Power from the People: The Empowerment of Distributed Generation of Solar Electricity for Rural Communities in Malaysia

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Abstract

This paper describes the decreasing energy security in Malaysia and the likely impact on maintaining power supplies to low income groups. The most vulnerable group is the low-income people in the rural areas, who have limited access to generate their own power supplies. The paper reviews the potential of distributed generation (DG) using photovoltaics as a means of mitigating this problem. Examples from other countries are reviewed and alternative methods of funding PV installations are discussed. Strategies such as community-based approach and innovative financing scheme will be introduced and discussed. The main objective is to utilize solar energy as the main energy resources for generating electricity and places rural people as the main stakeholder to deploy the strategic model. This model is also ideal to be integrated with the distributed generation (DG) system as one of the key components in developing a suitable energy policy that can helps to sustain the energy development of rural community in the future. The paper concludes that distributed generation (DG) is feasible and that innovative funding schemes are required based on local knowledge.

Keywords: Solar Photovoltaic, Distributed Generation, Financing Model, Sustainable Rural Community

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1. Introduction

In many developing countries in South East Asia, for instance Malaysia, Indonesia and Thailand, electrification of the grid system is centralized and controlled by the government or authorized corporate stakeholders. This type of electricity distribution model is prone to many issues of vulnerability as it is exposed to national and international energy security issues (Byrd, 2010), and carbon emission problems (Nel & Cooper, 2009) which will lead to unsustainable electricity distribution through the possibility of blackouts or load shedding due to grid systems failure. As these problems arise, people who depended on the supply of electricity via the grid become vulnerable and this can affect the livelihood of the people in the future. In the event of grid failures or load shedding it is likely that the more remote rural settlements, with lower income groups, are more vulnerable. As energy security decreases within the country, electricity from the grid may be cut-off to inadequate supply (Ahmad & Byrd, 2013).

Power outages, while often caused by technical errors at present, are a glimpse of the future when the electricity grid network is threatened by a lack of primary energy sources. Many ASEAN countries have passed peak oil production (IEA, 2007) and are threatened by an ownership dispute concerning territorial rights of the oil producing areas of the South China Sea (Energy Information Administration, 2008; Park, 1978; Severino, 2010). Malaysia, for instance, is heavily dependent on oil and gas from its fields in the South China Sea (International Gas Union (IGU), 2011) and to generate electricity, gas and oil constitute 93% of the fuel used to generate electricity (Ab Kadir, Rafeeu, & Adam, 2010). With the increasing rate of development and growth of population, electricity demand may become greater than supply and Malaysia is currently reviewing fuel sources to generate electricity including nuclear power (Oh, Pang, & Chua, 2010). Under these circumstances, energy security is improved by a more diverse source of fuels. One method is to introduce distributed generation (DG) system via renewable energy supplies in order to maintain adequate electricity supply. In this paper, deploying DG electricity using solar PVs will be discussed with the focus on sustainable rural livelihoods and financial mechanisms to make it available to lower income groups.

2. Sustainable Rural Livelihood

In 1986, the concept of “sustainable livelihood” was introduced during the World Commission on Environment and Development (WCED, 1987). The concept was then extended to include the rural population and introduced as “sustainable rural livelihood” by Chambers and Conway (1992). They defined a sustainable living as one which has four characteristics; capabilities, availability of assets and resources, and significant activities that can cope and maintain any shocks or disaster during livelihood. Through this concept, emphasis was made towards “securing the livelihoods of the rural poor” (WCED, 1987), and in 1998, this concept emerged effectively through the establishment of a sustainable livelihood framework (see Figure 1), which emphasised the human, natural, financial, social and physical capital (Scoones, 1998). This implies the need to face any vulnerability contexts that might compromise the livelihood of the people in many ways.

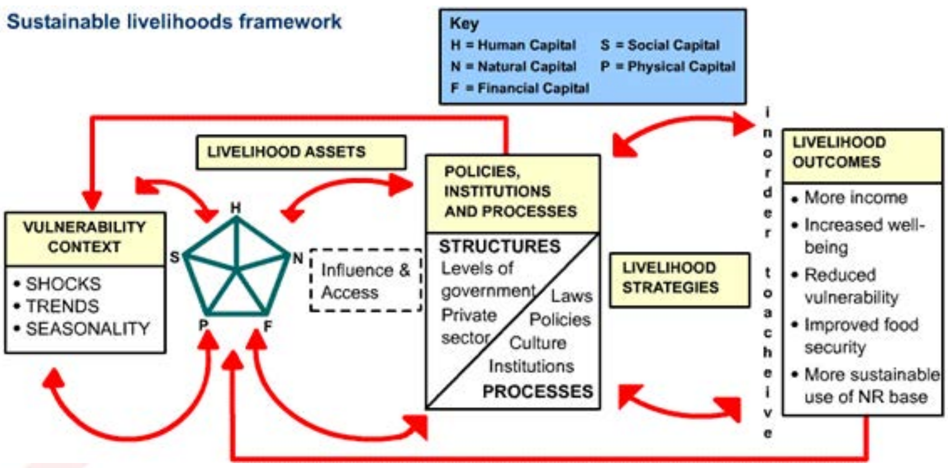

Figure 1: The Sustainable Livelihood Frameworks by Ian Scoones (1998).

To gain a sustainable livelihood requires a sustainable source of energy. At present Malaysia is dependent on fossil fuels to generate electricity, which is not sustainable. The electricity mix in Peninsular Malaysia is powered by resources of natural gas (45%), followed by imported coal (44%), hydro (5.7%), oil and petroleum (2.5%), distillate resources (2.5%) and small portion of imported resources (0.3%) (Noh, 2012) (see Figure 2) .

Currently the electricity grid network supplies all electricity in the country with only remote islands using DG electricity. This makes the population vulnerable to electricity load shedding (rationing) or blackouts should the imported coal or natural gas resources diminish. With the threat of electricity load shedding increasing and the likelihood of rapidly increasing prices, an alternative system based on localised generation of electricity becomes more financially feasible (Winter, 2007)

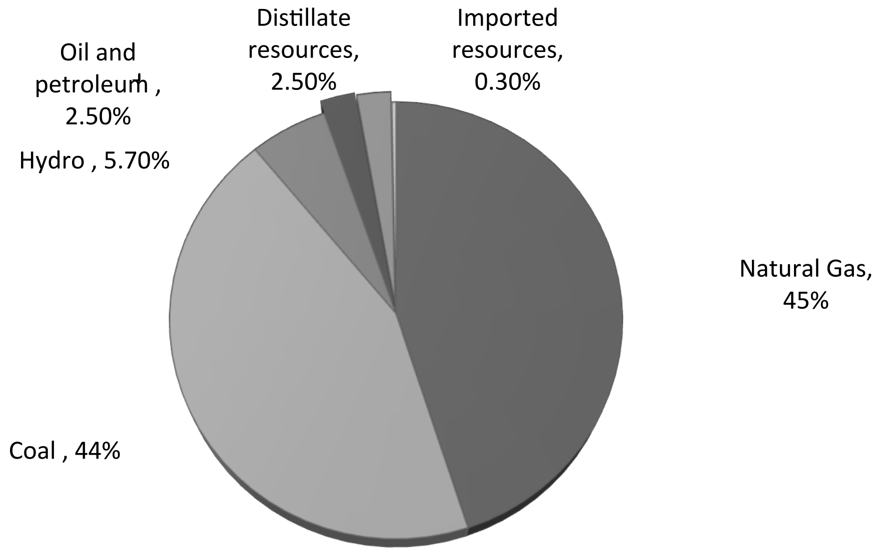

Figure 2: Generation Mix for Peninsular Malaysia (2011)
Source: Adapted from (Noh, 2012).

Livelihood strategies vary from individual needs, household needs, to a bigger context of village, states and nation (Chambers & Conway, 1992; Scoones, 1998). The cost-effectiveness of distributed generation depends upon the electricity demand profile of a community, not only for normal residential use but also for commercial activities that form the livelihoods of many of the rural community.

3. The Case of Malaysia: Solar Electricity and Rural Electrification.

The potential of exploiting solar energy for generating electricity through photovoltaics on Malaysian residential roofs is substantial, with an average irradiance per year of 1643 kWh/m^2 (Chua, Oh, & Goh, 2011) which is higher than Germany (1150 kWh/m^2), Spain (1613 kWh/m^2) and Japan (1400 kWh/m^2) (Lloyd & Forest, 2010). Through the establishment of the energy policy in the 9th Malaysia Plan (2006-2010) (Malaysia, 2006), PVs have been installed in many commercial and residential buildings in urban areas, but has not yet penetrated rural areas. At the moment, the price of PV panels for mass power generation is still high, between RM15,000 to RM 19,000 kWp (Jamaludin, 2009; MBIPV, 2011; Muhammad-Sukki, Ramirez-Iniguez, Abu-Bakar, McMeekin, & Stewart, 2011), which is far beyond the reach of the average homeowner if financing is not provided. This has becomes a constraint to the Government to introduce this technology to low income groups especially the rural communities.

Unlike many Asian countries, electricity coverage in rural Malaysia operates 24 hours a day throughout the country, with the coverage expanding from 79% in the 1970 to 95% in 2009 (TNB, 2009). Under the Rural Electrification Programme (BELB) which has been established by the Ministry of Rural and Regional Development (Jabatan Perdana Menteri Malaysia, 2011; Muhammad-Sukki et al., 2011), over 25, 000 MW of electricity (Naidu, 2010) was generated to fulfil household demand, which comprises 1/3 proportion from overall household's electricity needs in Malaysia. Electricity for rural areas has always been maintained at a lower price due to the aid of highly subsidized rate for electricity at 21.8 RM cents/kWh (TNB, 2012). Despite of the recent 19% increase in price for domestic electricity tariff (from 28.9 RM cents/kWh to 33.4 RM cents/kWh for 201kWh – 1000 kWh readings) (TNB, 2012), the electricity demand in housing sector continues to escalate every year averaging 4.9 percent growth per year for over the past 10 years (TNB, 2009).

People in Malaysia, especially the rural population are not fully aware of the consequences of energy insecurity and the potential impacts of a major power interruption. Only 1/3 of the population knows about renewable energy and from this population only 11% of the public know that this technology can be associated with electricity generation and this percentages came from well-educated people (university graduates) (Haw, Sopian, & Sulaiman, 2009).

Byrd (2010) has indicated that PVs mounted on the roofs of rural houses in Malaysia could generate about 25% of current electricity demand which shows a significant proportion of the electricity generation mix for Malaysia. This is due to the larger roof area provided by rural housing (averaging 92.5 m^2) in meeting the electricity requirements of low-energy households if to be compared with urban housing. In addition, the use of electricity in rural areas in Malaysia is lower than in urban areas. At the moment, houses in rural Malaysia correspond to only 27% of the electricity demand in Malaysia (TNB, 2009) which indicates that the surplus of solar energy can be shared widely to other communities in the country.

Based from the Ministry of Energy, Green Technology and Water (2012), Malaysia forecasts to achieve 985MW share of renewable energy in the energy mix by 2015. At present, renewable energy supplies less than 1% to Malaysian energy mix (KeTTHA, 2012). The share for solar PV is relatively small in comparison with the quota capacity from other types of RE, which is only 65 MW from 985 MW (Malek, 2010). However, the establishment of a Feed-in-Tariff in Malaysia has started to give more emphasis to solar PV. The fund was achieved by increasing the current electricity tariff by 1 %, and that amount was pooled into the FIT fund (Haris, 2010). The solar PV power will become competitive once there is an adequate reduction rate for this energy. It is expected that solar power in Malaysia will reach grid parity in 2017 (BERNAMA, 2010). By then, the government might have revised the capacity quota of solar PV energy to a feasible extent, making it viable for many, especially low-income people in rural areas. This will help rural dwellers gain access to the grid-connected solar PV system in order to generate income by selling energy back to the grid. This can only happen if there is a suitable enforcement programme for PV roof-mounted technology for rural housing. This is important in order to establish a way in which energy can be used efficiently in order to support social infrastructure despite the rising issues of fossil fuels depletion. It is necessary to advocate for solar energy as a means for creating sustainable lifestyles, especially for rural peoples.

4. Distributed Generation (DG) Using Solar Energy: Examples From Other Countries

DG is a system that involves small-scale power generation which is located at a strategic point near the consumption point, known as load centre points (Lai & Chan, 2007; Masters, 2007). The small scale loads at each DG point is usually range below than 50 MW systems (Brass, Carley, MacLean, & Baldwin, 2012) which can be connected from an owner (customer) and sold to a utility, where then power generated from this DG point can be sold (Lai & Chan, 2007). The owner can also use all of the power if needed (Masters, 2007) in an isolated way, or sell a portion of the power into the grid at an appropriate time (Lai & Chan, 2007). This type of generation is feasible, cost-effective, clean and can be integrated effectively with renewable energy resources (Farret & Simões, 2006). Brass, et al (2012) highlighted that DG system allow the owners to adapt energy supply to local demand and employ systems that suit their power consumption, which can be better than centralised grid networks. Figure 2 illustrates the basic concept of DG system.

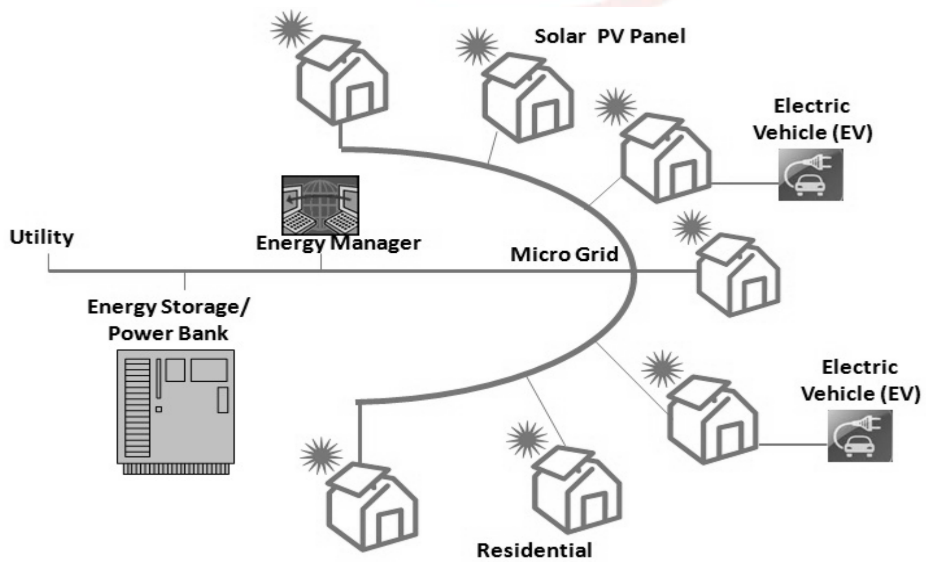

Figure 2 DG System Based On Solar Energy (illustrated by author)

Through the introduction of DG system, individual households will have alternative ways of generating their own electricity. The benefits of DG can be widely shared by many communities if the owners are able to supply the surplus of energy to the micro grids and share their electricity. However, there is a challenge that needs to be addressed in order to penetrate the DG system into Malaysian energy landscape. Focus need to be emphasised towards the suitable financing scheme that can be integrated to the system, which give benefit to owners and utility. Among the countries that are considering DG system for solar photovoltaic (PV) are European Union (EU) countries and Bangladesh. They viewed the potential for developing and establishing DG system in order to sustain long-term development outcomes and equitable energy resources (Biswas, Bryce, & Diesendorf, 2001; Brass et al., 2012; Dipal C, 2001; Rüther & Zilles, 2011).

For many developed countries, DG systems are gradually growing especially in the countries with bigger investment in renewable energy sector, for instance Germany, Spain and Denmark (Cossent, Gómez, & Frías, 2009). DG has been identified to help rural and poor communities in other parts of the world. In Bangladesh, an organisation known as Grameen Shakti has helped to install solar home system (SHS) for over 500,000 people in rural Bangladesh (Dipal C, 2001; Kabir, Dey, & Faraby, 2010). The application of solar PV technology through DG system has helped people to meet basic energy needs, increasing the quality of rural electrification in Bangladesh and is indirectly helping the people to generate additional income (Ahammed & Taufiq, 2008). The application of SHS has been identified to help reducing poverty and hunger through the increased income generation, increase education and safety through the application of solar lighting (Ahammed & Taufiq, 2008).

In Brazil, a larger scale of DG programs has been introduced to the people through many types of renewable energy projects. It is recognisable by many scholars that DG systems can help in providing a sustainable access to electricity for poor people (Borberly & Kreider, 2001; Weber & Vogel, 2008). Through DG programs, solar PV systems have been spreading across residential sector in Brazil due to its attractive tariffs, which is between US$ 0.17 (R$ 0.37) to US$ 0.39 per kWh (R$ 0.85) (Rüther & Zilles, 2011) and huge reduction of solar PV module prices from 23 US$/W in 1980 to 1 US$/W in 2012 (Jannuzzi & de Melo, 2013). According to Brazil's national energy agency, EPE, electricity from home solar panels is now lower than grid electricity which has created a competitive market (Nielsen, 2012). This has given an attractive option to home-owners in comparison with the price of grid-electricity in Brazil which is now rated at between US$ 0.19 (R$ 0.42) to US$ 0.47 (R$ 1.03) (Rüther & Zilles, 2011). With high electricity tariff, residential electricity users do not have any options than to consider solar electricity.

In India, through its NGOs, the Sadguru Foundation (Writers, 2009) and the Small-Scale Sustainable Infrastructure Fund (S^3IFD)(Sovacool, 2013) have embarked a Solar Lantern Project to aid rural people in gaining solar lighting without depending on international donor or financial institutions (Sovacool, 2013). This project established a simple renting scheme of light points for people which are charged from solar-powered batteries. Through a 'fee-for-service' model, many pro-poor rural people have formed small scale groups which amalgamate their savings to provide loans based on daily needs (Chaurey & Kandpal, 2009). Solar lantern projects have helped hawkers and home-owners throughout India by reducing 55% of the cost burden from kerosene lighting (from Rs 90 to Rs 50 for 5 days) (Sovacool, 2013). Many positive impacts gained from Solar Lantern projects especially in providing a longer duration of lighting supplied by the solar lanterns. Children can study in a longer period, women can perform household works at night and safety level in remote areas increased (Writers, 2009).

5. Strategies To Expand Distributed Generation Of Solar PV

Several scholars have argued on the importance of DG technology as the importance mechanism to diffuse solar PV energy on a national scale (Wüstenhagen & Bilharz, 2006; Zhang, Song, & Hamori, 2011). It is essential to identify the stimulant factors to promote and encourage people to deploy solar PV, especially for households needs. Cases in Germany and Japan have proven that, with government intervention and extensive subsidy policies, solar PV energy can be effectively diffused in many households (Beise, 2004; Zhang et al., 2011). It has been argued that in order to make solar PV energy possible for low-income people in rural areas, the best incentive is adopting the FiT scheme within the solar PV programme (Chua et al., 2011; Muhammad-Sukki et al., 2011; Zhang et al., 2011).

5.1 Community-based Approach

The 'community-based approach' is a concept that integrates all level of groups in the same community, from individuals to the wider community and can be extended to the generation and demand of energy within a community (Frame, Tembo, Dolan, Strachan, & Ault, 2011). The United Nations has highlighted the 'community–based approach' as a group "who recognizes themselves or is recognized by outsiders as sharing common cultural, or other social features, backgrounds and interests, and that forms a collective identity with shared goals" (UNHCR, 2008). M. I. Khan, Chhetri, and Islam (2007) and is usually considered as the main stakeholder. This mechanism is very important because it helps to disseminate and deploy energy beneficial-projects to locals with similar backgrounds and concerns with the aid of local leaders and public organisations (Frame et al., 2011).

Countries like Bangladesh (Mondal, et al., 2010; Islam and Islam, 2005) and Indonesia (Retnanestri and Outhred, 2011) have shown that a direct interaction with local people is a very important mechanism in educating and promoting this technology to rural people. This has been supported by Walker and Devine-Wright (2008) which highlighted that more local people should be involved in any energy projects in order to gain their support and understanding. This can be achieved by installing people' own micro-generation technology which encourage them to learn and to understand the technology (Dana Abi-Ghanem, 2011). Energy-community projects may be owned and managed by local organisations or community based cooperation (M. I. Khan et al., 2007). Using this approach, a head or leader of the community will consult with the government and disseminate information gained to the locals. Facilitators or trainers will participate in educating the people from individual unit (each household) to a neighbourhood and bigger community.

This is important, as part of the rationalization for public investment is to have stronger catalytic impacts in encouraging people to engage to renewable energy projects (Walker & Devine-Wright, 2008). For instance, renewable energy (RE) projects in India and Bangladesh proved that implementing a 'community-based approach' enables their government to persuade people to invest in local RE projects (Bhandari & Stadler, 2011; Dipal C, 2001; Writers, 2009). Through community project like Solar Home Systems and Solar Lantern programme, people are being educated through non-profit organisations on the importance of solar electricity for daily works. This does not necessarily mean that all people in the community have to be involved in a community-energy project, but more into gaining wider exposure and information towards every leader of the community, so that people understand and favour micro-generation projects (Sauter & Watson, 2007). Since local people will usually own these energy-community projects, more money will be re-circulated in the community, helping the locals into maintenance problems and strengthened local participation, communication and social engagements (M. I. Khan et al., 2007).

5.2 Innovative Financing Scheme

Innovative financing schemes can be defined as a range of non-traditional methods to increase additional funds for development aid; in this context - for renewable energy projects; through "innovative" energy projects (Girishankar, 2009). Among the popular innovative financing scheme are micro-financing, taxes and public-private partnerships (Girishankar, 2009).

5.2.1 Public-Private Partnership (PPP) Programmes

Public-private partnership (PPP) programme is a participation programme that involved by private organisations and the public sector which usually related with infrastructure projects (Sovacool, 2013), and for the context of this paper, it is focusing on energy infrastructure. This programme is also known as privatization or liberalization programmes and signifies broad relationships between national governments and public sectors, for instance local councils and state governments (Klaus, 2010). This relationship will be joined by private organisations which involve numerous organisations, for instance non-profit organizations (NGOs), finance institutions, manufactures, banks and private organisations, energy providers and the residents (Klaus, 2010).

The PPP programme can be associated with helping the poor communities in accessing energy services and providing a way for the residents to join the energy business venture based on 'community-based approach'. Under the PPP programmes, as underlined by Sovacool (2013), there are several types of approaches that suitable for low-income consumers, namely; (a) project finance model that provide soft loans and financial support from banks or financial institutions, (b) technology development model which focusing on the improvement of an affordable technology for the people, (c) micro-credit or micro-finance programme that helps the public to pay the technology periodically, (d) a co-ownership energy project which emphasised on the cooperation of the consumer and investors, where they can own the energy technology after certain period of time, (e) the 'fee for service' model which requires consumer to pay certain amount of fees for the energy services provided and (f) combination of all types of approaches.

In Malaysia, an example of small scale PPP projects has recently been established as a pilot project which similar to a 'rent a roof' scheme, with a target of small residential areas in Alor Gajah, Malacca. This project involves Malacca state government (public party), Green Earth Design Solution (GEDS) (private party), the residents of Taman Rembia Perkasa and an investor from Holland (Choong, 2012). With each installation of the solar PV panel performed at 5 kWp, the pilot houses will collectively contribute nearly 2 MWp of solar PV generation capacity to the Malaysian national grid. But, since the cost for each solar home will cost at least RM50,000 (MBIPV, 2011); which is 1/3 of an average house' prices in Malaysia, a supporting mechanism need to be underlined in order to aid the consumers within financial matters of employing solar PV technology into the grid. The private sector, GEDS will be responsible to finance the technology and the construction, together with the maintenance process for the duration of the contract period (11-years), which inclusive the entire system and all natural disturbances (Choong, 2012).

5.2.1.2 'Rent a roof' Scheme

Due to the limited financial resources of rural people, 'rent a roof' scheme can help rural dwellers earn an income from their own roof. Basically, there are two approaches to the co-ownership PV project. First, rural house owners have the mechanism to generate monthly income by 'renting' their roof areas to private investors or generating companies within agreeable rates and duration limits (Fricklas, 2010). The energy generated from the PV panels will be fully owned by the investors. This concept is very popular in Italy and Canada (Aanesen, Heck, & Pinner, 2012; Smith, 2007). Secondly, both parties (home owners and investors) reap equal benefits by installing PV panels at a cost supported by the investor. In return, the investor will profit from selling the electricity back to the grid within agreed upon revenue years. After the time is over, the house owner will claim ownership of the PV panels and continue to sell solar electricity to the grid (JFS, 2012; U Energy Solar, 2012). This is one way of beginning to solve the issue of the financial resources of low-income groups.

5.2.2 Social Bankability and Crowd Funding model

Many scholars agreed that there is a big hurdle of financing for clean and modern energy projects, especially renewable energy projects (particularly solar energy) in developing countries (Chandrasekar & Kandpal, 2005; Cossent et al., 2009; Girishankar, 2009; Kabir et al., 2010). In order to favour and to boost the market for distributed generation (DG) of solar PV technology, there is a need to gain crowd funding and to establish social bankability for energy projects. Crowd funding is one of the financial method that used to gather money from the public (Kaplan, 2013). At the moment, there are two examples of private organisations that have managed to establish an effective solar crowd funding platform, namely SunFunder (SunFunder, 2013) and Mosaic (Mosaic, 2013) that attract investors from the public to invest in solar energy projects using a simple periodical method as illustrates in Figure 3. The advantages of this model is (a) investors can invest only within a small cost of money (affordable to them) and able to choose their own community projects, (b) when the funding target achieved, the solar partners will start to facilitate and provide on-going energy services, thus, avoiding any hassle, (c) investors will be able to keep on track on their invested project through an online system, (d) increase the knowledge and attract the interest from local people and (e) secured with financial insurance. By this approach, funding for solar energy projects can be increased periodically in order to help poor-rural communities to gain this technology, without unduly dependent on government.

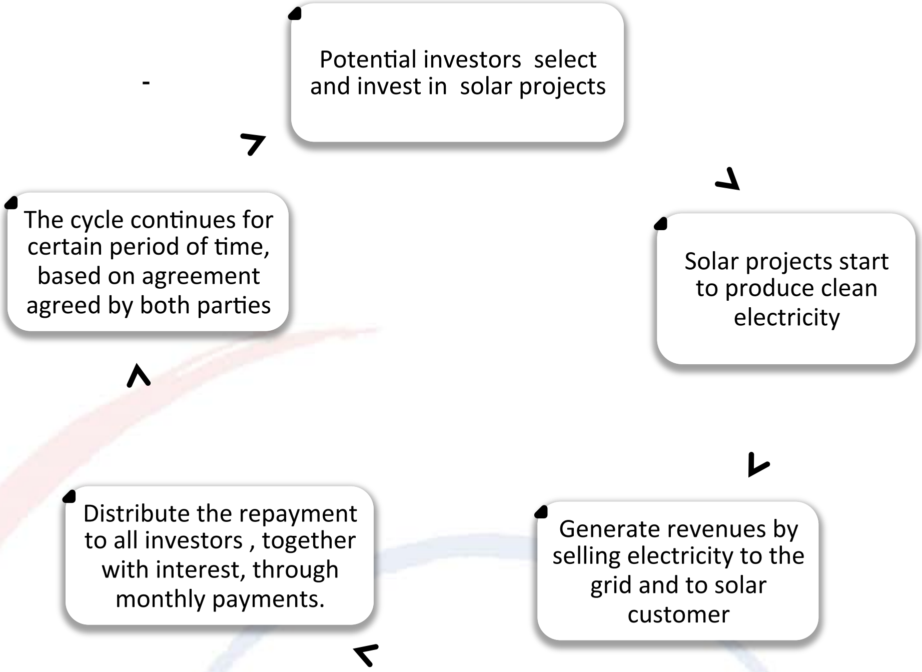

Figure 3 The cycle of crowd funding model

5.2.3 Micro-credit and micro-enterprises programme

A micro-credit programme is a fully structured financial aid scheme that helps people to access energy, parallel to a micro-enterprises programme, which provides technical training, maintenance service and product promotion at a mass level. This scheme has successfully been introduced in Bangladesh and had helped many rural women and small enterprises to generate income based on solar PV energy (Biswas et al., 2001; Dipal C, 2001; Kabir et al., 2010; H. J. Khan & Huque, 1998; M. I. Khan et al., 2007). This scheme allows peoples to pay different down-payments based on their monthly incomes and circumstances (Islam and Islam, 2005; Kabir, et al., 2010). People can choose the payment plan that suits their monthly expenditure. This programme has successfully set up technology centres in countries like Bangladesh and India, creating more prospects for employment for the locals, particularly in terms of starting up micro-enterprises programmes to help local businessman in PV sector (Alam Hossain Mondal, Kamp, & Pachova, 2010). This has developed into a long-term sustainable business model and promotes rural solar PV electrification (Campren, Guidi, & Best, 2000). Other examples, for instance countries like Kenya and Nepal which not only contribute towards the welfare and wellbeing of the people, but they have also increased the economic potential of rural dwellers, helping and educating local women in income-generating activities. 90% of the people pay for the system using cash sales from domestic businesses (Kabir, et al., 2010). This is all based on the implementation of the Micro-Credit scheme and the Micro-Enterprise Development programme (Islam & Islam, 2005) in the community.

6. Conclusion

In order to create conducive transition for solar PV development in rural communities, strategic measures, for examples community-based approach and innovative financing scheme are needed in order to evaluate the many push-factors for the diffusion of solar PV energy. This is essential especially in determining suitable policies, energy action plans, innovative financing schemes and incentives. The involvement of the government, energy stakeholders, private sectors and the local people are important in order to create an effective Public Private Partnership (PPP) ventures for the sustainable development of rural community. Rural communities can be educated to understand and appreciate clean electricity if they are fully exposed to the beneficial side of solar PV energy through extensive programmes and supporting schemes. Instead of just copying and adopting solar PV energy projects from overseas, local knowledge, characteristics and skills need to be explored in order to develop solar energy projects for rural Malaysia.

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