The Contribution of Solar Power Funding for Online Content Accessibility and Sustainability of Blended Learning in Rural Africa: The Tanzania Perspective

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Abstract: *Access to quality higher education is currently considered as an important vehicle for poverty alleviation in most African countries, including Tanzania. However, due to limited number of on-campus universities and lack of trained tutors in rural areas, only a tiny proportion of Tanzanian population have access to higher education and most of these are from urban areas. Blended learning, which combines and aligns learning undertaken in face-to-face sessions with learning opportunities created online, has proved to be an effective tool to impart higher education knowledge to people living in remote and rural areas. However, blended learning remains of little significance to rural areas in Tanzania due to lack of reliable and sustainable electricity which prevents learners from maximizing the potentials of using Information and Communication Technology (ICT) to enhance their learning. With the current problems facing the grid-power sector in Tanzania, having reliable and sustainable electricity in rural areas remains one of the key problems to overcome before the impact of blended learning can be seen. Solar electricity is of major interest for the rural energy sector in Tanzania because it offers the possibility of generating renewable electricity using sunlight. Despite these appealing features, penetration of solar electricity in remote and rural areas in Tanzania is limited by high initial cost of building a stand-alone solar system. This study reviewed eight solar power funding models (cash sales, donor-driven, layaway, dealer credit, end-user credit, hire-purchase, M-Kopa-pay-as-go and fee-for-service models) that are available in different developing countries, including Tanzania and recommended strongly the end-user credit model. This study has also illustrated how the identified solar power funding model can contribute to the acquisition of solar systems in rural areas in Tanzania thought the use of SACCOs, VICOBA and ROSCAs groups.*

Key words*: Blended learning, ICT, online content accessibility, solar electricity, solar power funding models, rural areas*

INTRODUCTION

Higher Education and Poverty Alleviation in Africa

Access to quality higher education is currently considered as an important vehicle for poverty alleviation in most African countries, including Tanzania. For long time, Economists have stressed that higher education has a significant role to play in poverty reduction. For example, Khan and Williams (2006) pointed out that higher education can directly reduce poverty through the contribution that productivity enhancement makes to economic growth; and indirectly in the way it helps to alleviate poverty through its positive spill-over effects on society. Furthermore, it has been observed that sustainable development in most developing countries, including Africa, will depend on individual and collective capacity to understand development challenges and to find effective solutions (Maguire and Zhang, 2007). It has been emphasised that the sustainability of economic growth and improvements in human well-being will depend on knowledge; and lack of knowledge is what separates rich countries from poor countries (World Bank, 1999). In spite of this fact, the status of higher education in Africa lags behind other regions of the world (UNDP, 2008) as reflected in economic decline, energy crisis, insufficient capital resources, poor transportation systems, lack of investment in technology, insufficient food supplies and health problems such as HIV/AIDS.

Like other African countries, Tanzania recognises the importance of higher education in poverty alleviation and it is one of the priority sectors specified in the Tanzania Development Vision 2025 and the National Strategy for Growth and Poverty Reduction (URT, National Development Vision 2025). According to Tanzania Development Vision 2025, by 2025, Tanzania should be a nation with high quality of education at all levels; a nation which produces the quantity and quality of educated people sufficiently equipped with the requisite knowledge to solve the society's problems, meet the challenges of development and attain competitiveness at regional and global levels. However, the current situation does not indicate a significant progress towards achieving the stated objective before the end of 2025. The slow progress is due to several challenges facing higher education in Tanzania, one of them being unequally enrolment between rural and urban population (URT, 1999). For example, in 2012, it was reported that, although about 74% of the Tanzanian population was living in rural areas (BTI, 2012), only a tiny proportion of these population had access to higher education. For poverty alleviation in Tanzania, higher education should be accessible by majority of people in remote and rural areas.

Blended learning (which combines and aligns learning undertaken in face-to-face sessions with online learning) is an effective and viable learning mode and rural households can attain post-secondary education through this mode. For the purposes of this paper, blended learning consists of an initial face-to-face meeting, weekly online assessments and synchronous chat, asynchronous discussions, email, a final face-to-face and a supervised final examination (Martyn, 2003; Rovai and Jordan; 2004). The face-to-face component can be either on the main university campus or the Lecturer/Professor can travel to rural areas to meet with students. Online learning means the use of electronic media and information and communication technologies (ICTs) in education. It is sometimes called technology-enhanced learning or virtual learning and it includes all forms of educational technology in learning such as world wide web (www), Video (YouTube, Skype or webcams), extranet, internet, whiteboards, Screencasting, satellite TV, Learning Management Systems, Computers, tablets and mobile devices, blogs and email (Dror, 2008; Moore et al., 2011; Anand et al., 2012). The importance of using these technologies for education purposes have been widely documented (Iskander, 2002; Jhurree, 2005; Robinson, 2008; Hechter et al., 2012).

The Purpose of the Study

In Tanzania, the significance of blended learning in remote and rural areas are yet to be seen due to lack of electrical energy which prevents learners from maximising the potentials of using ICTs to access various online information. It should be noted that all ICT devices require regular supply of electrical energy for online content accessibility. Therefore, having reliable, affordable, sustainable and clean electrical energy sources in rural areas remains one of the key problems to overcome if blended learning has to make a significant impact to the rural communities.

Solar electricity is clearly one of the most promising prospects since it is renewable, cost-effective and the resource (sunrays) is available everywhere in Tanzania. Despite of these appealing features, solar electricity is not accessible by the majority of people in rural areas due to high initial cost of building a stand-alone solar system (Paul, 2009; Paul and Uhomoibhi, 2013). One way to overcome this problem is through the use of avoidable funding models to mobilise the required capital.

The aim of this study, therefore, was to systematically document the existing solar power funding models in developing countries, including Tanzania, and illustrate how the recommended funding model can contribute to the acquisition of solar systems in rural areas in Tanzania.

Objectives

The overall object of this article was to systematically document the existing solar power funding models in different developing countries, including Tanzania, and illustrate how the best recommended funding model can contribute to the acquisition of solar systems in rural areas in Tanzania. It is anticipate that the availability of solar electricity in rural areas will facilitate online information accessibility and sustainability of blended learning in rural areas in Tanzania. Specifically, the study had the following objectives:

- To illustrate the significance of sustainable electrical energy availability for online content accessibility and sustainability of blended learning in rural areas in Tanzania;
- To review the existing solar power funding models in different developing countries, including Tanzania;
- To recommend the affordable solar power funding model for rural households in Tanzania;
- To illustrate how the identified solar power funding model can contribute to the acquisition of solar systems in rural areas in Tanzania.

Hypotheses

This study was guided by three hypotheses:

- The availability of solar electricity in rural areas in Tanzania will enhance online content accessibility and sustainability of blended learning;
- There are different solar power funding models in different developing countries and the suitability of each model varies from one country to another, depending on the nature of the financing institutions;
- The availability of affordable solar power funding model in rural areas in Tanzania will facilitate the acquisitions of solar electricity.

ONLINE CONTENT ACCESSIBILITY AND SUSTAINABILITY OF BLENDED LEARNING: THE ROLE OF SOLAR ELECTRICITY

Tanzania has been blessed by enormous non-renewable energy resources such as petroleum, natural gas, coal and uranium as well as renewable energy resources such as solar energy, wind energy, geothermal and hydropower (Kusekwa, 2011). However, the status of electricity in both urban and rural areas in Tanzania does not reflect these huge energy resources. For example, in 2013, only 14% of the whole population in Tanzania (44.8 millions) had access to grid electricity (FAO, 2013).

Of this, about 2% and 39% of rural and urban population, respectively, have access to grid electricity (FAO, 2013). For urban areas, inadequate electrical energy is associate with worn out infrastructure both for production and distribution, shortages in electricity production due to lack of reservoir, inability of the government to fund expansion of power sector, lack of maintenance of existing facilities due to inadequate finance/technical, inadequate revenue collection mechanisms and too much dependence on hydro-production which is subject to weather variations (CTI, 2011).

Nevertheless, for remote and rural areas, lack of electricity is due to high capital for infrastructure development, low capacity utilisation rates, high electricity line losses and sparse population (Mwahiva and Mbise, 2003). To address the challenges facing the electrical energy sector in rural areas, it is important that renewable energy sources such as solar electricity must be given high priorities.

Solar electricity is the electrical energy which is obtained through stand-alone solar system (Roberts, 1991). A stand-alone solar system is a small autonomous energy station, powered by a solar module that provides electricity for basic services such as lighting, radio, television, computer, internet facilities and operation of small appliances (Scheutzlich et al., 2001; Paul, 2009). It consists of a solar module which converts the sunrays into electricity; rechargeable battery which stores the generated energy for use at night and during cloudy days; charge controller which controls the charging of the battery; an alternative current (AC) inverter which covert direct current (DC) to AC current, switches, interconnecting wires and solar panel mounting rack (Roberts, 1991; Setter et al., 2012). It can also include electric generator as power back-up during extended heavy rainfall days. For a household or building with grid electricity, solar electricity acts as back-up electricity. An example of a stand-alone solar system for rural secondary school is shown in figure 1. The cost of such a solar system is governed by the type of a solar panel (figure 2) as well as the size and quality of the other components.

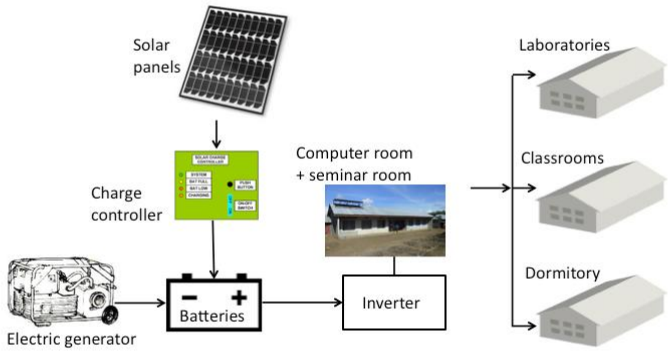
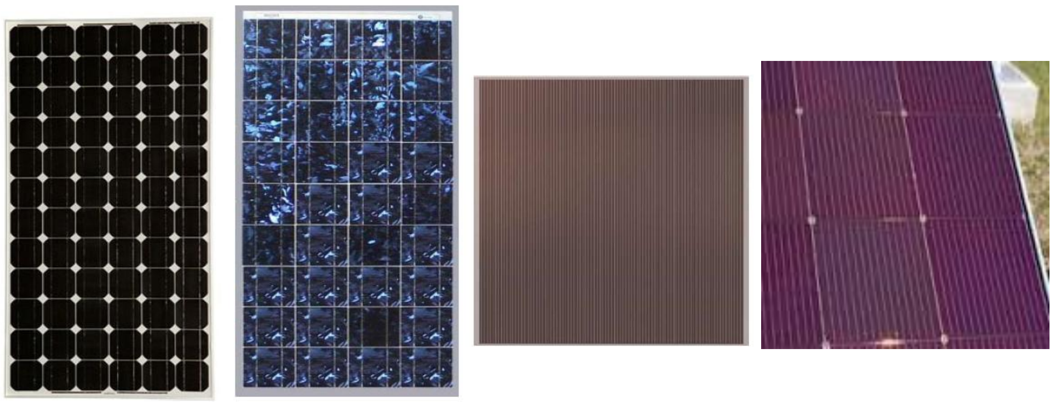


Figure 1: The basic stand-alone solar system components, adapted from Setter et al., (2012)



(a) (b) (c) (d)

Figure 2: Types of common solar panels in stand-alone solar systems (a) mono-crystalline silicon, (b) poly-crystalline silicon, (c) thin film and (d) amorphous, adapted from Chow (2010)

It is a well know fact that all devices for internet accessibility, requires regular supply of electrical energy. It is therefore, anticipated that the availability of solar electricity in rural areas in Tanzania will bridge the current digital divide by facilitating the accessibility of online course content and regular communication between learners and course instructors. Furthermore, since solar energy is renewable, solar electricity will facilitate sustainability of blended learning. Moreover, the availability of solar electricity will not only facilitate online content accessibility and sustainability of blended learning, but also will open windows for other online information about on-campus universities, distance learning and HIV/AIDS as well as education for girls and women. Such information possibly will include:

- Online information about different Higher Education Institutions (HEIs) in Tanzania;
- Online information about degree programmes offered by HEIs in Tanzania;
- Online information regarding fee structure for different HEIs and mode of payments;
- Online information on application and commencement of academic year in each institution;
- Online information about different scholarships, including Tanzania Higher Education Loan Board;
- Online information about the effect and prevent of HIV/AIDS, telemedicine and market prices for various crop products.

Despite of these appealing features, solar electricity is still very expensive to most people in rural areas in Tanzania. For example, in 2009, a 50 Wp[1] stand-alone solar system, consisting of a solar module, a charge controller and a battery bank, was sold at an average price of US$ 600 (Felten, 2010). From a rural economic perspective, such amount represents a significant fraction of the annual income of an ordinary rural farmer. The main problem is that building a stand-alone solar system requires relatively high up-front cash. The local banks or financial institutes are generally not interested in financing solar home systems due to the fact that it takes too long to recover the investment (MEM, 2002; Ishengoma, 2011). Therefore, an important requirement for expanding solar electricity in rural areas is the need to mobilise enough money for the acquisition of solar system. Without having access to an affordable solar power funding model, rural community will hardly be in a position to purchase a small solar system.

METHODS

This study was entirely based on secondary information collected from different sources like journal articles, conference proceedings, books and various reports.

RESULTS AND DISCUSSIONS

Solar Electricity Funding Models in Different Developing Countries

In the literature, there are eight formal solar funding models through which rural communities in developing countries can acquire solar electricity. These include cash sales, donor-driven, layaway, dealer credit, end-user credit, hire-purchase, M-Kopa-pay-as-go and fee-for-service models. In this section an overview of each model and countries which have practised each funding model are given. It should be noted that, under each funding model, the countries given are by no means exhaustive (i.e., many countries that have not been included in this review).

Cash Sales Model

This refers to a system whereby the end-user purchase the solar items; himself/herself either in cash or in piecemeal (Nieuwenhout et al., 2000; 2001; MEM, 2002; Kolk and Van den Buuse, 2012; Lysen, 2013). It is the most commonly model practised in all

[1] Wp stands for Watt-peak-power (the power generated under certain test conditions).

countries where solar electricity is used. In this model, the end-user has a flexibility of choosing the size and type of the solar system depending on the available fund. However, the main disadvantage of this model is the initial investment, which results in a small number of rural customers being able to purchase stand-alone solar systems. In addition, due to lack of qualified solar engineers/technicians at village level and low purchasing capacity (Paul, 2009; Paul and Uhomoibhi, 2013), the end-user tendency to purchase an undersized system to save the little available money. Furthermore, the system installation is not properly done as the end-users do not prefer to hire a solar engineer/technician. Moreover, replacement is not done on time, and if it is done, it is often done with cheap and non-compatible components which severely undermine the performance of the system and jeopardize the solar electricity technology acceptance.

For example, in 1984, 270 stand-alone solar systems were purchased and installed under cash sale model in Kiribiti, Kenya (Nieuwenhout et al., 2001). However, a survey in 1992 showed that about 90% of the systems were marginally operational. The main reasons given were that the end-users purchased undersized solar system and the systems were not installed as per given instructions.

Donor-Driven Model

This is a type of solar funding whereby developed countries or international donor provides the hardware for free to developing countries on a project basis and the government organizations are fully in charge of all aspects related to the project (Nieuwenhout et al., 2000; 2001; Martinot, 2001; MEM, 2002; Umree and Harris, 2006; ARE, 2008; Kolk and Van den Buuse, 2012). The main advantages of this model are zero initial costs for the end-user, the potential for cost reduction through economies of scale and rapid dissemination. However, in this model, the end-users are generally less involved and feel less responsibility to the system. In addition, the end-users have no choice on the size and type of the solar system. Furthermore, most donor-driven projects provide the hardware only, often neglecting the maintenance and services. As a result, some donor-driven projects do not sustain. For example, in Tunisia, solar systems were given free to the end-users and they were asked to pay an operating cost of US$ 5.20 per month, but they refused to pay (Nieuwenhout et al., 2000). This was not caused by an inability to pay, since some time later; the same end-users could afford US$ 208 for a grid connection (Nieuwenhout et al., 2000). Another example is from Guatemala, where an international Non-Governmental Organisation installed 124 stand-alone solar systems for free and each end-user was given a task of maintaining his/her solar system (Nieuwenhout et al., 2000). However, a survey carried out after 5 years revealed that 45% of the systems were not working mainly due to minor maintenance related problems (Nieuwenhout et al., 2000).

On the other hand, there is a substantial literature demonstrating that some donor-driven projects achieved the intended objectives. Such projects are shown in Table 1.

Layaway Model

Layaway solar electricity financing model is an agreement whereby a solar company sell solar items (such as solar panels, batteries, charge controller or inverters) to individuals on regular monthly payments agreement (Hankins and Van der Pla, 2000; UNDP/World Bank, 2000; Lysen, 2013). The solar company keeps the purchased solar item(s) until the accumulated deposits equal the agreed purchase price. There is sometimes a fee associated in this model since the solar company must 'lay' the item

Table 1: Examples of successful donor-driven projects in selected countries

Name of the Donor	Project Name	Reference
Global Environment Facility (GEF)/World Bank	Togo off-grid electrification, Togo	Martinot et al., (2001)
GEF/World Bank	Benin off-grid electrification, Benin	Martinot et al., (2001)
Solar Electric Light Fund (SEF)	Keyela school and computer solar electricity project in South Africa	SELF (2011)
U.S Department of Energy	Solar electrification project for three villages in Jigawa State, Nigeria	SELF (2011)
SELF and International Crops Research Institute for the Semi-Arid Tropics	Kalalé District farmers solar water pumping and drip irrigation solar systems, Benin	SELF (2011)
Clinton Foundation and Partners	Solar energy projects for rural health centers, Rwanda	SELF (2011)

'away' in storage until the payments are completed. If the transaction is not completed as agreed, the item is returned to stock and the money of the customer is returned minus a fee. The main advantage of this model is that no interest is charged and the item price is fixed during the period of re-payment. However, such arrangement favours only those with regular income such as teachers, technicians, doctors, nurses, small business dealers, etc. Farmers with seasonal income and individuals who are not known to the solar companies' administrators find themselves outside the layaway model equation. This is not a common model in developing countries.

M-Kopa-Pay-as-you-go Model

M-Kopa[2]-Pay-as-you-go model is type of financing mechanism whereby solar items such as solar phone-charger, solar panels, batteries and inverters are purchased on a pay-as-you-go basis, with payments accepted only through M-PESA[3] (Sullivan and Omwansa, 2013). In the literature, this type of solar funding mechanism is only found in Kenya (Sullivan and Omwansa, 2013). The target groups for this type of funding were rural customers with irregular incomes who are not connected to the grid electricity. This model operates as follows: the consumer makes an informal price agreement with the solar supplier and pays instalments through M-PESA according to the agreement. After a 15 – 20% down payment, a customer can take the solar item home. The client

[2] 'M' stands for mobile and 'Kopa' means borrow.
[3] PESA is a Swahili name for 'money', thus M-PESA is money payment through mobile phone.

takes up to a year to pay off the remaining amount; at a minimum rate of approximately 0.40 KES[4] per day. This minimum payment rate was determined based on the amount a typical kerosene user spends per day in rural areas in Kenya. The M-Kopa-Pay-as-you-go Model was launched in 2012 and by 2013; more than 8,000 solar systems had been sold (Sullivan and Omwansa, 2013). Many of these items have been fully paid and few end-users failed to pay and their solar items were taken back.

Whether this kind of arrangement will be widely implemented in Kenya or any other developing country will depends on two things: the willingness of the solar companies to participate in this business and the number of end-users who are able to repay the loan within the specified period. In our view, the M-Kopa-pay-as-you-go business model presents a huge potential for solar system acquisitions in rural areas in Tanzania, but the repayment period (of one year) is too short.

Dealer Credit Model

According to MEM (2002) and IEA (2003), this is a type funding whereby a solar company has a consumer credit or installment payment agreement. In this model the end-user pay the agreed solar system price in monthly or income cycles installments. The ownership of the solar system is transferred either when the down payment is paid or when the credit is repaid. The end-user is responsible for installation and maintenance of the system, although in some cases it can be carried out by the solar company in a separate agreement. In this model, the solar company does not have the working capital required to offer credit to the end-user. Therefore, end-users approach a funding source or credit provider to access credit. For the end-user, the main advantage of this model is that the main barrier of the high initial investment is lowered. However, this model is characterized by relatively short terms (mostly between 6 months and one year), high down payments (up to 50%) and high interest rates (rates of 20% to 25%) IEA, 2003). Furthermore, solar companies are typically not experienced and not capable of administering a credit scheme, as this requires an extra person and it is time consuming. Reported examples are from Zimbabwe and Sri Lanka (IEA, 2003).

End-User Credit Model

In this model, the solar company sells the solar system to the end-user, who obtains consumer credit from a third party credit institution, preferably one with rural outlets and experience with rural credit - that lends directly to the end-users (Nieuwenhout et al., 2000; UNDP/World Bank, 2000; MEM, 2002; IEA, 2003; Kolk and Van den Buuse, 2012). The solar company remains responsible for the sales, distribution and installation of the solar items. The end-user usually pays a down-payment (either directly to the company or to the credit institution), and the remaining payments are collected by the credit institution. The credit institution usually takes responsibility for the loan and pays the complete price to the solar company. The end-user is the owner of the system and responsible for maintenance and repair, although most credit institutes will state in their credit terms that they remain owner till the last payment is made. For a solar company, the main advantage of this model is that the company does not need to allocate budget to

[4] 1 US$ = 85.81 KES, as per 30th June 2013 exchange rate.

run the credit scheme; it is like a cash sale. In rural area, this model is restricted to end-users that the credit institution deems creditworthy (those with regular incomes such as teachers, technicians, health workers, small business dealers, etc).

Solar systems sale by end-user credit model is being practised in countries like Zimbabwe (Marawanyika, 1996), Kenya (Hankins and Van der Pla, 2000; Kabutha et al., 2007; Kariuki et al., 2010), Morroco (IEA, 2003) and Uganda (Kariuki et al., 2010).

Hire-Purchase Model

In this model, the solar company or an intermediate financial institution offers the solar system on a hire-purchase basis (Nieuwenhout et al., 2000; MEM, 2002; IEA, 2003; Ishengoma, 2011; Kolk and Van den Buuse, 2012). The end-user pays a regular monthly fee for a limited period to solar company or an intermediate financial institution. The solar company remains the owner of the solar system during the rental period and at the end of the term, the ownership is transferred to the end-user. The installation and after-sales service is carried out by the solar company. For the solar company, the main barrier of this model is the high initial investment required. One of the disadvantages of this model is that the end-users may not treat the systems with care, as initially the maintenance and ownership do not lie with them.

There have been a large numbers of stand-alone solar systems installed under this model in countries like Indonesia (Miller and Hope, 2000), Bangladesh (IEA, 2003), Sri Lanka, India and Vietnam (SELCO, 2005).

Fee-for-Service Model

In the fee-for-service model, a solar company installs a stand-alone solar system on individual houses and starts selling electricity at affordable fee (MEM, 2002; IEA, 2003; FEF, 2006; Ishengoma, 2011). The solar company remains the owner of the hardware and is responsible for installation, maintenance, repair and replacement of the solar system and, in some cases, its components. The end-user pays a connection fee and a regular fee (usually monthly) as long as the electricity is available and never becomes the owner of the system. The end-user owns only the wiring, lamps and appliances, which are covered by the connection fee. This type of funding requires a solar company to have a substantial capital because by selling electricity at a price which is affordable by the target group, it may takes between 5 and 10 years before the initial investment is recovered. Although this model is geographically restricted because of the extensive infrastructure needed for the collection of the payments and the maintenance of the systems, it is an attractive model for increasing accessibility of solar electricity in remote and rural areas.

For example, in Honduras, Soluz Honduras Company sells Solar Home Systems (SHSs) through fee-for-service model. The company maintains the ownership of the system but the end-user purchase the battery. The company sells electricity at an affordable monthly fee, ranging from US$ 10 to 20 per month. This amount is equivalent to that paid for kerosene, dry cell batteries and the re-charging of car batteries for TV uses. Research indicates that although Soluz Honduras Company sells solar systems through cash and credit models; it is the fee-for-service model that attracts more customers (IEA, 2003). Other examples of fee-for-service models are found in Morocco (IEA, 2003), Bangladesh (RERIC, 2005), Zambia (Ellegard et al., 2004), Argentina, Benin, Togo, the Dominican Republic and Cape Verde (Martinot et al., 2001).

Solar Power Funding Models in Tanzania: Discussions and Recommendations
This section presents the findings of the existing solar electricity funding models (in urban and rural areas) in Tanzania. For each funding model, recommendation whether it is relevant or not has been given.

Cash Sales Model
This is the most commonly model found in both urban and rural areas in Tanzania (MEM, 2002; Paul, 2009; Kariuki et al., 2010; Riddick, 2010). Like any developing countries, the size and type of stand-alone solar systems in Tanzania varies from smaller (10 – 20 Wp) to larger (50 – 100 Wp), depending of the locality. Due to low-income of rural households in Tanzania, this type of solar power funding is not recommended.

Hire-Purchase Model
In Tanzania, there are few formal solar hire-purchased models operating in the urban areas. Examples are Tunakopesha Limited and FINCA – in cooperation with Umeme-Jua[5] Limited (FEF, 2006, Ishengoma, 2011). The FINCA leasing project was unsuccessful due to limited financial capacity and its absence in rural areas. On the other hand, Tunakopesha Limited hire-purchase is generally expensive (over twice the normal retail cash price) because of the high cost of the loans. Since hire-purchase model requires solar companies that have high-working-capital, it is unlikely that solar companies in Tanzania are willing to invest in a risky business with long period of investment recovery (usually about 5 – 10 years). This model is not recommended for rural communities in Tanzania.

Layaway Model
To best of our knowledge, currently there is no formal layaway solar electricity funding reported in Tanzania. However, there are few informal cases which have been reported (MEM, 2002; Parpia, 2007). Due to its disadvantages, this type of funding is not recommended to rural households in Tanzania.

Fee-for-Service Model
Fee-for-service model has been reported in Tanzania, the Uzi project (Kihedu et al., 2006; Ishegoma, 2011). However, the Uzi project has a slightly modification characteristics from a model described in section 4.1.8. The solar panels for Uzi Island solar project (Zanzibar) were purchased by the fund from German-Tanzania Partnership while Tanzania Solar Energy Association and Zanzibar Solar Energy Association offered solar technical expertise. The households purchased the batteries and are paying a monthly fee in the region of US$ 1.6 to 2.4. This is an attractive solar power funding model for rural households in Tanzania in the view that the monthly fee is below the

[5] Umeme-Jua is a Swahili word which means electricity from the sun.

monthly expenditure on kerosene and dry cells. However, due to lack of enough capital, none of the local solar companies are interested in supporting such a business.

Dealer Credit and M-Kopa-Pay-as-you-go Models

These models have not been reported in Tanzania. Dealer credit model is not recommended due to its disadvantages. On the other hand, the suitability of the M-Kopa-pay-as-you-go model is yet to be established as it is in the experimental stage.

Donor-Driven Model

Several donor-driven solar electricity projects have been reported in Tanzania. These projects were either funded by government, international donors or jointly funded. Table 2 presents some of the donor-funded solar projects in Tanzania.

Although some studies (Nieuwenhout et al., 2000; MEM, 2002) have stated clearly that they do not recommend donor-driven funding model, in this paper we recommend it as one of viable alternative to assist rural households to acquire solar systems. However, for this model to succeed, the following must be observed:

- Strict monitoring during and after the project;
- End-users involvement: before, during and after the project;
- In each household, one person should be trained on how to maintain the solar system after the project;
- Clearly defined roles and responsibilities between donors and recipients, especially after project period expiration.

Table 2: Examples of solar electricity projects implemented under donor-driven model in Tanzania

Name of the Donor	Project Name	Reference
Kalwande African Mission	Solar systems installations in Mwanza, Shinyanga and Karagwe	MEM (2002)
UNDP/Tanzania-MEM	UNDP/MEM Mwanza Solar PV Project 2004-2009	FEF (2006)
Ministry of Foreign and Economic Affairs, the Netherlands	Umeme-Jua - Providing access to electricity for rural households in Tanzania through solar Photovoltaic (PV)	FEF(2006)
UNDP/UNESCO	3kW Umbuji Village solar electricity	UN (2001)
Solar Electric Light Fund	Masai people solar-power telephones and FM radios	SELF (2011)
Clinton Foundation and Partners	solar energy projects for rural health centers	SELF (2011)

End-User Credit Model

End-user credit model is the second most commonly model found in Tanzania, besides cash sales model. Table 3 illustrates few examples of solar systems implemented under end-user credit model.

Although there have been few cases reported under end-user credit model in comparison with the total number of solar systems installed, this is the suitable model for increasing acquisition of stand-alone solar systems for poor people in rural areas. The presence of teachers, police workers, heath workers, small business persons and farmers (both food and cash crops), with access to SACCOs[6] and VICOBA[7], make these people, perfect end-user credit clients.

Table 3: Examples of solar power implemented under end-user model

Financier's Name	Financier	Reference
FINCA Tanzania	• Borrowers, mostly from low end income earners in the rural areas without adequate assets to pledge • Individuals with salaries	Kariuki et al. (2010) Ishengoma (2011)
CRDB Bank	• Individuals with salaries • Individuals loans to those with productive businesses and adequate collateral • Well run profitable SACCOs	Kariuki et al. (2010)
Tujijenge Micro-finance	• Individuals with salaries • Individual with business • Well run profitable groups	Kariuki et al. (2010) Ishengoma (2011)
Tujijenge Tanzania	• Well organised groups • SACCOs	Kariuki et al. (2010) Ishengoma (2011)
Promotion of Renewable Energy-(PRET, funded by Tanzania Ministry of Minerals and Energy, MEM)	SACCOs groups	Kariuki et al. (2010)

The Contribution of End-User Funding Model in Acquisition of Solar Systems in Rural Areas in Tanzania

In the absence of other financial institutions, the locals are pushed to join into formal and informal small groups to mobilized resources from members. In Tanzania such groups include SACCOs (formal), VICOBA (informal) and Rotating Savings and Credit Associations, ROSCAs (informal) (Millinga, 2013). These groups (SACCOs, VICOBA and ROSCAs) get funds for lending to members from internally mobilized savings and

[6] SACCOS means Savings and Credit Cooperative Societies
[7] VICOBA means Village Community Bank.

loans from Commercial banks, Community Banks and Government programs such as Small Enterprise Loan Facility (Millinga, 2013). Since there are many members in rural areas with access to either SACCOs, VICOBA or ROSCAs, they should use the end-user model to acquire loan for purchasing solar systems.

However, the following challenges have to be addressed for the success of this model:

- Lack of qualified local solar engineers/technicians at village level to provide technical support;
- Availability of fake solar items in the market;
- Lack of awareness of solar electricity and end-user credit knowledge among SACCOs, VICOBA and ROSCAs members.

CONCLUSIONS

In this paper, the importance of quality higher education for poverty alleviation in Africa and Tanzania in particular, has been presented. Blended learning, which combines and aligns learning undertaken in face-to-face sessions with technology-enhanced learning, was found to be a suitable learning approach for rural communities to acquire post-secondary education. However, the significance of blended learning in remote and rural areas in Tanzania is limited by lack of electricity. Solar energy was indentified as the cost-effective and viable source of electrical energy. Despite of many advantages including cost effective and renewability, the penetration of solar electricity in remote and rural areas in Tanzania was found to be constrained by high initial cost of building a stand-alone solar system. This study reviewed eight solar power funding options (cash sales, donor-driven, layaway, dealer credit, end-user credit, hire-purchase, M-Kopa-pay-as-go and fee-for-service models) that are available in different developing countries, including Tanzania and recommended strongly the end-user credit model. The study has also illustrated the contribution of the end-user funding model in acquisition of solar systems in rural areas in Tanzania through the use of SACCOs, VICOBA and ROSCAs groups.

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