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Solar PV Transfer Strategy in Malawi for Sustainability

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Abstract

This paper aimed at developing a sustainable strategy for the transfer of solar photovoltaic (PV) technologies to the rural areas in Malawi. The paper evaluated two strategies used to transfer solar photovoltaic (PV) technologies to rural Malawi namely the centralised systems strategy and the decentralised systems strategy. More attention was paid to analysing the PV transfer strategies in terms of management, financing, community participation, skills transfer, and marketing systems. Questionnaires and interviews were used to collect the needed data. The study has revealed that the centralised systems strategy, which is based on solar villages, is unsustainable. On the other hand, the decentralised systems strategy, which promotes small-systems, has potential to be sustainable as long as the systems are not given out to the people as donations. Therefore, a new sustainable policy strategy, for the transfer of solar PV technologies to the rural areas in Malawi, named 'the commercialisation and entrepreneurship development strategy' was suggested.

Keywords: Rural areas; decentralised, centralised systems; commercialisation; entrepreneurship.

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1. Introduction

1.1 The Centralized systems

Malawi first experimented with Solar Photovoltaics (PV) technology transfer to the rural areas in 1997 when the United Nations Education Scientific and Cultural Organisation (UNESCO) funded the Makanjira Solar Demonstration Village Project in Mangochi District. The project was designed and implemented by the Malawi Industrial Research and Technology Development Centre (MIRTDC) from 1996 to 1997. Under the project, electricity is generated using several separate solar PV systems. There was no central generation facility. The project mainly targeted government institutions and community facilities such as the Makanjira Police Post, Makanjira Health Centre, a Makanjira Community Day Secondary School and a community hall. There were no connections to households [1]. In 1999, two years after the Makanjira project, the Department of Energy Affairs launched a major renewable energy programme known as the National Sustainable and Renewable Energy Programme (NSREP). The programme was funded by the Global Environmental Facility (GEF) through United Nations Development Programme (UNDP). It was aimed at enhancing the efficient and sustainable utilisation and marketing of renewable energy sources in Malawi [2].

As part of the NSREP activities, the Department of Energy Affairs carried out a baseline study to determine the level of renewable energy utilisation in the country. The study concluded that there was very little utilisation of renewable energy, including solar energy in Malawi. The study came up with several key findings. One of the findings was that prices of renewable energy technologies were very high, in fact too high, for the majority of Malawians. This meant that the market for the technologies was almost non-existent. Secondly, the study revealed that there was lack of technical skills for renewable energy systems design, installation, operation, repair and maintenance in the country. The third finding was that there was little awareness about renewable energy by the general public. Another key finding was that the country had no policy on energy and this absence meant that there was no specific direction or strategy for the sector. These were seen as barriers to the development and adoption of renewable energy technologies in the country. Consequently, in 2001, the government came up with a project to address these and other barriers that had been identified during the study. The project was called Barrier Removal to Renewable Energy in Malawi (BARREM). One notable accomplishment under the BARREM project, the Department of Energy Affairs (DEA) formulated and launched the National Energy Policy (NEP) in 2003.

Under the BARREM project, the Department of Energy Affairs (DEA) formulated and launched the National Energy Policy (NEP) in 2003. Among the key policy objectives was the need to restructure the country's energy supply mix, which was and still is dominated by biomass. As of 2003, biomass constituted about 93 percent of the total energy supply, while liquid fuels, electricity and coal accounted for 3.5, 2.3 and 1 percent, respectively. Renewable sources of energy, mainly solar, wind and biogas, contributed only 0.2 percent [1]. Consequently, the policy put in place measures that would enable the country to increase the proportion of electricity and other renewable sources of energy in the energy supply mix to 10 and 5.5 percent respectively by the year 2010. This trend was projected to continue all the way to 2050, when the proportion of biomass will be reduced to 30 percent while that for electricity will rise to 40 percent and other renewable sources of energy will account for 10 percent [1]. To achieve the energy policy objectives the government came up with different strategies and one of them was the introduction of solar villages which is a concept of centralised system.

A solar village is an electricity generation and supply system designed to serve a prescribed rural community, usually covering one or several villages. The solar village was set up to generate electricity in large enough quantities to supply between 100 and 150 households, a school and a trading centre. Some solar villages use solar PV systems only while some use hybrid systems, combining solar PV and wind turbines. A typical solar village project would target a rural area which has at least a school, a clinic or trading centre and a threshold of households. The aim is to take the electricity to only those areas that have potential for socio-economic transformation and growth. The solar village concept was revived in 2007. Through this project, six solar villages have been established in Malawi namely Chitawo solar village in Chiradzulu district, Kadzuwa in Thyolo District, Chigunda in Nkhotakota, Elunyeni in Mzimba, Mdyaka in Nkhatabay, and Kadambwe in Ntcheu. The government hired a contractor to construct the electricity generation facilities, then handed over the facilities to the community (ownership and management). There is a remarkable difference in the design and implementation and management of these latter schemes compared to the earlier one at Makanjira in terms of financing arrangements for the maintenance of the installed systems after commissioning. Unlike in the case of the Makanjira Solar Demonstration Village, where there was no provision for the maintenance of the installed systems, the new solar village schemes provide for monthly financial contributions from the concerned communities for the maintenance of the facilities, although major repairs are still a challenge. This is a marked departure from the Makanjira project, where the beneficiaries expected the government to be responsible for even minor repairs.

Makanjira Solar Village project design did not provide mechanisms to fund the maintenance of the installed systems, which would ensure their sustainability beyond the project life. By 2006, most of the facilities established were in a state of disrepair and no needed maintenance. The community assumed that Malawi Industrial Research and Technology Development Centre, the organisation that did the installations, would maintain the systems. In terms of raising awareness, the community never appreciated the systems as there was no single installation in private homes. Omission of the household sector rendered the project weak in terms of outreach. Therefore, one may argue that the strategy employed in the project was not sustainable in terms of ownership and maintenance [3]. On the other hand, the UNDP-GEF funded Barrier Removal of Renewable Energy BARREM project in Malawi had good intentions in subsidising the capital costs of the PV systems for schools and clinics, but a dependency syndrome was created. While the subsidy assisted in raising of public awareness about the PV systems, it proved difficult for subsequent projects to ask for 100 percent payment of the capital costs by the beneficiaries. However, the project did well by not subsidising the system cost for individual private customers, and letting them pay full cost, which commercialised the solar PV systems [4].

Promoting the use of solar energy systems is one of the key area of the Malawi Government, noting that over 15 million Malawians live out of reach of the main electricity grid [5]. The Malawi Renewable Energy Strategy targets off-grid solar systems. The provision of modern, sustainable, reliable and affordable energy is mentioned explicitly in Agenda 21 and the Sustainable Development Goals (SDGs) and it is widely recognized as an essential area of development that is required to underpin other higher-level development objectives [6-7].

1.2. Decentralised systems strategy: the barefoot engineers concept

In contrast to the centralised approach of the Malawi government to the solar electrification inherent in the solar village concept, other project sponsors adopted a decentralised approach to solar PV technology transfer to the rural areas. Under this strategy, smaller units of solar PV systems, commonly known as solar home systems (SHSs) are propagated. Thus, instead of a large generation and distribution system that is supplying electricity to a hundred plus households, there are dozens of individual systems installed for each household.

In Malawi, the above strategy has been adopted by the Centre for Community Organisation and Development (CCODE). CCODE has teamed up with the Barefoot College in India, to develop both technical and financial capacity for the dissemination and the uptake of SHSs in selected remote villages. In its approach, CCODE utilises its country-wide network of rural women to identify remote villages that can be considered for solar electrification. In this regard, remoteness is defined as being at least ten kilometres away from the national electricity grid and with no prospects for connection to the grid within the next 5 to 7 years. Over and above these, the village must show interest and should accept the project [8]. Before bringing the technologies to the selected village, some women from the village were sent for training in basic solar PV engineering at the Barefoot College in India. Others were sent to Ethiopia. The selected women had to be semiliterate and aged between thirty-five and forty years. The Indian Government under the Malawi-India partnership provided the scholarships. The women were not given any

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formal certificates upon completion of the course. The purpose for this was that they should not seek any employment anywhere but should remain in their villages and use their technical skills to install and maintain solar PV systems. They are referred to as “grandmas”.

In addition to the development of technical capacity in the concerned villages, the project also establishes a Solar Energy Rural Maintenance Fund which is managed by the villagers themselves. Households that want the solar PV systems commit themselves to contribute to the fund and a bank account is opened in the name of the village, with three signatories. The fund is used for the maintenance of Solar Homes Systems (SHS) in the village. Many villages have benefited from the Barefoot Engineers Project such as Chitala and Chimonjo in Salima District, Kaphuka in Dedza District and Makunganya in Zomba District. A total of 60 households have solar PV systems installed in Chitala village while 75 households have benefited in Chimonjo village. Makunganya Village has 81 household installations. The highest number of installations is in Kaphuka Village, with 100 households served. The households use the solar energy for lighting, supply of power for small radios and charging cellular phones.

1.3. Commercialisation and entrepreneurship development strategy

Under this strategy, the people in the concerned communities has been viewed as customers rather than beneficiaries. The project sponsors took a commercial approach to the dissemination of the PV systems and aimed to build a sustainable project through entrepreneurship [9].

The entrepreneurship strategy brought economic empowerment and financial independence. Entrepreneurship was incorporated simply as in depended on entrepreneurs to import and install the technologies. Without entrepreneurs, there would be no solar PV industry as it facilitated the sustainable diffusion of the technologies. This strategy was also used by some NGOs such as Solar Aid from the United Kingdom and Empower Inc.

1.4. Study area

The study was conducted in all four regions of Malawi. Malawi faces various acute energy problems and electricity access rates is only for 10 % of the population [10]. Just looking at the state of electricity supply alone, Vision 2020 laments that the provision of electricity supply is unreliable, inadequate and inaccessible [11]. The utilisation of solar energy in Malawi is very low. In 2013, the proportion of all alternative sources of energy in the total energy supply mix was 0.2% [11]. Therefore, the government has a strategy to supply electricity to many areas through solar PV systems, among other options. However, the country needs to adopt urgent and innovative strategies to disseminate renewable energy resources such as solar energy.

On the other hand, most of the solar PV technologies was brought through projects, which were sponsored by donors with a specific timeframe or politicisation for personal benefits such

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to gain political mileage. The centralised system strategy that is employed by the government had political orientation as it was part of the election campaign within the constituency, where there was a member of the parliament from the ruling party. Once the projects were over, everything collapsed. Moreover, most of the solar PV technologies tended to malfunction within a short period of time after installation. Similar observations were raised at the Solar Energy Symposium in Blantyre. Participants decried the state of most of the installed solar energy systems in various parts of the country that had ceased functioning due to the lack of local technical expertise and the financial resources for maintenance. The issue of dysfunctional solar PV installations was articulated in the National Energy Policy, as it stated that about 5,000 renewable energy technology systems had been installed in the country by 2003 but more than 50 % of them are malfunctioning or have completely stopped working due to the poor artisanship and the lack of after-sales support [1].

From all of the mentioned above, it is clear that the strategies through which the technologies were introduced to the communities they were supposed to serve had some shortfalls have overlooked some critical issues pertaining to technology transfer, particularly with regard to the technical and financial capacity of the communities to maintain the facilities as well as the sustained availability of funding for replication of the projects in other parts of the country, a part of the sponsors. The study analysed these underlying in order to determine how to overcome them through assessing the elements built into the design of those projects, considering the cost of the solar PV technologies, the low incomes characteristic of rural communities and the lack of local technical capacity to install and maintain the systems

This paper aimed to evaluate various strategies for the solar photovoltaic technologies transfer to the rural Malawi, with emphasis on sustaining and growing it at a larger scale making it a viable electricity supply option for the rural communities. The study also examined the projects impacts at the lowest unit of the rural community, the household, and the development of local capacity to sustain the project outputs after its completion. The paper also propose a Solar Energy Rural Maintenance Fund managed by the villagers themselves, by which households can contribute to the fund and a bank account is opened in the name of the village. The fund would be used for the maintenance of SHSs in the village [12].

2. Methodology

2.1. Project design and strategy

The study used descriptive research design to analyse and describe the prevailing solar PV technology transfer strategies that are being used in Malawi. Thus, the paper took the form of explanatory research in a combination of descriptive and explanatory research, descripto-explanatory study [13].

2.2. *Population and target population*

For the solar villages, primary data was collected from the contractors, the village headmen, heads of institutions present in the villages and the villagers themselves in the form of focus groups. In the case of the other projects, data was sourced from the project sponsors, the village headmen concerned and members of the local community. For the private sector analysis, data was collected from department of Energy Affairs and the suppliers and installers. For more comprehensive and in-depth understanding of the strategies, the research involved field visits to all the selected solar villages. These visits provided a good opportunity to observe certain aspects of the projects that a questionnaire could not capture. Considering the qualitative nature of the study, NVIVOL software was used for data analysis.

3. Results and discussion

3.1. Centralised system strategy

3.1.1. Management of the facility

The solar villages are run and managed by a local committee set up by the village chiefs and members in the local wards. The size of the committees varies in different districts ranging for 5 to 12 people. There is no qualification required for a person to be a committee member. he community establishes a committee to be responsible for day to day management of the facility, revenue collection and repair and maintenance beyond the one year contract. A member of the community is employed as operator of the facility while another one is employed as a the security guard. According to the respondents, there is no formal handover of the power generating facility to the local community on completion of the project issue. As a result, people do not know where to source the batteries for the systems, components of the system including the right fit of LED bulbs were opposed with incandescent ones.

In terms of financing and payment, some villages had been supplied free of charge while others paid $0.20 - $0.50 per month to a local fund, used for paying an operator of the plant, the security guard and some minor repairs. The committee was also responsible for the collection of the revenues from the users, punishing defaulters through power disconnections and approving new connections. The cost was $2 per connection including materials or $1 excluding materials. There is no reconnection fee for defaulters but there is a mandatory one-week delay between the settlement of outstanding payments and the reconnection to discourage people from defaulting. Although there were cases of defaulters in paying for the electricity, the majority of those connected paid every month.

It is worthy to note that the electricity pricing mechanism in solar villages was unsustainable. The guidelines for pricing of the electricity supplied to the consumers in some solar villages were that the households should pay an equivalent of their monthly expenditure on illuminating

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paraffin and on batteries for torches, radios and any other electrical appliances used for entertainment. According to the state-owned utility company, the Electricity Supply Commission of Malawi, a rural household supplied with electricity from the national grid pays an average of $2 per month, assuming the uses are limited to lighting, supplying power to a radio and charging cellular phones [14], which means that the electricity tariffs in the solar villages are too low considering that actual power supplied. Thus, these prices cannot justify the capital expenditure of the solar villages. However, one can argue that this is typical for any social project, where the government is obliged to provide a service to its people. The only problem in this case is that the government does not seem to be ready to finance the repair and maintenance of the solar villages. Obviously, this calls for cost-reflective price for the electricity supplied to the people, otherwise the whole initiative can simply fall apart.

3.1.2. Transfer of technical skills

There is a general concern that the contractor, Power Link Solutions Limited, did not adequately train any member of the community on the operation and maintenance of the facility. Rather, there were some individuals who used to hang around the construction site, watching and observing how the contractor was working just out of interest. Therefore, it is undeniably that these facilities may not be operated efficiently and effectively. In addition, it is highly risky for some people to be entrusted with the operation of such sophisticated piece of engineering, for example, in Elunyeni, an inverter burned out within 1 year after the commissioning of the plant. Fortunately, this was within the warranty period provided hence, the contractor sorted out the problem. However, with an untrained person in charge of the daily operation of the facility, one might wonder whether the burning out of the component was as a result of normal wear and tear or was caused by poor handling of the system. There was also delays in maintenance services as it was difficult for the communities to purchase costly spare parts or pay for major repair works using the little money collected from the users. For instance, most of the storage batteries were worn out and needed replacement. The government could not get the damaged components repaired after they got burned and the beneficiaries did not have technical or financial capacity to carry out the repairs themselves. This undermined the sustainability of the solar villages as a strategy for transferring solar PV technologies to the rural areas in Malawi.

3.1.3. Complex and costly electricity generation and supply systems

The solar systems that were established in the solar villages were not simple to be operated by anybody, they are quite complex and needed experts and engineers. Just looking at the powerhouse engineering alone. Coupled with the network of distribution lines, stay wires and everything else, the solar village is too complex a facility for it to be entrusted to local people to operate or manage. The solar village is a complex and the systems are very costly. For example,

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according to the Department of Energy Affairs, a solar village system with a capacity of 20 kW and a water supply component costed around $68400 in 2008. It costed $60000 million without the water supply component. Therefore, it is difficult for a rural community to maintain such expensive facilities or replace the burnt batteries [15]. That is why the community at Elunyeni was unable to replace the 60 batteries that burnt out. That is also why the people at Mdyaka Solar Village were stranded and left with a non-functioning power house since December 2012, when it was struck by lightning. The story is the same for Chigunda Solar Village where there has been no electricity supply since October, 2012 due to worn out batteries.

This raises serious questions about the sustainability of the solar village concept, particularly in its current design. This argument corroborates to Damian Miller who observed that at first, the government or some aid agencies try to put solar to work for unelectrified populations. However, in some projects, these agencies tried an intuitive approach, by which they centralised the solar panels in the middle of the village or at its outskirts, strung distribution wires to each home, and then transported the solar power to the local families or enterprises. This approach was known as “rural mini-grid”, and its track record in terms of sustainability and cost-effectiveness was low [16].

3.2. Decentralised systems strategy: the barefoot engineers concept

The Barefoot Engineers concept was introduced in Malawi through a project that was financed by the Indian Government in collaboration with the Malawi Government through the Ministry of Foreign Affairs and International Cooperation. The objective of the project was to disseminate solar PV technologies to vulnerable people in the rural areas. The Indian Government provides full scholarships for training selected women in solar PV engineering. On its part, the Barefoot College had partners in countries where the project was implemented. In Malawi, the partner was the Centre for Community Organisation and Development (CCODE). CCODE is the agent that introduced the project idea to 119 villages in different districts such as Salima, Dedza and Zomba districts.

The concept of barefoot engineers is being promoted by the Barefoot College, which is based in India. The college promoted electrification of rural households using solar home systems. Unlike centralised systems, solar home systems were individual electricity generation units which could be purchased, installed, owned and managed at the household level, which made these systems simple and cost-effective. Therefore, households can operate and manage them effectively as long as they got some education. It is also possible to train rural communities about all the technical aspects of the systems, from the basic engineering principles to assembling, installation, repair and maintenance. In this way, the community can develop the technical capacity to maintain the systems on its own.

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The concept involves the training of semi-illiterate rural women in the electrification of their villages using solar home systems. The training course, which was offered in India and Ethiopia, aimed at equipping the women with technical skills required for the design, installation, repair and maintenance of solar PV systems. Women were preferred to men simply because they were less likely to move out of their villages to seek employment elsewhere, as compared to men. Women will most likely remain in their villages and use their skills to serve themselves and their communities in terms of solar electrification. Moreover, participants were not given any certificates after the training to prevent them from leaving their villages to seek employment in other places.

3.2.1. Transfer of technical skills

One key component of the project was skill transfer to the local community. In this regard, three women were selected and sent abroad for training in the design, installation repair and maintenance of solar PV systems.

3.2.2. Beneficiary identification

For a person to qualify for the PV installation, he or she should be an active member by contributing regularly to all the three funds that were established by CCODE, by which members should contribute $0.50 each monthly. The first fund is called Mchenga, for the development works; the second one, Chisoni, for assistance during funerals and condolences; and the third fund is called Khodo-Khodo which is a community savings scheme, managed by the local people themselves through an elected committee comprising a chairman, treasurer, secretary and some committee members. The savings scheme has a bank account with the Malawi Savings Bank in the name of the community. Community members deposit their savings into the scheme and earn a 2 percent interest. On the other hand, members are also allowed to borrow from the scheme. The borrowers are charged 10 percent interest. Any excess funds are deposited at the bank, hence the ability to earn more interest and grow the fund.

3.2.3. Repair and maintenance

Another important component is the construction of workshops in each of the villages. The Barefoot Engineers used the workshops to carry out repair and maintenance of the systems. In this kind of set-up, people could repair and maintain the installed technologies. Solar home systems, including portable solar lanterns, are much smaller than centralised systems by any comparison. Therefore, they cost less and an average rural household might be able to afford one and repair. The people's ability to pay for the systems can be enhanced with the support of micro-credit schemes. Thus communities can easily be mobilised to establish such schemes and become economically empowered enough as to purchase the systems themselves at household level. Thus, it only requires a change agent, either in the form of a non-governmental organisation or a community based organisation, to introduce the concept of micro-credit schemes matched with commercialised solar PV systems. It is also important to introduce a wide variety of the systems, possibly ranging from small portable lanterns to the conventional solar home systems so that households can choose according to their energy needs and ability to pay.

3.2.4. Greater involvement of the local community

CCODE involved the local people in the project from its preparation phase. They asked the community first whether they wanted the project or not. This was a very important strategy, by which the communities would participate positively in projects that were appeal to them. Secondly, selected women from the community were sent on training abroad. This gesture cemented the relationship to build a trust between project sponsors and the beneficiaries, besides building the local technical capacity. In this kind of scenario, people are more likely to take care of the project outputs long after the project is completed [4]. The decentralised systems strategy lends itself easily to local participation.

3.2.4 Reliance on Handouts

The strategy is seriously weakened by the very fact that the first lot of the systems was given out to the people free of charge. Indeed, it is inconceivable that a system costing about $250 can be given as a handout. When one considers the fact that the beneficiaries were already in the practice of contributing to various community welfare or development funds, as already mentioned above, it is difficult to understand why a change agent would introduce the concept of handouts. Here, the project sponsors lost a golden opportunity to set up a sustainable dissemination system for the technologies. Dependency has been entrenched by starting the project with donations of solar PV systems to the people. As can be seen, there is no provision for people purchasing the systems on their own. This means that the rest of the villagers are looking forward to "receiving" rather than "buying" the systems. Due to dependence on donations, the project had a very limited coverage. For example, Chitala Centre comprises 19 villages but only 4 of them were covered by the project denoting a 21 percent coverage rate whereas coverage was slightly better at Chimonjo Centre where 12 out of 22 villages benefited from the project. This translates to a coverage rate of 55 percent.

A similar analysis at the household level shows a clearer picture. For example, there are 240 households under Chitala Centre and only 60 of them received the systems, representing a 25 percent access rate. Thus 75 percent (180 households) are looking forward to receiving the systems. The situation at Chimonjo Centre is that out of 260 households only 75 received the solar home systems, leaving out 185. This means that only 29 percent of the households had access to the systems at Chimonjo Centre. As a result of the limited coverage, there is now pressure mounting to identify donors to donate more systems for the remaining households and

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expectations are so high that every visitor is treated as a potential donor. But how much donor money is required to satisfy this huge need for the PV systems? And how many donors are forthcoming? Simply put, unless there is a large donation or a series of donations, either in the form of cash or the actual PV systems, it will be hard to sustain the project. There is therefore urgent need to shift from "donations" and "beneficiaries" to "selling" and "customers" as the country strategies to promote wide-scale uptake of solar PV systems.

3.3. Commercialisation and entrepreneurship development strategy

This is an innovative approach to the dissemination of solar PV technologies. This emerging strategy links technology transfer with entrepreneurship such as Pay-As-You-Go (PAYG). The hallmark of this strategy is commercialisation of the technologies and entrepreneurship development. In this strategy, entrepreneurship is required either to get the technologies to the market or to develop the market. There is also room for intrapreneurship, which means coming up with new business ideas within the established enterprise.

In this context, electricity from solar PV systems is used to enhance productivity or value-addition in already established enterprises. The solar PV technologies can facilitate the development of entrepreneurship by enabling rural enterprises, such as grocery shops to have extended business hours and therefore, increase daily sales. The technologies also present new business opportunities in that entrepreneurs can engage in the marketing and distribution as in the case of SunnyMoney, the largest seller and distributor of high quality solar lights in Africa. On the other hand, entrepreneurs support the development of solar PV technologies by engaging in the production of the technologies themselves. Relatedly, entrepreneurship brings economic empowerment and financial independence. Entrepreneurship in rural areas helps to overcome the persistent barrier of low incomes and inability to pay for the PV technologies by rural households. Thus, through entrepreneurship, the need for donations is eradicated or, at least, minimised and solar PV dissemination projects can be self-sustaining.

4.0. Towards a Sustainable Strategy for the Transfer of Solar PV Technologies to Rural Areas

This study has unearthed key factors that must be included in a strategy to transfer solar PV technologies to the rural areas in a sustainable manner. These can be segmented into upstream, mid stream and downstream depending on the stages at which they must feature in the transfer process. The whole process of technology transfer must occur within a conducive environment with enabling government policies as well as institutional and legal frameworks. A proposed sustainable strategy for the transfer of solar PV technologies to the rural areas in Malawi is presented in figure 1 below.

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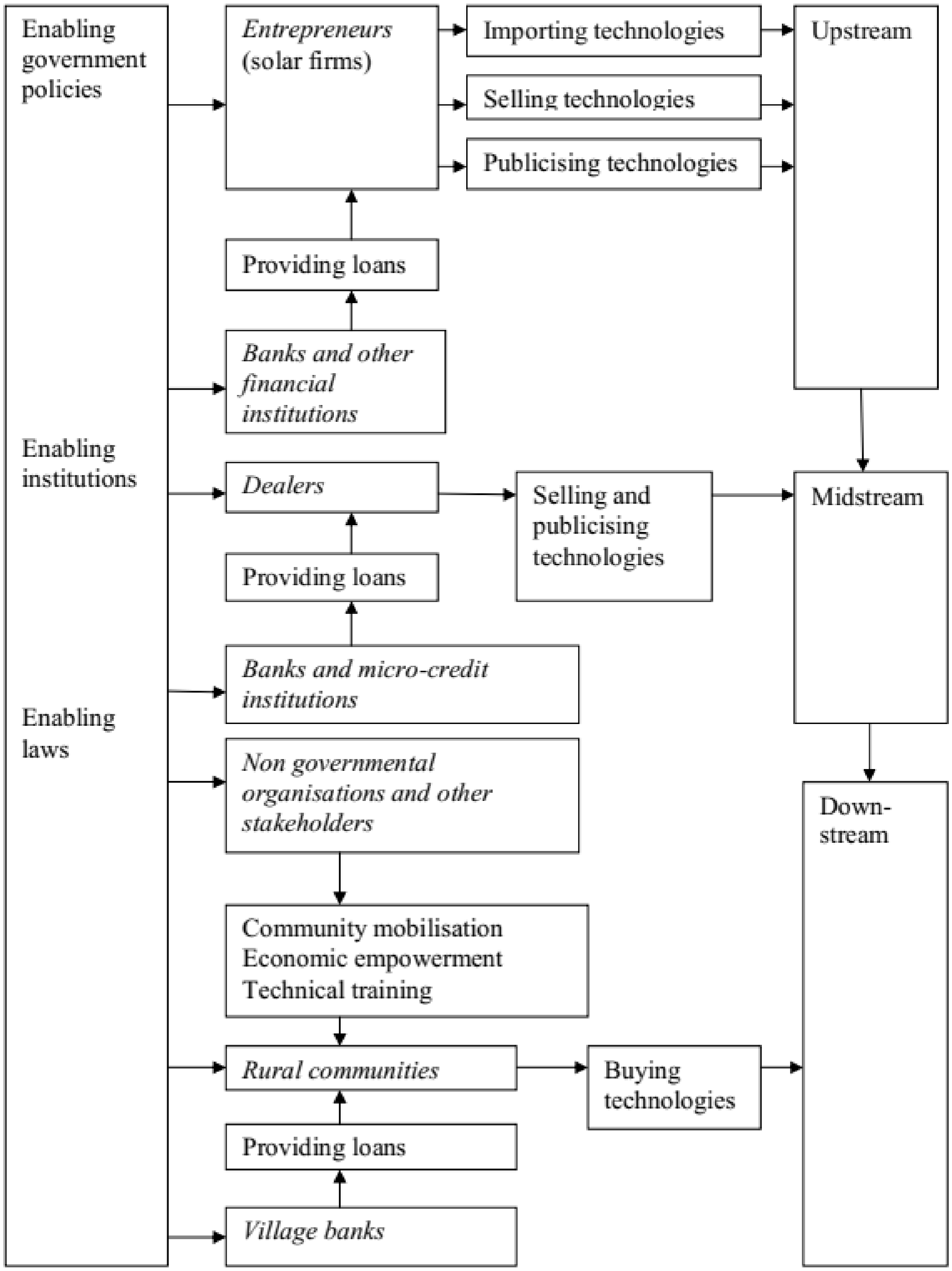

Figure 1: A Sustainable Strategy for the Transfer of Solar PV Technologies to Rural Areas in Malawi

4.1. **Upstream**

(i) Entrepreneurs: Firstly, in the upstream segment, there is need for entrepreneurs who take the risk to invest their money in the establishment of solar firms. Thus, the more the entrepreneurs in a country, the more the solar firms established. A large number of firms is necessary for competition and high quality of products and service delivery.

(ii) Access to Credit: It is important that once established, the firms must have access to credit in order for them to develop adequate capacity to supply the market with the required variety of solar PV technologies as well as carry out installations of high standards. This means that there must be banks and micro finance institutions that are willing and ready to provide loans to the solar firms.

(iii) Technical Skills Development: The government should formulate policies that promote the transfer and development of technical skills for designing, installing, operating, repairing and maintaining solar PV systems at the national level. On their part, the solar firms must take advantage of such institutions to train their technical staff, thereby developing a threshold of technical capacity in the country.

(iv) Publicity: Knowledge about the efficacy of solar PV technologies is very crucial for the growth of the market for the technologies. In order for people to have this knowledge, there must be publicity. Therefore, both the government and the solar firms must engage themselves in publicising the technologies through the radio and print media, trade fairs, agricultural fairs and other channels.

4.2. Midstream

(i) Dealerships: Dealerships seem to be the best way to penetrate the rural areas with the technologies. The placement of dealers in different parts of the rural sector means that customers do not have to travel long distances to buy the technologies. This can help reduce the perceived high cost of the technologies by cutting out or minimising transport costs.

(ii) Access to Credit: For the dealers to establish themselves in the industry, they might need credit facilities. Therefore, credit is also critical in the midstream segment. Banks and micro-finance institutions must be prepared to extend their facilities to these people as well.

(iii) Publicity: Just like in the upstream segment, publicity is also required in the midstream. The delears must advertise their products and services so that the people know them. Such publicity, happening at the grass root, is bound to take the message about the technologies deep into the rural areas.

4.3 Downstream

(i) Knowledgeable and Active Community Leaders: In the downstream segment are the rural communities. This is the arena where the technologies are to be adopted and utilised. This is

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where technological innovation must take place. Communities must therefore be mobilised to embrace this innovation. In order for this to happen, there is need for knowledgeable and active community leaders. These can be traditional leaders or any form of leaders acceptable to the people. However, it is not advisable to involve political leaders.

(ii) Economic Empowerment: Another critical factor for the downstream segment is economic empowerment of the concerned rural communities. There is need for the availability of formal credit or loan schemes at the community level in the form of village banks or other similar facilities from which the people can get loans that they can use to purchase the technologies.

(iii) Transfer of Technical Skills: The transfer of technical skills to the communities is also important. The ability to handle and take proper care of the systems once installed will ensure that customers get maximum satisfaction. However, technical ability to carry out installations and repairs is even better and must be developed within the communities.

(iv) Availability of Maintenance Workshops: The availability of maintenance services in the form of well equipped maintenance workshops is very important. This is where the people to whom the technical skills have been imparted will work. People will know where to go if they need their services.

(v) The Need for an Enabling Environment for Private Sector Participation in Solar PV Technology Transfer: The private sector has a critical role to play in the dissemination of solar PV technologies in any country. To begin with, the technologies themselves are manufactured, marketed, installed and maintained by private firms. Secondly, in countries where there is no local manufacturing capacity, such as Malawi, the technologies are imported by private firms.

For there to be sustainable transfer of solar PV technologies to the rural areas in Malawi, there must be a conducive environment that will attract entrepreneurs into the solar PV industry. The government is the key player in this aspect. The government has to ensure that its policies, laws, institutional framework and a myriad of related issues combine to provide an environment that is favourable to the sustainable transfer of the technologies. Specifically, the environment should encourage entrepreneurship in solar PV, promote the development of the financial sector and access to investment capital, facilitate importation of the technologies and uphold standards for the imported products as well as installed systems. The government should also play a leading role in deliberate development of the market for the technologies by putting in place various economic empowerment programmes and loan schemes for the rural population to have the financial capacity to pay for the technologies.

4. Conclusions

The Solar Village Concept as a strategy for publicising solar PV technologies in the rural areas registered some success. In some solar villages, there are signs of ripple effect for example, a number of people from Elunyeni Solar Village were motivated enough to purchase their own

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solar home systems. However, the solar village concept, strategy for Solar PV technology transfer has been proven to be unsustainable due to its large size, system complexity, capital and maintenance costs. These factors make it difficult for rural communities to understand, operate and maintain them.

Given that the communities are already operating various community funds on their own initiative, it should be relatively easy for the project sponsors to ask the villagers to pay for the PV systems in instalments, even if it means spreading the payments over a number of years. Thus, the criteria for selection of beneficiaries should be ability and willingness to pay, and not membership of the federation as it was the case.

It was noted that there is a need to foster a strong link between entrepreneurship and Solar PV technology transfer. Enterprises can innovate and introduce new products through value-addition or new entrepreneurs. The paper has also shown innovation through new forms of community organisation, as in the case of the Barefoot Engineers Project. Whatever the case might be, all forms of entrepreneurship, including intrapreneurship and social entrepreneurship, have the potential to flourish within this framework of interdependence, as long as sound business principles are adhered to.

5. Recommendations

5.1. Redesign solar villages

Subsequent solar village projects should take the form of the Makanjira Solar Demonstration Village, where decentralised PV systems, rather than large centralised power houses. In this way, it will be much easier for the local communities to appreciate the variety of available technologies and it be easier for well-trained expert to maintain the installations.

Review Financing of Solar Village Projects: The successes of solar villages should be integrated with decentralized strategies for efficient and a more robust transfer of technologies, as it is in Makanjira. The government should stick to its policy decision to incorporate off-grid electricity generation systems into the Malawi Rural Electrification Programme (MAREP).

5.2. Commercialise existing solar villages

There is an urgent need for a paradigm shift in the strategy used by the government in technology transfer of Solar PV technologies, which requires redefining the projects as commercial and not social. In addition, those who are connected to the local electricity grid should be referred to as customers and not beneficiaries, which make it a business relationship between the supplier and the customer. In this scenario, electricity connections should only be based on ability and willingness to pay, particularly for households.

5.3. Review management of existing solar villages

While the focus of the Department of Energy Affairs might be on future projects, it should not neglect the already established solar villages. The department should therefore revive its

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partnership with ESCOM in this initiative and let the utility manage the existing solar villages on commercial lines, just like any other rural electrification schemes.

References

[1] Malawi Government, (2003). *National Energy Policy. Department of Energy Affairs*. Lilongwe.

[2] Aldover,R., and Gondwe, K., (2008), Final Evaluation of the Renewable Energy Project MWI/00034063 (MLW/98/007) and An Outcome Evaluation of UNDP Assistance to the Malawi National Sustainable and Renewable Energy Programme (NSREP), Lilongwe.

[3] Department of Energy Affairs, (2003). *Power sector Reform Strategy*. Montfort Press, Limbe.

[4] Adedoyin, A., and Kaunda, C. (2008). *Barrier Removal to Renewable Energy in Malawi (BARREM), Final Evaluation*. Blantyre.

[5] Malawi Government, (2017). *Malawi Renewable Energy Strategy 2017-2022*. Ministry of Natural Resources, Energy and Mining. Lilongwe.

[6] The United Nations Programme of Action from Rio, (1992). *Agenda 21*. Retrieved November 26, 2017 http://www.un.org/esa/dsd/agenda21/.

[7] The United Nations (2015). Transforming Our World: The 2030 Agenda for Sustainable Development. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

[8] Malawi government, (2016). *Concept paper for the energy sector. Public Private Partnerships on electricity generation for rural areas*. Government Press, Lilongwe.

[9] Government of Malawi, (2012). *Malawi energy survey report*. National Statistics Office, Zomba.

[10] Overseas Development Institute (ODI), (2016). *Accelerating access to electricity in Africa with off-grid solar. Off-grid solar country briefing*: Malawi.

[11] Malawi Government, National Economic Council (2000), *Vision 2020: The National Long-Term Development Perspective for Malawi*. Central Africana Limited.

[12] Ministry of Finance and Development Planning, (2012). *Malawi Growth and Development Strategy II, 2011-2016*. Ministry of Finance, Lilongwe.

[13] Saunders, M., Lewis, P., and Thornhill, A., (2009), *Research Methods for Business Students*, Fifth Edition, Pearson Education Limited, Essex, p.124

[14] Kabwazi W., (2013). Electricity Price. Electricity Supply Corporation of Malawi, Blantyre.

[15] Malawi Government, Ministry of Finance and Ministry of Economic Planning and Development, (2006). Comprehensive Review of the Malawi Poverty Reduction Strategy, Lilongwe.

[16] Miller, D., (2011). Selling Solar: The Diffusion of Renewable Energy in Emerging Markets, Earthscan Ltd, London, p.10

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