately, more focus and attention should be given to students with non-science educational background and those who came from Bottom 40 economic group in understanding renewable energy. There is also a gap on interpretation that indicates the need for more intellectual activities that covers information on development, technologies and benefit of RE.

Keywords: renewable energy; energy education; environmental awareness; university students

1. Introduction

The concern towards fossil fuel reserves that are expected to be depleted in the near future and numerous problems stemming from the use of fossil fuels has shifted global attention to renewable energy (RE) sources [1]. In Malaysia, a comprehensive RE Policy and Action Plan has been established to push the uptake of RE technologies due to the lack of achievement in the Fifth Fuel Policy as only 0.3% of electricity was generated by RE at the end of 2005 [2].

To overcome this inadequacy, Feed-in-tariff (FiT) mechanism has been introduced by the Malaysian government in accordance with RE Act 2011 and Sustainable Energy Development Authority (SEDA) Act 2011 to promote the growth of RE [3]. Solar energy, biogas, mini hydro, biomass and geothermal are five RE resources mentioned under Renewable Energy Act 2011 [4]. As a statutory body, SEDA core responsibilities are not limited to RE, but also promoting the use of energy efficient technologies and approaches to reduce energy consumption towards achieving energy security and autonomy [5]. The introduction of FiT mechanism in Malaysia has been influenced by successful stories of many countries including Germany, Italy, Spain and Thailand in accelerating RE deployment, reducing the carbon emissions and creating jobs [6].

A year after its implementation, there are four significant impacts that have been obtained which are the significant increase of uptake in RE installation especially solar photovoltaic, increment of foreign and domestic direct investment related to renewable sectors, creation of more 'green' jobs particularly in manufacturing and installation sectors, and lastly, the demand to include wind and thermal energy in the FiT scheme [2]. A total of 4,301.67 GWh of RE has been generated in 2018 with the largest contribution is solar energy (40.15%), followed by biomass (34.07%), biogas (16.09%), and small hydro (9.69%), that contribute to 2.77 million tonnes of CO_2 reduction [3].

Despite of the high increment of RE generated from FiT mechanism, Malaysia is still depending on fossil fuels for energy supply that are dominant of natural gas, crude oil, coal and coke. RE only contributes 5.2% in the energy mix, and this percentage is mostly contributed by hydropower with 4.4%, while the rest are biodiesel, biomass and solar [7]. These percentages revealed that the RE generated from FiT mechanism could only support a minor contribution to the energy mix in Malaysia.

The percentage increment is seen to be impossible in the near future as the level of success in this FiT mechanism is highly dependent on the RE fund management, and analysis showed that the Malaysian government will face a shortage in its RE fund budget [8]. High installation costs claimed to be one of the reasons of low RE implementation [9]. This is in agreement with [10] who suggested fiscal incentives should be provided for the RE as long as the cost of generation from renewable resources is higher than the cost of power generation from conventional sources. Thus, Green Investment Tax Allowance (GITA) and Green Income Tax Exemption (GITE) have been introduced under Green Technology Tax Incentive as an initiative to encourage investment in green technology on project basis either for business purposes or own consumption, motivate companies in acquiring green technology assets and enhance the number of green technology service providers [11]. This incentive was announced in Budget 2014 and extended until 2023 [11].

Apathetic to the current energy issues due to no urgency and unattractive costing, most of RE

resources in Malaysia remains untapped. Malaysia currently enjoys a state of energy security due to Malaysian's own vast crude oil and natural gas reserves which are not only capable of fulfilling domestic demands but also compensates potential import dependency [12]. With regards to fossil fuel pricing, it is cheaper in comparison to other countries in the region owing to the huge amount of subsidy on energy to rationalise the cost of living and enhance the economy [13].

Unfortunately, the Malaysian government decided not to fully compensate subsidies for fuels due to the budget deficit and fiscal management difficulties, contributing to a large portion in the government total annual budget on subsidies [14]. The subsidy rationalisation initiative which is part of the New Economic Model foreseen as being able to improve economic efficiency and promote economic growth, while avoiding a substantial leakage of benefits to the non-poor [15]. As a result, the energy subsidy has been reduced on average by 10% annually since 2011 [13]. It is agreed that the removal of subsidies is beneficial for economy and environment. Still, policymakers should be concerned with their negative impacts on households and provide some offsetting policy to cover these negative impacts [16].

A social and welfare assistance scheme called Bantuan Sara Hidup which previously known as Bantuan Rakyat 1 Malaysia (BR1M) has been introduced in return with an allocation of RM 5 billion in Budget 2020 as a direct aid from the government to the targeted group [17]. However, this assistance scheme is not able to cover the impacts of rising petroleum prices that is corresponding to the living cost, especially at the city area as the fuel price has been revised to a weekly price system. This system is based on the Automatic Pricing Mechanism formula that caused price fluctuations. Simulation studies done by [18] indicate that the distributional impacts of rising petroleum prices tend to be regressive, affecting poor people more severely than richer people. Even there is a social and welfare assistance scheme, the calculation of consumption for daily needs is very subjective as it depends on an individual's utility and with a lack of control over consumption may lead the receivers misuse it for other purposes beyond their needs [13]. Therefore, this is a wakeup call to the nation to support and accelerate the effort on RE development to reduce dependency on fossil fuels for energy supply.

It is highly critical to educate young generation as they will become future leaders in the decade to come. The people who lack of knowledge are in the position of judging, so this sometimes can be resulted in misjudgements that cause damage for investors and creates a problem about the production of RE [19]. With the Industry 4.0 booming where the consumption pattern and reliance on the energy grid is expected to rise, as well as the ongoing climate change, Malaysia needs to enhance its RE sector, both for national energy security through true diversification, as well as reduction of the national carbon footprint [12]. Malaysia is highly dependent on energy as a source of production and consumption as well as a source of national income [13]. Therefore, awareness is one of the fundamental elements to encourage the development of RE in Malaysia [2]. In fact, only 11% of 29,000 MW hydropower potential in Malaysia has been developed so far and limited awareness becomes one of the common challenges of development along with lack of sufficient funding, less private sector participation, lack of technical facilities and less income of rural people [20].

Thus, this research aims to examine the perception and interpretation of university students, as the potential leaders for future generation on RE. The focus was given on education aspect and expressions towards RE resources in both, general and Malaysia context. The correlation of the perception with the socio-demographic profile including gender, educational background and family economic status was statistically analysed to reveal the most important factor that should be highly

considered to increase the acceptance and awareness of young generation to RE. Expectedly, findings from this research will provide fundamental information especially to the policy makers in order to increase the percentage of RE in the current energy mix and reducing dependency on fossil fuels. For optimistic future, RE education must be quickly and efficiently spread to the future generation [21], especially to university students as they reflect the most important public decision makers in the decades to come [22].

2. Materials and method

A set of questionnaire was prepared and adapted based on awareness studies about RE [1,21]. Amendment was done to ensure all questions are appropriate with university students' level and embrace the Malaysian perspective. The questionnaire was divided into three sections starting with the socio-demographic profile consisting of educational background and family economic status. This is due to the fact that household's income influences energy related awareness and behavioural change [23]. In the second section, there are two questions to obtain opinions on the type of clean energy that Malaysia should focus on and factors that influence the decision to use RE. The respondents need to give an answer based on six options provided after each question [22]. In the last section, there are two statements about the influence of education and knowledge on future energy practice and RE choice. It is followed by 16 statements on the aspects of RE source, and the first six statements are in the Malaysian context. All these 18 statements are self-reported statements with a five-point measure scale to discover the expression of university students on RE. Each point represents to a specific scale which the; 'strongly disagree', 'disagree', 'undecided', 'agree', and 'strongly agree'.

All the collected questionnaires were analysed by using (Statistical Package for Social Science) SPSS computer software. The descriptive analysis has been used to establish the norm and pattern, including chi-square test to analyse the relationship between socio-demographic profile and perception, as well as interpretation of university students on RE. The estimated values of Cronbach's alpha (0.737) reflected the satisfactory level of overall consistency among individual responses in the reliability scale [24]. The graphical diagram of the study is depicted in Figure 1.

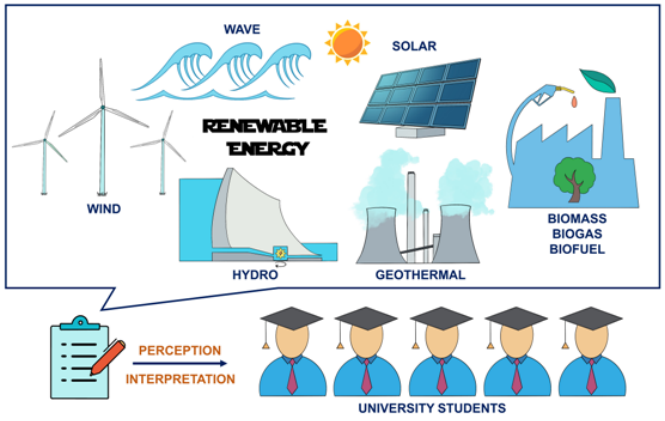

Figure 1. Graphical diagram of this study.

3. Results and discussion

A total of 2,863 complete questionnaire were retrieved, represented 50.6% of science students who are coming from the science-based faculties, including medical, engineering and information technology. Other 49.4% is non-science students who studied in law, accountancies, Islamic studies, linguistic, business, administration and others. With regards to family economic status, 45.5% of respondents came from B40, which is a targeted economic group to receive a social and welfare assistance scheme from the Malaysian government. The middle-income group, M40 was represented by 32.1% of total respondents, and highest family economic status, T20 was the smallest group with 21.7%. The latest revision on minimum household's monthly income for group B40 or Bottom 40% is less than Malaysian Ringgit 4,360 (±USD 1,000), while M40 or Middle 40% in the range of Malaysian Ringgit 4,360 to 9,619 (±USD 1,000 to 2,220) and to be in T20 or Top 20%, a minimum household's monthly income is Malaysian Ringgit 9,619 (±USD 2,220) [25]. The percentage distributions for the collected data for the second and third section are presented according to educational background and family economic status. As presented in Tables 1 and 2, most of the respondents voted 'solar' as a type of clean energy that should be the focus for the future of Malaysia and 'environmental responsibility' was the main factor that influences their decision on the use of RE. The 'efficiency' and 'cost' were the second and third factors without any dissimilarity.

Table 1. Frequency distribution for the relationship between opinions on the type of clean energy that should focus on based on different educational background and family economic status.

Opinion	Background	Percentage (%)					
		Wind	Solar	Biomass	Wave	Don't Know	More than one
Type of clean energy that should focus on for the future of Malaysia	Science	4.1	36.3	13.5	4.1	4.6	29.9
	Non-Science	6.2	41.9	15.2	4.4	5.6	21.4
	B40	5.7	38.9	15.8	3.8	5.3	24.5
	M40	4.8	40.0	14.2	4.4	5.4	25.0
	T20	4.3	38.1	11.6	4.6	4.4	29.5

Table 2. Frequency distribution for the relationship between opinions on the influence of decision to RE usage at different educational background and family economic status.

Opinion	Background	Percentage (%)						
		Cost	Efficiency	Environmental Responsibility	Patriotism & Energy Security	Policy	Don't Know	More than one
What could influence your decision to use renewable energy?	Science	13.8	20.5	30.4	3.5	2.2	3.7	25.9
	Non-Science	9.0	19.7	42.3	5.0	2.3	4.5	17.2
	B40	10.9	19.3	38.7	4.8	2.1	4.2	20.0
	M40	10.0	21.2	36.8	3.9	2.3	3.9	21.9
	T20	14.7	19.8	30.1	3.6	2.6	4.3	24..9

Results of the chi-square test (Pearson chi-square) showed that there is a significant difference in the type of clean energy between individuals in the two groups of educational background, $\chi 2$ (6, N = 2806) = 39.39, p = 0.000).

By referring to residual values, there are different findings as to the standardised residual values of 3.1 (science—more than one) and 1.7 (non-science—wind & solar) made contribution to the differences. In other words, students with science educational background (n = 1,425) select 'more than one' type of clean energy, while non-science students (n = 1,381) stated 'wind' and 'solar' are two types of energy that should focus on for the future of Malaysia.

Vice versa, there is no association between individuals in the three groups of family economic status, $\chi 2$ (12, N = 2787) = 14.81, p = 0.252). The small standardised residual value (0.1 to 1.8) shows that the difference in the observed frequency and the expected frequency is too small that probably caused by sampling errors.

Solar and biomass are the main viable RE sources beside hydropower as Malaysia is a country known for its agriculture and blessed with abundant of sunshine and rainfall throughout the year [26]. There is a huge potential to establish large-scale solar panel plants as Malaysia receives in the range of 400 to 600 MJ/m^2 of average solar irradiation per month [27]. Numerous efforts have been taken by the government to promote the use of solar energy that initially used only for water heating in residences. Started with Small Renewable Energy Power (SREP) programme from 2001 to 2010 and followed by Malaysian Building Integrated Photovoltaic (MBIPV) in 2005, it became a solid foundation of FiT that has been introduced in 2011 [6]. Utilisation of solar energy is a very simple way of reducing building energy need but it should be well-planned [28]. In addition, five RE were emphasised under SREP programme including biomass, biogas, municipal solid waste, solar photovoltaics and mini-hydroelectric facilities [29]. With the brightest potential with a comprehensive effort by the government, this solar energy is more widely acknowledged by the nation together with biomass energy.

As the second-largest producer in the world, Malaysia's palm oil industry generates about 100 million dry tonnes of solid biomass annually [30,31]. Biomass in Malaysia also contributes by mesocarp fibre and woody biomass from forests that indirectly able to secure sustainable and clean energy supply [32]. With regards to wind energy, the potential seems to be small due to the low wind speed, with the maximum recorded value is 4.1 m/s [6]. This source of RE is not listed under FiT mechanism, and it has been selected as clean energy together with solar by most of the non-science students in the survey. This indirectly exposed the lack of knowledge on the current development of RE among them.

Hydropower was not listed as one of clean energy selection in the questionnaire as it is the existing technology that contributes to the energy mix in Malaysia. Even only 11% of 29,000 MW hydropower potential has been developed so far, the new development comes with various problems including high initial investment and heavy pressure of loan refunding with higher expenses due to cost overrun after construction [20]. Moreover, there are socio-technical barriers that can be classified into six categories, namely technical, economic, political, legal and regulatory, social, and environmental [29]. Thus, more intention needs to be given to the new RE sources with minimum effects that include wind, solar, biomass and wave. For the main factor that influence respondents' decision on the use of RE, there are an association between individuals in the two educational background, $\chi 2$ (6, N = 2799) = 71.04, p = 0.000) and in the three groups of family economic status, $\chi 2$ (12, N = 2780) = 23.97, p = 0.021). The standardised residual values of 3.5 (science—more than

one) and 3.7 (non-science—environmental responsibilities) contribute to the difference. Significantly for these samples, students with science educational background (n = 1,424) select 'more than one' factors and 'environmental responsibility' is the sole factor that influences the decision of non-science students (n = 1,375) to use RE.

With regards to family economic status, 'environmental responsibility' is the highest factor with the residual value obtained by group B40 (residual = 1.5), 'efficiency' for the group M40 (residual = 0.8) and 'cost' for T20 (residual = 2.4). Relatively for these samples, 'environmental responsibility', 'efficiency' and 'cost' are the main factor that influence decision to use RE of students who came from B40 (n = 1,272), M40 (n = 897) and T20 (n = 611) groups, correspondingly. RE is a new technology in Malaysia. As a group with high monthly income, they are able to afford this new technology that comes with a high price. High cost is not an issue and the payback period become one of their main concern that will refer to the 'cost' [33]. For the middle group, they are more enticed to use new technology and willing to invest a sum of money even they are unable to afford it. Thus, 'efficiency' is their main concern as they want to make sure that the technology will worth their investment. For the B20 group, most of them are supported by a subsidy from the government. Those who are underprivileged and registered in the e-Kasih system, the monthly electricity bills are subsidised up to Malaysian Ringgit 40 (±USD 9) under government assistance program [17]. The e-Kasih system is an integrated database system for those live under Poverty Line Income, established by the Malaysian Government for poverty eradication programs. For this particular group, 'environmental responsibility' is the main factor that influences their decision to use RE. The daily survival is their main concern as compared to the accessibility to new technology. Referring to the first two statements in Table 3, majority of respondents, regardless to their background and status are 'strongly agree' that education plays an important role in their future energy practice and influence their RE choice.

Table 3. Frequency distribution towards RE based on education and socio-economic status.

Statements		Background	Percentage (%)				
			Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1.	Education plays an important role in our future energy practice.	Science	0.4	0.7	7.9	23.5	67.4
		Non-Science	1.0	1.5	10.5	25.8	61.1
		Values of chi-square test, χ^2 (4, N = 2790) = 18.72, p = 0.001					
		B40	0.8	0.8	9.8	24.9	63.8
		M40	0.9	1.7	8.80	25.3	63.4
		T20	0.3	1.0	8.7	22.6	67.3
		Values of chi-square test, χ^2 (8, N = 2771) = 8.46, p = 0.390					
2.	Knowledge on the environment influence RE choices.	Science	0.1	0.8	10.9	34.5	53.6
		Non-Science	0.3	2.0	15.1	34.3	48.3
		Values of chi-square test, χ^2 (4, N = 2782) = 22.30, p = 0.000					
		B40	0.2	1.7	14.3	34.8	49.0
		M40	0.0	1.6	11.8	35.2	51.4
		T20	0.5	0.5	11.9	32.3	54.8
		Values of chi-square test, χ^2 (8, N = 2763) = 16.45, p = 0.036					

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Statements		Background	Percentage (%)				
			Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
3.	I believe that Malaysia currently uses its existing potential in RE.	Science	2.4	8.5	28.8	38.8	21.5
		Non-Science	1.9	5.8	29.8	39.9	22.5
		Values of chi-square test, χ^2 (4, N = 2784) = 8.56, p = 0.073					
		B40	1.9	5.8	27.8	40.6	23.9
		M40	2.1	7.9	28.6	41.6	19.7
		T20	2.8	8.9	33.2	33.6	21.5
		Values of chi-square test, χ^2 (8, N = 2765) = 23.34, p = 0.003					
4.	Malaysia is leading other ASEAN countries in RE development.	Science	4.0	9.9	44.8	28.3	13.0
		Non-Science	2.0	9.2	38.9	32.8	17.1
		Values of chi-square test, χ^2 (4, N = 2780) = 26.76, p = 0.000					
		B40	2.8	7.7	40.6	31.8	17.2
		M40	2.7	10.2	43.1	30.0	14.0
		T20	3.9	12.3	43.1	28.6	12.0
		Values of chi-square test, χ^2 (8, N = 2761) = 23.00, p = 0.003					
5.	Malaysia can do more in RE development.	Science	0.1	1.6	14.5	36.7	47.0
		Non-Science	0.5	2.8	15.2	36.3	45.2
		Values of chi-square test, χ^2 (4, N = 2761) = 7.90, p = 0.095					
		B40	0.3	2.3	16.7	34.6	46.1
		M40	0.5	2.1	13.6	39.2	44.6
		T20	0.2	2.2	13.1	36.3	48.3
		Values of chi-square test, χ^2 (8, N = 2744) = 10.26, p = 0.247					
6.	Malaysia is not currently developing its solar energy potential sufficiently.	Science	2.5	12.1	35.6	30.9	18.9
		Non-Science	5.3	13.2	35.7	29.8	15.9
		Values of chi-square test, χ^2 (4, N = 2770) = 18.72, p = 0.001					
		B40	5.0	13.7	35.7	28.8	16.9
		M40	3.5	12.1	36.9	31.3	16.2
		T20	2.0	11.2	33.8	33.0	20.0
		Values of chi-square test, χ^2 (8, N = 2752) = 19.19, p = 0.014					
7.	I know that Malaysia is rich with biomass energy resources.	Science	1.8	5.1	36.5	35.2	21.5
		Non-Science	2.1	6.9	42.7	29.6	18.7
		Values of chi-square test, χ^2 (4, N = 2774) = 20.21, p = 0.000					
		B40	2.5	6.2	40.4	30.3	20.6
		M40	1.7	6.4	37.9	34.4	19.7
		T20	1.2	5.0	39.6	34.5	19.8
		Values of chi-square test, χ^2 (8, N = 2757) = 10.63, p = 0.223					

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Statements		Background	Percentage (%)				
			Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
8.	Malaysia should develop its biomass energy potential.	Science	0.7	1.4	21.9	42.0	34.0
		Non-Science	0.8	2.9	27.8	38.9	29.5
		Values of chi-square test, χ^2 (4, N = 2765) = 24.31, p = 0.000					
		B40	1.0	2.4	25.2	40.2	31.2
		M40	0.7	2.1	24.0	41.3	31.9
		T20	0.5	1.5	25.4	39.6	33.0
		Values of chi-square test, χ^2 (8, N = 2747) = 4.00, p = 0.857					
9.	RE resources should be effectively used to meet the rapid increase in energy demand.	Science	0.3	2.5	12.1	32.3	52.8
		Non-Science	1.2	2.8	18.8	34.0	43.3
		Values of chi-square test, χ^2 (4, N = 2768) = 40.93, p = 0.000					
		B40	0.7	2.7	16.5	32.1	47.9
		M40	0.9	2.7	13.6	35.6	47.1
		T20	0.5	2.5	16.0	31.2	49.8
		Values of chi-square test, χ^2 (8, N = 2750) = 7.11, p = 0.525					
10.	I do not think that traditional energy production techniques destroy the environment.	Science	10.5	16.2	39.3	21.6	12.5
		Non-Science	10.1	11.2	41.7	21.7	15.3
		Values of chi-square test, χ^2 (4, N = 2771) = 17.25, p = 0.002					
		B40	8.2	12.2	41.8	22.2	15.6
		M40	11.3	15.1	39.9	21.6	12.1
		T20	13.2	15.0	38.8	20.5	12.5
		Values of chi-square test, χ^2 (8, N = 2753) = 22.45, p = 0.004					
11.	I believe that all countries should use nature-friendly RE resources.	Science	0.9	2.2	16.8	29.5	50.6
		Non-Science	1.5	3.7	19.3	29.2	46.3
		Values of chi-square test, χ^2 (4, N = 2764) = 12.47, p = 0.014					
		B40	1.3	2.9	18.9	28.8	48.1
		M40	0.6	3.6	18.6	30.2	47.1
		T20	1.8	2.0	15.8	29.3	51.1
		Values of chi-square test, χ^2 (8, N = 2746) = 12.14, p = 0.145					
12.	RE and its resources are subjects that I have no idea about.	Science	25.3	23.8	28.9	14.2	7.7
		Non-Science	20.7	21.4	33.5	16.3	8.1
		Values of chi-square test, χ^2 (4, N = 2767) = 14.71, p = 0.005					
		B40	23.4	21.4	31.3	15.8	8.1
		M40	23.3	23.5	29.9	16.1	7.2
		T20	22.0	24.0	32.6	13.1	8.3
		Values of chi-square test, χ^2 (8, N = 2749) = 6.07, p = 0.0640					

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Statements		Background	Percentage (%)				
			Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
13.	I believe that the use of RE resources, which are also named as clean energy resources, is more limited when compared to the use of traditional energy resources.	Science	8.7	12.9	34.6	30.5	13.4
		Non-Science	7.3	10.0	36.5	29.7	16.6
		Values of chi-square test, χ^2 (4, N = 2770) = 12.63, p = 0.013					
		B40	7.2	10.6	34.2	31.3	16.7
		M40	9.2	10.7	38.4	28.1	13.6
		T20	7.9	14.2	34.4	30.2	13.2
		Values of chi-square test, χ^2 (8, N = 2752) = 17.48, p = 0.025					
14.	I do not believe that RE resources will be easier to use for me.	Science	18.9	24.9	34.0	15.6	6.7
		Non-Science	15.9	22.0	37.0	18.2	6.8
		Values of chi-square test, χ^2 (4, N = 2771) = 10.64, p = 0.031					
		B40	16.2	22.6	37.0	16.7	7.5
		M40	18.7	23.7	34.2	16.5	7.0
		T20	18.2	25.2	34.4	17.7	4.5
		Values of chi-square test, χ^2 (8, N = 2753) = 11.00, p = 0.202					
15.	I am not attracted to the RE resources because they require advance technology.	Science	29.4	26.8	26.2	12.2	5.4
		Non-Science	24.8	24.6	31.8	13.5	5.3
		Values of chi-square test, χ^2 (4, N = 2761) = 14.87, p = 0.005					
		B40	25.3	25.0	30.4	13.4	5.9
		M40	26.4	27.4	27.6	13.2	5.4
		T20	32.2	25.2	27.6	11.1	3.8
		Values of chi-square test, χ^2 (8, N = 2743) = 15.72, p = 0.047					
16.	I would not prefer RE because I think it is not easy to use, although it is needed for the environment.	Science	30.1	26.7	25.2	12.1	5.8
		Non-Science	24.7	23.6	32.7	13.5	5.4
		Values of chi-square test, χ^2 (4, N = 2769) = 24.46, p = 0.000					
		B40	25.8	24.4	30.8	13.0	6.0
		M40	27.5	26.0	26.3	13.7	6.5
		T20	31.3	25.7	28.7	11.1	3.2
		Values of chi-square test, χ^2 (8, N = 2751) = 19.01, p = 0.015					
17.	I use fossil fuel but I do not know anything about their disadvantages.	Science	28.5	25.1	29.0	12.4	5.0
		Non-Science	22.7	21.6	35.6	14.3	5.7
		Values of chi-square test, χ^2 (4, N = 2768) = 24.36, p = 0.000					
		B40	24.5	22.6	34.3	13.4	5.3
		M40	26.4	23.8	29.7	14.5	5.5
		T20	26.9	24.1	32.2	11.7	5.0
		Values of chi-square test, χ^2 (8, N = 2752) = 7.49, p = 0.485					

Continued on next page

Statements		Background	Percentage (%)				
			Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
18.	I do not believe that global warming would cause a very important problem and related to our energy usage.	Science	49.0	15.0	20.1	9.1	6.8
		Non-Science	42.0	14.4	24.5	12.3	6.8
		Values of chi-square test, χ^2 (4, N = 2764) = 20.28, p = 0.000					
		B40	43.5	15.3	23.4	10.6	7.2
		M40	46.6	15.3	19.9	11.1	7.0
		T20	48.3	12.6	23.5	10.3	5.3
		Values of chi-square test, χ^2 (8, N = 2747) = 10.52, p = 0.230					

There are significant differences ($p < 0.05$) in both statements about the influence of education and knowledge on future energy practice and RE choice between individuals in the two educational backgrounds. Similar results can be observed with regards to the family economic status, but only limit to the second statement which is 'Knowledge on the environment influence RE choice'. Education has a strong influential factor for shaping general environmental knowledge and energy awareness [34,35]. Nevertheless, education contribute to awareness and it is one of the best ways to transform human behaviour; that has a mutual influence on attitude, especially for the rational use of energy even require long-term investments [36]. This is in line with another research which claimed that individual literacy on energy is primarily determined by education and reflected to rational decision making [37]. Now, energy literacy is an important life skill that is able to empower our young generation as well as the general public [38]. Information and human behaviour must be fundamental elements of any policy that aims at the social and economic development of a population [39].

With respect to 16 statements that were used to discover the perception and interpretation of university students on RE, most of the respondents voted 'undecided' on half of these self-reported statements. These included the statement on Malaysia as a leader in RE development in ASEAN, the current development of Malaysia on solar energy potential, the richness of biomass energy resources in Malaysia, the impact of traditional energy production techniques in destroying the environment, an idea of respondents on the RE and its resources, limitation of RE resources as compared to conventional energy resources, the ease of RE resources usage, and, the disadvantages of fossil fuels. It revealed that most of the respondents are not aware of current RE development, especially in Malaysia and the impacts of fossil fuels to the environment. These are obviously observed among students with non-science educational background and those who came from B40 groups. The chi-square test of independence shows that there are significant differences ($p < 0.05$) in all these statements between individuals in the two educational backgrounds and four out of eight statements between individuals in the three groups of family economic status.

Different responds were observed on two statements with regards to both educational background and family financial status. There are, *'I am not attracted to the renewable energy resources because they require advance technology'. 'I would not prefer renewable energy because I think it is not easy to use, although it is needed for the environment'.*

Most of the non-science students were voted 'undecided', as compared to science students who were 'strongly disagree' for both statements. With regards to family economic status, similar

response can be observed between respondents from group B40, who were frequently voted 'undecided' and T20 who were 'strongly disagree' for both statements. For respondents from group M40, they were 'undecided' on the first statement, while 'strongly disagree' with the second statement. Further chi-square test shows that there are significant differences ($p < 0.05$) between individuals in the two educational backgrounds and the three groups of family economic status in both statements. This indirectly supports the previous findings indicating most of the respondents with non-science educational background and those who came from B40 groups are not aware of current RE development.

For the other six statements, there are no differences of responds perceived with regards to both educational background and family economic status. Most of them 'agree' that Malaysia currently uses its existing potential in RE and Malaysia should develop its biomass energy potential. Furthermore, they answered 'strongly agree' that Malaysia can do more in RE development, RE sources should be effectively used to meet the rapid increase in energy demand and believe all countries should use nature friendly RE resources. Lastly, all of them were 'strongly disagree' on the statement which expressing hesitation about the contribution of energy usage to global warming, that has caused a critical problem. Results of the chi-square test for the research samples on these six statements show that there are no significant differences ($p > 0.05$) between individuals in the three groups of family economic status, except for one statement on the trust of respondents about current use of existing potential in RE by Malaysia. With regards to two different educational backgrounds, there are significant differences ($p < 0.05$) of responds for four out of the six statements. These include the statements on the need of Malaysia to develop biomass energy potential, the effectively use of RE resources to meet the rapid increase in energy demand, the necessity of all country to use nature-friendly RE resources and the relation of our energy usage on global warming that would cause a very important problem. Merely, the proportion of subjects who respond the statement on capabilities of Malaysia to do more in RE development statement did not differ by both educational background and family economic status.

Comparatively, another research in Turkey reported a higher awareness level about RE sources among university students [21]. Similar finding was also identified by another researcher which determined all respondents are aware of the significance of education relating to RE sources [1]. These are in line with the current development of RE sources in Turkey that is more diverse with a higher percentage in the energy mix in comparison to Malaysia. On the other hand, Table 4 depicted policy instruments of countries in South-East Asia for future renewable energy awareness study and outlook.

Table 4. Energy policy instruments of South-East Asian countries and access to electricity [26].

Countries	Energy policy instruments	Population electricity access
Malaysia	Capital subsidies, Feed-in-tariff	Very High
Indonesia	Feed-in-tariff	Intermediate
Brunei	Need to be developed	Very High
Singapore	Tax incentives, Feed-in-tariff, Permits	Very High
Myanmar	Need to be developed	Intermediate
Thailand	Tax incentives, Feed-in-tariff, Permits	High
Philippines	Renewable Portfolio Standard, Capital subsidies, Tax incentives, Feed-in-tariff	High
Cambodia	Tax incentives, Permits	Low
Vietnam	Tax incentives, Feed-in-tariff, Permits	Intermediate
Laos	Tax incentives, Permits	Low

The renewable electricity generation in Malaysia for year 2016 is only from two sources, which are hydro (20,019.0 GWh) and solar PV (310.0 GWh), while there are four sources with higher capacity of renewable electricity generation in Turkey including geothermal (4,819.0 GWh), hydro (67,231.0 GWh), wind (15,517.0 GWh) and solar PV (1,043.0 GWh) (IEA, 2020). Unfortunately, the comparison of awareness between these two countries is not holistically comprehensive due to the different aim and respondents. The intention of this study is to explore the perception and interpretation of university students regardless of their educational background to be selected as respondents. Both reported studies in Turkey above were only involved respondents with science educational background by focusing on the awareness elements. Although the questionnaire was adapted from these studies, some amendment was done to embrace the perspective of Malaysian. Thus, the generalisation of comparative findings are inappropriate, but it can be a kick start to initiate further studies to enhance the acceptance and development of RE in Malaysia as all of the studies shared a similar concern which is 'education'. The declined number of students taking science, technology, engineering and mathematics (STEM) in Malaysia over the years give an implication on the available professional talents needed for the country's development [40]. Referring to the findings of this study, the strong intervention is needed by introducing a basic science knowledge that related to daily life to non-science students especially on RE.

4. Conclusions

Most of the university students who participated in the survey agreed that solar energy should be in the focus for the future of Malaysia. This is aligned with the aspiration of Sustainable Energy Development Authority (SEDA) Malaysia. By order in rank, environmental responsibility, efficiency and cost are three factors that influenced their decision to use RE. Conclusively, they have a positive perception towards RE resources in both general and Malaysian context. In order to fulfil the rapid increase of energy demand, they are really optimistic on the development and usage of RE, including biomass energy. This approach should be extended to all countries especially in South East Asian region as they strongly believe that rampant energy usage could contribute to climate change.

Unfortunately, there is a gap on interpretation as most of the respondents are not aware on the disadvantages of fossil fuels and current RE development, especially in Malaysia. Most of the

respondents were voted 'undecided' on half of the self-reported statements in the questionnaire. These are obviously observed among students with non-science educational background and those who came from B40 groups. Therefore, more intellectual activities are needed to promote and increase the awareness about RE among university students including the information on current development, technologies and benefits of RE. As future leaders, the acceptance of young generation on RE is essential to realise the percentage increment of RE in the current energy mix and reducing dependency on fossil fuels. Concomitantly, this will help to reduce the impacts of climate change as resulted from combustion activities.

For further research, motivation, awareness and behaviour elements need to be included to get a comprehensive expression of the young generation about RE. Similar study should be done with the school children with appropriate approaches to ensure a reliable feedback. With regards to demographic profile, the analyses should not limit to educational background and family economic status only. Perhaps, it can be expanded to the broader aspects including the ownership of information technology and communication devices such as smartphone, computer, etc. with the purpose for measuring the capabilities of respondents to access to knowledge about RE.

Moreover, their preference techniques to receive knowledge that probably can be determined through open-ended questionnaire or focus group discussion with multiple activities to attract their attention. Thus, it will provide initial information that can contribute to the development of syllabus to increase RE literacy among the young generation, precisely school children and university students.

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Conflict of interest

The authors declared no potential conflicts of interest with respect to research, authorship, and/or publication of this article.

Author contributions:

All authors contributed equally in the preparation of this manuscript and research analysis.

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