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Small-scale households renewable energy usage intention: Theoretical development and empirical settings

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ABSTRACT

The slow growth of acceptance is a major barrier to small-scale renewable energy development. This study examines the determinants of acceptance of small-scale renewable energy in Malaysia. The research model for this study was developed based on the theory of planned behaviour, the technology acceptance model, the diffusion of innovation theory and the existing literature on technology adoption. This study tested five hypotheses based on a survey, of 200 Malaysian urban residents and which used structured questionnaires. Multiple regression analysis results reveal that perceived ease of use, perceived behavioural control, awareness, relative advantage and cost reduction have significant impact on small-scale renewable energy usage intention. This study not only contributes to and extends our understanding of small-scale renewable energy purchasing behaviour, it also identifies the rationales for purchasing small-scale renewable energy. From a managerial viewpoint, the findings not only provide support for investment decisions but also take into consideration the concerns and needs of businesses and Malaysian government agencies.

1. Introduction

Sharp increases in investment in small-scale renewables clearly indicate that this field is a critical area of research in both academia and industry. Most of the existing research into renewable energy has looked at technology options, comparative costs, resource potential, environmental and social benefits, research and development, commercialisation, and technical performance [1]. Recently, Renewable Energy.com [2] cited a report by UNEP's Division of Technology, Industry and Economics (DTIE), from Bloomberg New Energy Finance, in stating that investment in renewable energy reached US$211 billion in 2010—an increase in more than 32% from US$160 billion in 2009 and US$159 billion in 2008. This is nearly five and one-half times the figure achieved as recently as 2004. According to the report, investment increases were particularly noticeable in small-scale distributed capacity and government and corporate R&D. The total amount invested in small-scale renewable energy and government-funded R&D was US$68 billion in 2010, up from US$37 billion in 2009 and US$26 billion in 2008.

Renewable energy researchers reported potential growth in small-scale renewable energy due to the public's growing environmental consciousness and the increasing cost of energy. The Frankfurt School – UNEP Collaborating Centre for Climate & Sustainable Energy Finance has reported that small-scale renewable energy projects attracted $76 billion of investment worldwide in 2011, which is up one-quarter from the $60 billion spent in 2010, despite rapidly falling prices for photovoltaic (PV) panels [3]. According to the report, Italy invested US$24.1 billion, and Germany invested US$20 billion. The report also reveals that Japan, the US, Australia, the UK and France also made significant investments in small-scale PV panels [3].

The installation rates of small-scale renewable energy are also increasing in many countries, even though some countries have small populations [4]. However, Malaysians are very reluctant to use small-scale renewable energy for their house-hold energy needs. According to Ling [5], the Malaysian government has decided to increase the amount of electricity generated by renewable energy from less than 1% up to 11% by 2020. It is therefore

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important to create awareness of energy issues among the Malaysian public and to encourage a change of lifestyle that will boost renewable energy usage. To this end, it is important to identify the factors that influence Malaysian residents' small-scale renewable energy usage. Research into small-scale renewable energy from the user's perspective is available in developed countries [6,7]. Studies on renewable energy in developing countries, such as Malaysia, have largely highlighted technical and policy considerations [8–11]. However, there is a need for closer examination of small-scale renewable energy usage in specific countries. There exists a large research gap, particularly between developed and developing countries, which may differ significantly in their small-scale renewable energy usage [12,13]. Dewan and Kraemer [14] also have argued that research findings from developed countries are not directly transferable to developing countries. Spanos et al. [82] studied on information system implementation and found that system implementation depends on specific social, cultural, economic, legal and political context, which may differ significantly between countries and that limit the generalisation of the research results from developed countries to developing country context. These arguments justify an empirical research of Malaysians' awareness, perception and readiness or concern about their current and potential use of small-scale renewable energy to uncover the factors that encourage or deter small-scale renewable energy usage.

The rest of the study is organised as follows. We first will identify the relationships between certain important factors and intent to use small-scale renewable energy. Second, we will analyse the factors that influence intent to use small-scale renewable energy among urban residents of Malaysia.

2. Government initiatives for the enhancement of renewable energy

Recognising the benefits and importance of renewable energy, the Malaysian government has adopted several policies and measures to ensure economic, energy and environmental sustainability. Unlike the Australian government, the Malaysian government is not directly involved in household renewable energy projects. However, one of the major steps taken by the government has been to set a target for 2080 MW, or 11% of all electricity, to be generated from solar and other renewable sources by 2020 [15]. Energy efficiency in commercial building (MS1525) is another step included in the Fifth-Fuel Policy under the 8th and 9th Malaysian plans. Malaysian buildings integrate photovoltaic programmes (MBIPV) and Biomass [16] according to the requirements of the Kyoto Protocol. As of April 2011, Malaysia has adopted an advanced renewable tariffs system. In addition, in April 2011, the House of Representatives passed a Renewable Energy Bill (RE Bill) and a Bill for Sustainable Development Authority (SEDA Bill), pursuant to which the government will pay a 1% feed-in tariff (FiT) to a renewable-energy fund that has been effective since September 2011. Under the FiT project, eligible sources are biomass, biogas, mini-hydropower and solar energy. The Malaysian government is investing in infrastructure to provide grid access to electricity providers and buyers (power purchase agreements).

3. The conceptual framework for this study

The adoption of renewable energy from conventional energy sources is a socially oriented process in which individuals' perceptions play a pivotal role [3]. It can be argued that the diffusion of innovation (DOI) is similar to the study of renewable energy usage, and renewable energy it needs own study that has its own unique features [17]. Usage of technology is largely influenced by multidimensional forces that have societal, regulatory and economic dimensions [18–21]. Similar to other technological innovations, renewable energy has technical components. The theoretical debate over renewable energy technology has concluded that technology adoption is a dynamic rather than a static process. Thus, various studies have cited the diffusion theory of innovations [22]. Diffusion has been the topic of many researchers [23–26]. In the social sciences, DOI theory has been used widely in previous research [27–29]. Rogers [24] defined diffusion as "the process by which an innovation is communicated through certain channels over time among members of a social system". Out of five factors (i.e., relative advantage, compatibility, complexity, trialability and observability), the relative advantage factor has been found to have a significant and positive influence on new technology adoption intention [23,27,30,31]. However, this study aims to examine a preliminary understanding of household users' perceptions of the small-scale renewable-energy concept. This study does not examine the manner in which new renewable technology is transmitted to society. Hence, the theoretical framework should focus on users' pre-adoption perception of small-scale household renewable energy.

Users will certainly embrace renewable technology if they perceive that the new technology is simple to use and of higher value. As in Rogers's innovation diffusion theory, the Technology Acceptance Model (TAM) has been used in another basic theory of adoption of technological products and services [32]. TAM focuses on attitudinal explanations of intention to use a specific technology or service. The main predictors of the TAM model are "perceived ease of use (PEU)", which is defined as "the degree to which a person believes that using a particular system would be free of effort", and "perceived usefulness (PU)", defined as "the degree to which a person believes using a particular system would enhance his or her job performance" [33]. Another key component is "behavioural intention to use (BI)" [34].

Although researchers used TAM, and DOI separately to understand the determinants of individual's technology acceptance behaviour, few researchers have suggested to combine these models to cope with rapid changes of technology and to improve specificity and explanatory power [34,36,37,72]. Similarly, Wu and Wang [73] and Chen, Gillenson and Sherrell [74] suggested to integrate these two theories to provide stronger model than either standing alone. Sigala et al. [75] study integrated these two models to provide better research results. Theory of Planned Behaviour (TPB) is another widely utilised model in the technology acceptance research. Many researchers [76,77] used and suggested to combine Davis's TAM model and TPB model.

Davis's TAM and Rogers's DOI models are complementary; both are not only widely supported in the empirical research but also follow up that research. Rogers's two basic constructs are quite similar to Davis's model. Specifically, relative advantage is similar to Davis's usefulness, and complexity is similar to Davis's ease of use [35–37].

The Theory of Planned Behaviour [38] shares a number of common determinants of users' perception of and attitude towards new technology. Ajzen [38] stated that a person's action is determined by behavioural intentions, which in turn are influenced by attitude, subjective norms and perceived behavioural control (PBC). PBC influences the individual's decision through behavioural intention. Armitage and Conner's [39] empirical study supports this theory. Armitage and Conner's study confirmed that intention is one of the best predictors of behaviour. PBC is informed by beliefs regarding an individual's possession of the opportunities and resources needed to engage in the behaviour [38]. Based on these theories, among others, perceived ease of use, behavioural intention and perceived behavioural control have a significant link to the