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Solar home systems in Botswana—Opportunities and constraints

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ABSTRACT

Lack of access to electricity grid form the main challenge facing majority of developing regions particularly in rural communities. The situation is driven mostly by the absence of electricity infrastructure in most of the developing countries particularly in rural communities. A number of developing countries are now encouraging the use of solar home systems in isolated areas. Botswana is not immune to this trend. Consequently, available evidence puts the overall contribution of solar energy to primary energy supply in Botswana to less than 1%. A plethora of factors are responsible for inhibiting rapid development of solar home systems in isolated areas in Botswana. Some major impediments often cited as causing low use of solar home systems by rural communities in Botswana include, among others, the following:

(i) Low-income status of most rural inhabitants.
(ii) Migration of house-owners from village status to lands, or cattle posts.

This paper, therefore, analyses factors that impede the rapid development of photovoltaics power generation systems in rural environments in Botswana. The analysis is based on photovoltaic power generation pilot project which was carried out in three (3) villages in Botswana, namely Kudumatse, Lorolwana and Motlhabaneng.

Contents

1. Introduction

Access to modern energy service is fundamental for social development and economic growth world-over. However, available evidence indicates that 1.6 billion people across the world have no access to modern energy service and more than 80% live in South Asia and Sub-Saharan Africa [1]. Concern has been expressed that absence of energy services is linked to many poverty indicators such as infant mortality, illiteracy, life expectancy, and total fertility rate [2]. On the basis of the above observations, efforts to improve access to affordable energy services for sustainable development and poverty eradication form the main global challenge facing the world today, particularly developing nation.

It should be noted that lack of access to modern energy resource affects mostly rural communities of developing regions, because the same groups of communities represent majority of the population in developing regions. For example, in Botswana, rural

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communities represent more than 70% of the country's population [3]. In Namibia, also, two-thirds of the population live in rural communities, particularly in the Northern region of the country where rainfall is relatively high [4]. It is pertinent to mention that rural communities in the majority of the developing regions depend mainly on traditional agriculture and pastoralism for their livehood. Previous studies including [5,6], revealed that rural areas are characterised by low population densities with scattered clusters of households usually inhabited by low income groups. These findings are consistent with observations made by Botswana Government Statistics Office that the average monthly income for rural residents in Botswana is below Botswana Pula (BWP) 530 per month, [3] which is equivalent to approximately US$ 87.

Based on the above observations particularly low population densities the development of electricity infrastructure network in majority of rural communities is not attractive business for private power generating and distributing companies. As a direct result of this rural electrification rate in the majority of the developing regions is low. For example, Sub-Saharan Africa recorded rural electrification rate of 7.5% compared with 51.3% for urban electrification rate in 2000 [1]. It is pertinent to mention that Botswana with a population of 1.8 million, only 0.7% of the population thus 38% enjoy connectivity to electricity grid [7]. Previous study by Ref. [8] puts the overall level of electrical access to national grid in isolated communities in Botswana to just 12%. Based on the above observations, several countries, Botswana included have implemented a wide range of energy sector reform aimed to increase access to modern energy resources in rural communities.

In Botswana the reforms focus on strategy to expand the use of photovoltaic lighting systems in rural communities. Emphasis on the use of photovoltaic systems has been reflected in a number of government policy documents. For example, The Vision 2016 which is the country's blue-print for future national aspirations spells out that the country must be developed as a centre of excellence for solar energy technology. The document further spells out clearly that solar power is a potential source of electricity for public schools in isolated communities. Botswana Energy Master Plan, first published in 1996 and reviewed in 2003 also sets out a number of goals and programmes for rural electrification using renewable energy sources. The components of the programmes are articulated as follows:

(i) Promotion of solar energy by the Botswana Government.
(ii) Integration of grid and non-grid technologies.
(iii) Encouragement of research and development with regard to renewable energy sources.
(iv) Identification of an appropriate institutional framework for rural electricity using renewable energy.
(v) Development of strategies for removing the barriers to widespread use of renewable energies.
(vi) Promotion of women and children's welfare through the provision of PV power generation (lighting) [9].

It should be stressed that presently only few of the above listed components (i, iv and v) are being implemented as reflected in Section 2. However, development of integration of national electricity grid and non-grid technology is not receiving widespread attention from energy sector. This is demonstrated by the closure of solar mini grid community power system at Motshegaletau village in 2007. The closure was driven by the extension and distribution of national electricity grid in the same village by Botswana Power Corporation [10]. It is pertinent to mention that a study by Ref. [11] reported that women and children form the majority of poor people in any community and are usually major users and suppliers of energy resources in marginalised communities. Based on this observation, particularly on component (vi) of the programmes for rural electrification, it is clear that the approach by Botswana government to increase access to modern energy in marginalised communities is pointing to the right direction.

It is further noted that the Revised National Policy on Rural Development [12], also emphasises the importance of using renewable energy resources. The policy document clearly spells out that the use of renewable energy should be encouraged as a measure to reduce harmful emissions and conserve natural resources. The same policy document further notes that the provision of energy using renewable resources is likely to promote the development of productive activities in rural communities which are not necessarily based on agriculture.

The authors believe that productive activities referred to in the Revised National Policy document include establishment of small enterprises, communication services, improved school-related activities, and improved health-related needs. All these lead to the conclusion that provision of modern energy services to marginalised communities is likely to improve their living conditions, and ultimately break the cycle of poverty by creating enhanced opportunities for education, employment and improved livehoods.

Based on the above observations, it becomes apparent that there is an urgent need for the Botswana government to respond to the lack of energy services in rural communities by providing photovoltaics systems. However, it should be stressed that despite strong government ambitions to increase the use of renewable energy resources, backed up by excellent solar conditions in Botswana, with an average of 320 clear, sunny days per year and an average global irradiation of 21 MJ m^{-2}/day throughout the country, the contribution of solar energy to primary energy supply is currently less than 1% in Botswana [13]. However, considering excellent solar conditions prevailing in the country, and low population density in rural communities as mentioned earlier, it becomes clear that the country has potential market for the use of photovoltaics. This conjures several questions, the primary one being factors which adversely affect the rapid development of photovoltaic power generation in rural environment in Botswana. Available evidence indicates that photovoltaics already provides electricity to an estimated 1 million rural households in developing countries who lack access to electricity grids [14].

This paper analyses, among others factors that impede the rapid development of photovoltaics power generation systems in rural environments in Botswana. The analysis is based on photovoltaic power generation pilot project which was carried out in three (3) villages namely Kudumatse, Lorolwana and Motlhabaneng from early-2002 by Energy Affairs Division (EAD) in collaboration with Japanese International Cooperation Agency (JICA). The overall objective of the pilot project was to assess feasibility of using photovoltaics systems for power generation in rural communities in Botswana. The paper further outlines strategies required to sustain rapid development of photovoltaic power generation systems in rural communities in Botswana.

2. Project brief

In line with the global challenge to address the issue of energy poverty among the rural communities, the Government of Botswana in collaboration with Japanese International Cooperation Agency (JICA) implemented a pilot project on PV solar system in 3 villages mentioned earlier. The pilot project started in early 2002, and was completed in December 2005. The project aimed at providing lighting for rural dwellers using PV Solar Home System (SHS) ranging from 50 to 250 Wp.

The project employed fee-for-service model. In this model an energy-service company provides electricity to households in a