SURVEY OF COMMUNITY SUPPORT FOR A RENEWABLE ENERGY SYSTEM IMPLEMENTATION PROGRAM IN SUMATERA, INDONESIA

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ABSTRACT
This paper explores some of the local drivers and barriers for an implementation program of a hybrid renewable energy system (HRESRWS) in the Mesuji – Tulang Bawang district (MTB) of the Lampung province on Sumatera. In this study, secondary data obtained from field surveys from the village of Tanjung Menang in the MTB have been analysed using quantitative and qualitative methods to assess the drivers and barriers for the program. Quantitative data are obtained from the survey questionnaires using Gutman and Likert scales. The results of the surveys indicate that although only 15% of the respondents currently use renewable energy via an existing renewable energy system (PKM) installed in Tanjung Menang, 72% of the respondents have a good technical understanding of the PKM and 79% of the respondents would have sufficient qualification to monitor and report on the HRESRWS. Overall 81% of the respondents indicate that they believe that their community would support the implementation program. It is concluded from preliminary results that there are sufficient drivers from within the community for the implementation program to be successful.

INTRODUCTION
The Lampung province of Indonesia has a population of approximately 7 million people of which 38% are below the poverty line. The Lampung government consists of 10 districts with 162 sub-districts and 2133 villages (BPS Lampung 2004). For two decades (1990-2006), the Lampung government has established a sustainable program featuring public sanitation support programs (PSSP) and water supply systems (WSS) (BPS Lampung 2007). These programs were designed to combat the serious spread of disease brought about by poor water quality and water management systems that have led to sanitation water and waste water delivered to river basins. Diarrhea, dysentery, typhoid (in the dry season) and dengue fever and malaria (in the rainy season) are common diseases for village communities.

For the WSS, it was reported that 65-68% of households are supplied with water from wells. From the total achievement, 75% of water supply is only gained by a capital city – Bandar Lampung. The hygienic value of water quality (bacteriology criteria) of the...
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achievement was in the range of 55.45% - 57.32%. Comparatively, with the villages of South Lampung, it has been observed that the achievement of WSS has reached an extremely low value of 20%-39%. The lowest achievement of WSS was reported in the MTB of which 140 villages of 300 villages reached a value under 10%. It is not surprising that the spread of disease has periodically increased in the MTB for almost 30 years (Dinas Kesehatan Lampung 2007).

There are four main factors contributing to the increasing spread of disease for the MTB, namely (1) over 82% of the villages in the MTB are not provided with public facilities (water and electricity supplies); poor education facilities and limited numbers of local health centres; (2) the MTB has poor water quality since a large portion of its area is swamp valley; (3) geographically the MTB is located on the borderline between the Lampung and South Sumatera provinces and administratively is given low priority in the list of rural development projects of both provinces. Also the location is costly for goods transportation since it takes a long time (7-8 hours) for transportation from the provinces; (4) the character of the MTB people causes problems for the local government. People come from multi-tribes from Sumatera and Java islands in which cultural barriers (mostly violent behaviour towards one another) leads to destruction of public facilities (Yudiantoro & Ristanto 2003).

The geography and topography of the Indonesian archipelago leads to a huge distribution of rural and remote areas. This condition has been identified as a major barrier to the national rural electrification program since the cost of power supply in those places is very high. Based on a census, there are 18 million houses in rural areas where 46% of the houses are supplied with the state electricity public company (PLN). This condition indicates that another 10 million houses are not yet supplied by the grid (LAPI-ITB 1992). On the other hand, this condition has created significant opportunity for the application of renewable energy. The opportunity has created a wide variety of renewable energy system such as MWp Photovoltaic Rural Electrification Program in 1997 (Miller & Hope 2000).

As a result, due to the factors mentioned above, the MTB is defined as a critical rural area in Lampung - Indonesia. These factors also put the MTB community in a disadvantaged position in terms of gaining a better economic life and a better education for their children.

To solve the problems, it is urgent that affordable water and electricity supplies are provided. It has been suggested that utilization of local resources (people and materials), local energy and local technology are the main success factors for providing an affordable water supply (Pope et al 2004).

In 2004, the Pijar Cendikiawan Foundation (YPC) installed a single wind-driven water pumping system, called the Capillary Wind Pump (PKM) that was initially designed and constructed using only local resources. The PKM was installed in the village of Tanjung Menang, Mesuji sub-district, Lampung province Indonesia (Yudiantoro et al. 2006). The PKM program is part of the YPC mission to improve agriculture productivity, health life and education in neighbourhood of the village. Through intensive field observations, the YPC identified that the PKM required further development in order to meet the growth in demand for water and power. To this end, the YPC has obtained a
A research grant to develop the PKM into a hybrid system and to expand the system to other villages.

The main problem in developing the PKM is to determine a set of local resources (materials, tools, labour, etc) and to maintain these resources through correct procedures (Taufik & Yudiantoro 2004, Taufik et al. 2006, Taufik 2007). To address this problem, it is strongly recommended to conduct further research, analysing all of the available resource information and then mapping this resource information in order to compile a data base. The data base will then be used to provide the optimum characteristics of the PKM development. To obtain the data base, it has been strongly suggested in previous works that the research study include comprehensive field surveys (Noordwijk 2007, Taufik 2007). Refer to previous paper, Taufik et al (2006) suggests that the use of local resources that the use of local resources is an effective method for the PKM development. This is a critical factor for the next step of PKM development which is named as the HRESRWS research project.

The present study forms part of collaborative project between Murdoch University and the Pijar Cendikiawan Foundation (YPC). The primary objective of the project is to develop a set of performance criteria that can assess the feasibility of using a hybrid renewable energy system to supply the water and power needs of the community of Tanjung Menang in the MTB district. The secondary objective is to predict the impact of installation of the system on eleven other villages in the MTB area.

This paper deals with a part of the project that explores some of the local drivers and barriers for an implementation program of a hybrid renewable energy system (HRESRWS) in the MTB of the Lampung province on Sumatera. The paper uses secondary data from four baseline surveys to describe the necessary conditions for the MTB community to carry out the HRESRWS program in near future.

METHOD & PROCEDURES

Six baseline surveys were accomplished by the YPC in 2007, namely: (1) Survey of Technology Used; (2) Survey of Energy Used; (3) Survey of the Education (formal education); (4) Survey of Collaborative Work; (5) Survey of Existing Wind Pump Technology (Capillary Wind Pump-PKM); and (6) Survey of Electricity Supply (Taufik et al 2008). In this article, selected results from four surveys (surveys 1 to 4) have been analysed. Fig. 1 depicts the survey area in the Tanjung Menang village of the MTB area.

Standard formulations are used for calculating parameters associated with statistical samples and populations (Kenkel 1996). The sample size of the survey was determined by taking 10% of total population of the villages, which equated to 250 participants. In practice, there were only 200 respondents. The survey’s structure consists of two parts (Parts A and B). Part A is designed to measure general or basic information and Part B is designed to measure specific information provided in Part A. To produce quantitative data from the respondent’s answers the Gutman and Likert weighting scales were used. In general, the Gutman scale is used in Part A and the Likert scale is used in Part B. The Gutman scale consists a binary value, 1 for “Yes” answer and 0 for “No” answer. The Likert scale expresses a range of values for a given answer as depicted in Figure 2.
analysing the quantitative data from the questionnaires, the results are presented based on methods designed by the Teaching and Learning Centre (TLC) of Murdoch University (http://www.tlc.murdoch.edu.au). The results are be presented in two ways, analysis of the overall questionnaire and analysis of individual questions.

Fig. 1 Research location; (a) the Lampung province as a lower part of the Sumatera island in Indonesian archipelago (http://www.seasite.niu.edu) and (b) the Lampung province indicates its 10 districts (http://tapis.unila.ac.id).
RESULTS AND DISCUSSION

Survey of Technology Used
To measure the basic technology available for both electronic and mechanical devices, the survey focused on the familiarity of the MTB villagers in dealing with audio-visual devices such as radio, TV, DVD, traditional carriage/trolley, bike, motor bike, mechanical hand pump and diesel generator.

is the survey indicates that 150 villagers have a radio and 168 villagers like listening to radio; 15 villagers have TV and 164 villagers like watching TV; 5 villagers have a DVD players and 125 villagers often watch a DVD movie or music. It is predicted that the audio-visual technology would be a successful media for promotion, education and training program of the HRESRWS. The training material, indirect consultation-discussion and teaching-learning activities all could be prepared in various multimedia format, ready for presentation to the villagers.

However, considering previous studies on distance learning for adult literacy using multimedia (Aydm 2008 & Antonis 2008), this method alone does not provide a successful indicator for the HRESRWS implementation program since education and training are strongly depended on the types of learning materials and method of training procedure.
For mechanical and electrical technology, it is indicated that 163 villagers have a bike, 24 villagers have a motorbike, 31 villagers have a mechanical hand pump, 125 villagers have a traditional trolley and 15 villagers have a diesel generator. It is noted that some aspects of the mechanical technology available in the MTB community have the same function with as key HRESRWS components such as turbine blades and transmission system. These results suggest, at the very least, that the HRESRWS components are not products that are completely unfamiliar to the community and may even be a positive indicator of the potency of community involvement in relation to mechanical and electrical devices.

In measuring the villagers' skill on operating and repairing the devices, it is observed that none of the villagers have skills related to repairing TVs and DVDs and only 3 villagers have the profession of motorbike/diesel generator repairer. Logically, this means that the villagers will have a problem repairing any electronic or mechanical devices used in the HRESRWS program. This problem is likely to introduce delays in terms of the time required for operation and maintenance of the system.

**Survey of Energy Used**

For energy used, it was indicated in Yudiantoro (2003) that before the PKM installation the villagers have no experience with gas, solar and renewable energy resources. The survey shows that 15% of villagers have an experience with renewable energy via the PKM system. 153 villagers use wood for cooking, 64 villagers use kerosene for light and 11 villagers use coal to cook. This situation indicates that more effort may be required for implementing novel renewable energy technologies (e.g. PV/wind turbines) to villages in the MTB area.

For energy consumption in the MTB area, there are three main sectors observed, namely (1) energy cost for cooking; (2) electricity cost for battery charging; and (3) maintenance cost for the electronic devices. Fig. 3 shows that for each sector, the greatest number of respondents spend a low proportion of their income on energy consumption. There are three predicted conditions causing the low proportion, namely: (1) abundant energy resources are available for cooking e.g. woods and coconut shell; (2) Most of the MTB villagers are below the poverty line; and (3) the MTB villagers may put more budget allocation on water particularly in the dry season.

For the energy cost for cooking, it was observed that 125 villagers were grouped in the low energy cost/income ratio class, 42 villagers were grouped in the relatively low ratio class, 11 villagers were grouped in the moderate ratio class and 5 villagers were grouped in the relatively high ratio class. Only 3 villagers were grouped in the very high ratio class since these villagers run a small business such as wood processing, ice making and boat painting.

It is observed that the low energy cost/income ratio is related to use of wood for cooking. Considering the increase in prices of kerosene for cooking and diesel for electricity, it is observed that more villagers use wood for cooking, and kerosene and candles for lighting. This is a challenging condition for the HRESRWS program since a high capital investment is required to install the HRESRWS station. In the previous
study, Green (1996) indicated that pilot projects of renewable energy in Indonesia tend to fail due to high investment of renewable energy technology and low income villagers expected to sustain the pilot project.

For the energy cost for battery charging, it was observed that 137 villagers were grouped in the low energy cost/income ratio class, 34 villagers were grouped in the relative low ratio class, 14 villagers were grouped in the moderate ratio class and 3 villagers were grouped in the relatively high ratio class. Only 4 villagers were grouped in the very high ratio class groups, 3 of whom have been referred to above in the very high energy/income ratio for cooking and 1 villager is running a DVD rental studio.

The results of the energy use survey promote the idea that villages in the MTB are potential markets for introducing renewable energy technologies (PV, solar thermal application, batteries charging, biomass and wind). The situation in the MTB is similar to several previous studies that propose the implementation of renewable energy in developing countries situation described (Bhuiyan et al 2000, Singal 2007, Sharma 2007 & McEachern 2008). In particular, it has been observed in Dasuki et al. (2001) that villagers' income and productivity in Indonesia have been increased by deploying solar thermal for cooking and PV for lighting.

![Fig. 3: Distribution cost of energy consumption](image)

**Survey of Education (formal education)**

The results show that overall the villagers can demonstrate skills related to basic reading, writing and speaking. 71 villagers have graduated from junior secondary high school (equivalent to year 10-12 of the Australian educational system). This level of education is a supporting factor for the HRESRWS program.

In Part A of the survey on education, it was observed that 12 villagers had studied physics/chemistry, 76 villagers had studied finance/management/macro-economics and
52 villagers had studied metal working. This is a positive indicator towards successful operation and management of the HRESRWS program.

Results from Part B of the survey, indicate that 29 villagers have excellent ability in writing/reporting, 10 villagers have excellent ability on speech/explaining, 12 villagers have a high skill level in technical drawing and 20 villagers have professional training experience in metal working. This is a positive indicator of towards successful maintenance procedures of the HRESRWS program.

Survey of Collaboration Work

In this survey, the enthusiasm of the villagers towards conducting collaborative work have been identified (Part A) and a measure of the abilities of the villages in regards to operation and maintenance devices of public facilities is gained (Part B).

In the Part A, ten areas of interest that are related to collaborative work/projects have been addressed, namely: enthusiasm of villagers to (1) the idea of a collaborative group; (2) contributing idea to the group; (3) donate financial support to the group; (4) manage the group; (5) give tutorials to other group members; (6) undertake construction work; (7) design a specific project or product ; (8) write financial reports and/or look after account; (9) distribute component parts; and (10) undertake engineering work including operation and maintenance. Table 1 indicates the response from the villagers towards collaborative work.

<table>
<thead>
<tr>
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<th>Answer</th>
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</tr>
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<td>1</td>
<td>Enthusiasms of collaborative group</td>
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<td>15</td>
</tr>
<tr>
<td>2</td>
<td>Contributing ideas to the group</td>
<td>57</td>
<td>116</td>
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<td>3</td>
<td>Donating financial support to the group</td>
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<td>25</td>
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<td>4</td>
<td>Managing the group</td>
<td>154</td>
<td>35</td>
</tr>
<tr>
<td>5</td>
<td>Giving tutorial to members of the group</td>
<td>93</td>
<td>85</td>
</tr>
<tr>
<td>6</td>
<td>Construction work</td>
<td>127</td>
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<td>7</td>
<td>Designing a specific project or product</td>
<td>74</td>
<td>93</td>
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<tr>
<td>8</td>
<td>Writing financial report/accounting</td>
<td>129</td>
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<td>9</td>
<td>Part distribution</td>
<td>158</td>
<td>36</td>
</tr>
<tr>
<td>10</td>
<td>Engineering work including operation and maintenance</td>
<td>67</td>
<td>114</td>
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</table>

From Table 1, the majority of villagers are strongly enthusiastic about collaborative work. From the 10 areas of interests, 6 areas have significant values, 2 areas have moderate values and 2 areas have low values. The fact that 141 villagers indicated
financial support is very promising. There were significant numbers of villagers interested in being involved in project management (154), distributing component parts (158) and construction work (127). Moderate numbers of respondents were interested in the tasks of giving tutorial to members of the group (93) and designing (74). The tasks that had the least interest were those of contributing ideas to the group (57) and engineering works (67). The surveys conducted to date provide encouragement that the villagers of Tanjung Menang at least will look to get involved in various aspects of the HRESRWS program. It is important to note however that cultural - behavioural and sustainable aspects of rural community have to be considered a priority in the implementation of new technology in rural isolated areas (Seneviratne 2004, Sharma 2007 & Taufik 2007).

CONCLUSIONS AND RECOMMENDATIONS

Four out of six baseline surveys that were carried out by the YPC in 2007 have been analysed, namely: (1) Survey of Technology Used; (2) Survey of Energy Used; (3) Survey of the Education (formal education); (4) Survey of Collaborative Work. These surveys provide preliminary indicators as to the potential for success of the HRESRWS implementation program in the Tanjung Menang village and in the wider MTB area of the Lampung province.

From the Survey of Technology Used, it is indicated that the audio-visual technology available in the Tanjung Menang village can be used to enhance education and training related to the HRESRWS implementation program. Further surveys are required to identify the optimum format of the training material and to map critical factors for an education and training program.

It is also observed that the mechanical and electrical technologies available in Tanjung Menang have similar functions to some components of the HRESRWS. Furthermore, it is indicated that a few villagers of the village have the essential skills required to repair or modify the technology. Further surveys are required to identify typical local technology for supporting the HRESRWS implementation program.

From the Survey of Energy, the HRESRWS implementation program faces critical challenges in terms of economic and investment aspects. Abundant energy resources for cooking and low cost electricity for battery charging are defined as the most significant challenges. The growth in water and electricity demand for the Tanjung Menang village has created a new market for the HRESRWS implementation program. Further analyses on the economics of funding mechanism of the program, and on the available renewable energy resources in the area are required to optimise the HRESRWS pilot project for widening the potential market to the MTB area.

From the last two surveys, the results of the Survey of Education provide strong indication of success in terms of accelerating the HRESRWS implementation program, while the results of the Survey of Collaborative Work give strong evidence of interest in sustaining the HRESRWS implementation program in the MTB area.
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**BRIEF BIOGRAPHY OF PRESENTER**

Mr. Ahmad Taufik is an MPhil student at the School of Engineering and Energy, Murdoch University. He is also an activist as well as a principal researcher of a NGO in Indonesia dealing with renewable energy, named Pijar Cendikiawan Foundation. Since 2001, he has been doing several research studies in the areas of renewable energy, conservation energy and technological transfer (training and education) for a marginal people in developing country, particularly Indonesia.