The drivers to adopt renewable energy among residential users.

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Abstract. This study aims to examine the drivers to adopt renewable energy (RE) among residential users in Malaysia. Based on the theoretical framework of a consumer’s decision making process, an empirical study of the adoption of RE was conducted. A total of 501 residential users were used in this study. This study proved that perceived utility of new technology, perceived utility of new service, and perceived benefit of new technology are the drivers to adopt RE among residential users. These factors are known crucial to RE suppliers and producers because it will generate more demand from the residential users and the percentage of energy mix from RE sources can be increase.

1. Introduction
Malaysia population is growing at an average of 1.2% every year and this growth has led to the increase of energy consumption at 2.3%. The demand of energy consumption between 2007 and 2012 is increased by 25% in Peninsular Malaysia. Moreover, in 2012, 36.8% of the energy demand came from transportation segment, 29.8% consumed by industrial sector, and 16% used by non-energy sector i.e. residential and commercial [1]. Past trends state that petroleum has generated a major source of energy mostly in the transportation segment. According to [2], the uses of crude oil, petroleum, natural gas, coal, and hydropower to supply the energy across Malaysia have declined between 2007 and 2012. The main reason behind the slight shortage used of fossil fuel sources is due to the continuous effort by the government to replace sources of energy with renewable sources. Moreover, high dependent use of fossil fuels have caused in increasing the global warming. Due to that, the alternative energy solution which is renewable energy (RE) should be capitalized and commercialized to the users. The slow growth of using RE is not only recorded in developing countries but also reported in developed countries like UK which to date is recorded only 5% of UK population is using RE. They expect the number will grow to 15% in 2020, however the progress is slow.

The government commitment towards mitigating the climate change is proved through the establishment of Sustainable Energy Development Authority of Malaysia (SEDA Malaysia) in 2011. This statutory body is formed in the conjunction with the implementation of Sustainable Energy Development Authority Act 2011 (Act 726) and RE Act 2011 (Act 725). As at 2012, renewable sources of energy supply such as biomass, biogas, and solar was only at 0.4% [1]. The figure indicated that the policy makers, RE providers and suppliers must combined efforts to create awareness among residential users to adopt the RE. Publics’ interest in RE becoming strong and growing because minimizing use of fossil fuels and tendency to use RE will ensures the better global climate change [3;4]. Furthermore, as
the demand for RE in the emerging markets is growing significantly, it is important to understand the residential users’ attitude towards the intentions to use the RE.

Over the last two decades (1990-2010), a numerous of studies have been executed to identify the factors influencing attitude of the potential users’ towards RE in different western countries. Then, those factors can be classified into three major clusters namely social, political or regulatory and technical [5]. However, lack of studies tries to identify the driver factors to the intentions to adopt the RE. Thus, this study aim to study the perceptions of residential users towards the driver factors associated with the adoption of RE. The results of this study later could help the policy makers, RE providers and suppliers to better understand the factors that have contributes to the adoption of RE. The remainder of paper is structured as follows. This study first review the relevant literature. The following section details the method applied. The third part is to discuss the findings and the last part is the conclusion.

2. Literature Review

2.1 Research Model and adoption to use

With regard to adoption behavior related to the new technology, Theory of Reasoned Action (TRA), and Technology Acceptance Model (TAM) have been the most fundamental and influential theories discussed by researchers. These models study about human behaviors’ are preceded by subjective norms, individual attitudes, perceived usefulness, and perceived ease-of-use of technology. Therefore, to discuss the residential adoption of RE, it is important to identify residential perceptions that influence intentions to adopt RE. Several studies have discussed adoption behavior with regards to technology such as telephone, social media, search engines, and RE using TRA or TAM [6;7;8;9;5]. The positive beliefs toward innovative technology in products or services perceived by consumers and will drive them to form an adoption intention to use the technology. Most of the time, to fulfill the adoption intention, consumers will proceed to form the purchase intention to buy the product or service. The construct of adoption intention is defined as the likelihood that a person will intend to use an innovative product [10].

2.2 Perceived utility of new technology, perceived utility of RE, and perceived benefit of new technology

Perceived usefulness, perceived ease-of-use, and perceived enjoyment are the crucial beliefs that influence user adoption intention [11;12]. Subsequently, the TAM theory is well adapted to this study. Another essential point is the understanding of the attributes of an innovation. This is because individual beliefs related to these attributes are significant predictors of future adoption and use [13]. According to [10], in the research fields of marketing and advertising, some studies have proposed the concept of perceived utility (tangible or intangible) to discuss the related identified perceptions of consumer acceptance. For that reason, the construct of perceived utility has been adopted in this study. The perceived utility of a new technology refers to the consumer’s overall evaluation of the utility based on the perceptions of what is obtained from the technology.

According to [14], the consumers’ are focused on the importance of a technology’s as the extrinsic value and against the intrinsic value. Moreover, as the extension of Roger’s diffusion model, Moore has indicated that the differences between the needs and behaviors of each adopter may stall the transition between stages. Besides, [14] observed that although forerunner adopters will tend to respond to the intrinsic value of a new technology, but most consumers will seek the extrinsic benefits embedded in the service [15]. Due to that, the researchers must focus to the extrinsic benefits with respect to service adoption.

When evaluating a new product or service for possible adoption, consumers weigh the benefit against the cost of adoption, and if the perceived benefit overweights the perceived cost, consumers are more likely to adopt [16]. As suggested by Construal level theory (CLT), the costs (e.g. monetary cost,
learning effort, time commitment) of adopting a new product or service are construed as low-level, whereas the benefits of adopting a new product or service (e.g., that which enables one to do new things) are construed as high-level. Moreover, when considering the possible adoption of a new product or service, feasibility considerations are important only if the adoption is desirable, but desirability remains important whether feasibility is high or low. Desirability of a new product or service would thus result from the perceived benefits of adopting the new product or service, whereas feasibility would be derived from the perceived costs of adopting the new product or service. Thus, the following hypotheses are proposed:

**H1:** Users’ perceived utility of RE technology will have a positive influence on their intention to adopt a RE.

**H2:** Users’ perceived utility of RE services will have a positive influence on their intention to adopt a RE.

**H3:** Users’ perceived benefits of RE will have a positive influence on their intention to adopt a RE.

From the Figure A1 (refer appendix A), the conceptual model is incorporating driver factors as the observed factors for intentions to adopt RE. In this model, drivers of RE are treated as the independent variable and adoption intentions of RE as the dependent variable.

3. Research Methodology

This study was able to obtain 501 respondents from residential users living in Klang Valley. Klang Valley is selected because it is the largest metropolitan areas that support the largest heterogeneous individuals as well as homogenous group of people in Malaysia. Besides, Klang Valley is fortified with modern facilities, compared to the other states in Malaysia [17]. Also, self-administer questionnaire using convenience sampling will be applied for this study. The subjects in this study involved adults over 18 years of age with consumption capability and behavior [18]. A pre-test of the questionnaire was performed with 20 subjects. All comments and suggestions received led to several minor modifications and then, the questionnaire is subsequently been revised. The process of distribution and collection of the questionnaires was carried out over a period of three months. Analysis of the socio-demographic data from the all valid questionnaires also indicated that the seven personal information items were adequately representative of this study sampling requirements. Table A1 (appendix A) presents the sample demographics.

The survey questionnaire is consist two parts. The first part indicates the drivers to adopt RE. The second is the subject’s demographic information. Data will be obtained using a six point Likert-type scale, ranging from ‘strongly agree’ to ‘strongly disagree’. A total of 21 items will be used to justify the first part of the questionnaire. All items are adapted from [10] and [19]. Furthermore, the items used is based on three earlier theories developed by [20;10;21]. The data then has been analysed using Partial Least Square (PLS). The analyses were conducted in two stages. First, the measurement model was tested to ensure that the constructs had sufficient psychometric validity. Then, it was followed by an assessment of the structural model in which the hypotheses were tested. A bootstrap resampling procedure also conducted to estimate the coefficients.

4. Findings and discussions

After data collection, measures were subjected to a refinement process to assess their construct reliability, convergent validity, and discriminant validity. The Cronbach alpha values ranged from 0.841 to 0.920 for four constructs that exceed the 0.7 threshold [22]. The values indicates that the high internal consistency of measure reliability and in line with [23]. Likewise, the composite reliabilities for all measures were high, ranging from 0.904 to 0.949. As shown in Table A2 (refer appendix A), twelve
items of construct loaded is higher than 0.8, ranging from 0.804 to 0.941. Additionally, the R square value is reported at 0.564. It indicates that 56.4% variations of intentions to adopt RE is explained by the model using perceived utility of new technology, perceived utility of a new service, and perceived benefit of new technology as predictors. The remainder of 43.6% remains unexplained and may be due to the other predictors which are related to intentions to adopt RE.

Next, the item total correlations for these construct (see Table A3 in the appendix A) was examined. The correlation pattern indicated that every item had a stronger correlation with its construct than another construct. Moreover, the average variance extracted (AVE) also represented the value higher than 0.5 which ranged from 0.760 to 0.862, were above the recommended threshold of 0.5 [24]. In general, the results show that all the four constructs namely relative perceived utility of a new service, perceived benefit of new technology, and perceived utility of new technology are all valid measures of their respective constructs. Moreover, the square root of each AVE (shown on the diagonal in Table A3) is greater than the related inter-construct correlations in the construct correlation matrix, indicating adequate discriminant validity for all of the reflective constructs [25]. Therefore, the discriminant validity was confirmed.

To validate the proposed hypotheses and the structural model, the path coefficient between two latent variables is assessed. The results of structural model is used the bootstrap procedure with 5000 times of resampling. Based on previous studies, the path coefficient value needs to be at least 0.1 to account for a certain impact within the model [26;27]. Assessment of the path coefficient (see Table A4 in the appendix A) shows that all proposed hypotheses are supported. From the analysis, supported hypotheses are significant at the level of 0.01, have expected sign directions (i.e., positive) and consist of a path coefficient value ($\beta$) ranging from 0.208 to 0.471. Based on the analysis, it indicates that the intentions to adopt RE are influenced by perceived utility of new technology ($\beta=0.471, t=28.985, p<0.001$), perceived benefit of new technology ($\beta=0.208, t=16.740, p<0.001$), and perceived utility of a new service ($\beta=0.238, t=15.546, p<0.001$). These results have indicated the similar findings from previous studies [10;9;28;29].

5. Conclusion
The policy makers, RE technology providers and services could have a chance to recognize and identify the factors that drives the residential users to adopt the RE. Analyzing and understanding those factors is very essential because it will affect the decision to adopt the RE among the residential users. The results have indicated factors i.e. perceived utility of new technology, perceived utility of a new service, and perceived benefit of new technology are significantly influence the residential users to adopt the RE. By knowing these factors it may increase the level of RE usage among the residential users. Thus the support from the RE producers are much needed in order to increase the use of RE in Malaysia.

Since this study was limited to residential users in Klang Valley, therefore in future, the researcher can further expand the geographical areas in Malaysia. Identifying others related factors of motivating and inhibiting the residential users to adopt the RE also needed. By doing so, the policy makers, producers and services of RE technology could have benefits with the future study. Future studies could focus on the specific type of RE sources rather than the whole scope of RE sources. It would also be interesting to compare the adoption of RE sources in Malaysia.
References

[1] Energy Commission Malaysia 2014. Towards a world-class energy sector: Spark of efficiency ensuring national energy security vol 1 (Kuala Lumpur: Percetakan Skyline Sdn. Bhd.) p 36-9

[2] U.S. Energy Information Administration 2014 (Malaysia Primary Energy Consumption Statistics) retrieved from: http://www.eia.gov/beta/international/analysis_includes/countries_long/Malaysia/malaysia.pdf

[3] Clare H, Ready R, Eshleman J and Yoo J 2012 Pennsylvanians’ attitudes toward renewable energy (Harrisburg PA: The Center for Rural Pennsylvania) p 1-23

[4] Moriarty P and Honnery D 2009 Energy Policy 377 2469–74

[5] Alam S S and Rashid M 2012 Energy Research J. 3(2) 37-44

[6] Bruner G C II and Kuma A 2005 J. of Bus. Research 58 553–8

[7] Lu J, Liu C, Yu C-S and Wang K 2008 Information & Management 45(1) 52–64

[8] Wu J-H and Wang S-C 2005 Information & Management 42(5) 719–29

[9] Zahari A R, Esa E, Baharudin M H and Amat Paijan M I 2013 Terengganu International Management and Business J. 3(2) 34-46

[10] Teng W, Lu H-P, and Yu H 2009 Telecommunications Policy 33 628-41

[11] Davis F D 1989 MIS Quarterly 13 319–40

[12] Davis F D, Bagozzi R P and Warshaw P R 1992 J. of Appl. Social Psychology 22 1111–32

[13] Rogers E M 1995. Diffusion of innovations (vol 4) ed (New York, NY: The Free Press)

[14] Moore G and McKenna R 1999 Crossing the chasm: Marketing and selling high-tech products to mainstream customers (New York: Harper Business)

[15] Chakravorti B 2003 Harvard Business Review 82(2) 58–67.

[16] Wang Q, Dacko S, and Gad M 2008 Advances in Consumer Research 35 416-22

[17] Siwar C and Kasim M Y 1997 International J. of Social Economy 24(12) 1524-35

[18] Yuwa H W 2008 The future and me: Power of the youth market in Asia (New York: John Wiley & Sons)

[19] Hoeffler S 2003 J.of Marketing Research 40 406-20

[20] Ajzen I and Fishbein M 1980. Understanding attitudes and predicting social behavior (Englewood Cliffs, NJ: Prentice-Hall)

[21] Ajzen I 1991Organizational Behavior and Human Decision Processes 50(2) 179-211

[22] Nunnally J C 1978 Psychometric Theory (New York: McGrew-Hill)

[23] Nunnally J C and Bernstein I H 1994 Psychometric Theory (New York: McGraw-Hill)

[24] Barclay D, Thompson R and Higgins C 1995 Technology Studies (2:2) 285-309

[25] Fornell C and Larcker D F 1981 J. of Marketing Research 34(2) 161-88

[26] Hair J F, Ringle C M and Sarstedt M 2011 J. of Marketing Theory and Practice 19(2) 139-151

[27] Wetzel M, Odekerken-Schroder G and van Oppen C 2009 MIS Quarterly 33(1) 177-195

[28] Ahmad A, Rashid M, Alam S S and Omar N A 2014 J. Pengurusan 41 123-131

[29] Alam S S, Nik Hashim N N, Rashid M, Omar N A, Ahsan N and Ismail M D 2014 Renewable Energy 68 255-263
Appendix A

![Conceptual framework diagram](image)

**Figure A1.** Conceptual framework

| Description          | Frequency (N = 501) | %    | Description          | Frequency (N = 501) | %    |
|----------------------|---------------------|------|----------------------|---------------------|------|
| Gender               | Male                | 319  | Ethnicity            | Malay               | 353  | 70.5 |
|                      | Female              | 182  |                      | Chinese             | 95   | 19.0 |
|                      |                     |      |                      | Indian              | 37   | 7.4  |
|                      |                     |      |                      | Others              | 16   | 3.1  |
| Age                  | 30 years old and below | 90   | 18.0                 | Level of education  |       |      |
|                      | 31 to 40 years old  | 241  | SPM or STPM          | 58                  | 11.6 |
|                      | 41 to 50 years old  | 87   | Diploma              | 125                 | 25.0 |
|                      | 51 years old and above | 83   | Bachelor’s Degree    | 232                 | 46.2 |
|                      |                     |      | Master’s or PhD      | 82                  | 16.4 |
| Job                  | Professional        | 145  | Income               | Others              | 4    | 0.8  |
|                      | Top Management      | 43   |                      |                      |      |      |
|                      | Middle Management   | 139  |                      |                      |      |      |
|                      | Supervisory         | 33   | Less than RM 2,500   | 84                  | 16.8 |
|                      | Administrative or Clerical | 77   | RM 2,501 to RM 5,000 | 191                 | 38.0 |
|                      | Technical           | 41   | RM 5,001 to RM 7,500 | 103                 | 20.6 |
|                      | Others              | 23   | RM 7,501 or more     | 123                 | 24.6 |

Table A1. Demographic
Table A2. Results of measurement model

| Construct                          | Item | Loadings | AVE  | Composite Reliability | Cronbach’s Alpha |
|-----------------------------------|------|----------|------|------------------------|------------------|
| Intentions to adopt RE           | IU1  | 0.904    | 0.760| 0.904                  | 0.841            |
|                                   | IU2  | 0.903    |      |                        |                  |
|                                   | IU3  | 0.804    |      |                        |                  |
| Perceived benefit of new technology | PI1  | 0.926    | 0.815| 0.929                  | 0.888            |
|                                   | PI2  | 0.941    |      |                        |                  |
|                                   | PI3  | 0.919    |      |                        |                  |
| Perceived utility of a new service | PR1  | 0.920    | 0.814| 0.929                  | 0.886            |
|                                   | PR2  | 0.927    |      |                        |                  |
|                                   | PR3  | 0.859    |      |                        |                  |
| Perceived utility of new technology | PS1  | 0.911    | 0.862| 0.949                  | 0.920            |
|                                   | PS2  | 0.893    |      |                        |                  |
|                                   | PS3  | 0.902    |      |                        |                  |

Note: R square = 0.564

Table A3. Discriminant validity of constructs

|                        | Intentions to adopt RE | Perceived benefit of new technology | Perceived utility of a new service | Perceived utility of new technology |
|------------------------|------------------------|-----------------------------------|-----------------------------------|-------------------------------------|
| Intentions to adopt RE | 0.872                  |                                   |                                   |                                     |
| Perceived benefit of new technology | 0.414     | 0.903                             |                                   |                                     |
| Perceived utility of a new service | 0.600     | 0.152                             | 0.902                             |                                     |
| Perceived utility of new technology | 0.713     | 0.359                             | 0.703                             | 0.928                               |

Note: Values in the diagonal (bolded) represent the square root of the AVE while the off-diagonals represent the correlations.

Table A4. Hypothesis testing

| Hypothesis | Relationship | Std. Beta | Std. Error | T value | Decision |
|------------|--------------|-----------|------------|---------|----------|
| H1         | Perceived utility of new technology -> Intentions to adopt RE | 0.471 | 0.016 | 28.685 | Supported* |
| H2         | Perceived utility of a new service -> Intentions to adopt RE | 0.238 | 0.015 | 15.546 | Supported* |
| H3         | Perceived benefit of new technology -> Intentions to adopt RE | 0.208 | 0.012 | 16.740 | Supported* |

* = p<0.001