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# Social, cultural and political dimensions of off-grid renewable energy programs in developing countries

Tania Urmee*, Anisuzzaman Md

*Murdoch University, School of Engineering and Energy, Murdoch Drive, WA 6150, Australia*

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ABSTRACT

Renewable energy based off-grid rural electrification programs are one of the most effective ways to increase access to energy in remote areas of developing countries. While a large number of such programs have been implemented, the rate of success, to ensure a long-term sustainable program, is low. Many of these programs have failed to appropriately address the social and cultural issues of target communities, which resulted low or no acceptance by the users. Similarly, many rural electrification policies fail to incorporate the needs and views of the users resulting in an unresponsive policy measures. In this paper a framework is presented that would assist in assessing community attitudes and their needs by presenting key factors that need to be considered in different stages of program development and implementation. The framework has been developed in line with the concept of "diffusion of innovation", which has been found to be in agreement with the stages of off-grid renewable energy program development. It is anticipated that this holistic framework will not only help to achieve a long-term sustainable program, but will also offer a significant contribution in achieving Sustainable Development Goals (SDGs) by improving access to energy for rural people in developing countries.



## 1. Introduction

Access to modern energy services, such as electricity and gas, is the cornerstone of economic and social development of a community, as well as a nation. Many developing countries do not have sufficient electricity supply to cover the entire population. Lack of resources, competing national priorities and lack of a strong political desire prevent them to establish a nation wide electrification program. Conventionally, electrification occurs as a part of the process of economic development, which is described as a "virtuous cycle" of energy [1]. According to this view, investment in, and access to, energy supply underpins the economic development [1]. The industrial and commercial activities that come as a result of economic development create employment and generate wealth. This stimulates the demand for better quality of life and higher standards of living and thus alleviates poverty.

There are over one billion people globally who do not have access to electricity, and some 3.3 billion are still cooking with polluting fuels like kerosene, wood, charcoal and dung [2]. Many of these people are living in rural and remote communities of developing countries and use diesel generators to meet their electricity needs. This not only contributes to greenhouse gas emissions (GHG), but also lack of electricity prevents them from contributing to economic development. In addition, these communities are exposed to diesel and kerosene price hikes.

Use of renewable energy resources, to meet electricity requirements, have potential to reduce GHG emissions, safeguard the community from increasing petrol and diesel prices, and provide opportunities for increased access to electricity. Renewable energy (RE) electricity generation projects, however, have high initial capital costs and these communities are usually unable to afford such costs. Therefore, it is common for renewable energy based rural and remote electrification programs in developing countries to be funded through capital grants provided by either donor organisations or by governments.

Many governments and policy makers continue to lack confidence in the ability of renewable energy technologies to provide reliable and affordable electricity. Although information on the success of programs is often difficult to obtain, evidences suggest that many Solar Home System (SHS) programs implemented to date had limited success [3]. While the technical design, delivery and short-term success of these systems are well understood and

* Corresponding author. School of Engineering and Information Technology, Australia.
*E-mail address:* t.urmee@murdoch.edu.au (T. Urmee).

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eminently achievable; the long-term sustainability of RE based rural electrification program, as explained by many case studies, presents significant challenges. These include, for example, appropriate design and planning of RE based electrification program to meet users' needs, an appropriate funding mechanism to cover the cost of operation and maintenance, and availability of local after-sales-service. However, most studies have ignored the importance of inclusion of social and cultural issues of target communities in deployment of systems and to provide a long term sustainable project. Similarly, while the importance of RE policy in the development of off-grid electrification is widely recognized, not much information is available on how policy context of a country can impact the promotion of RE for off-grid electrification.

This paper aims to identify the key socio-cultural and political factors that play an important role in an off-grid energy delivery and how those can be incorporated into design, planning and implementation of rural electrification programs. In doing so, delivery of off-grid energy services has been explained from the perspective of "diffusion of innovation" theory. First, the issues related to long-term sustainability of an off-grid energy delivery program, using renewable energy sources, have been discussed. Secondly, the social, cultural and political issues of off-grid renewable energy based energy delivery programs have been identified, and then a detailed discussion has been provided on how those factors need to be built in the project design and planning to achieve a long-term sustainability. Finally, the paper presents a design and planning framework that would help policy-makers, project developers and practitioners to develop and implement a program that would not only be well-accepted by the targeted users/community but also would have high chances of success from the long-term sustainability perspective.

## 2. Sustainability of RE based rural electrification programme

The word "sustainability" is commonly derived from the term "Sustainable Development", which was introduced by the International Union for the Conservation of Nature in its "World Conservation Strategy," and was refined in 1987 in the Brundtland Report of the World Commission on Environment and Development [4]. It involves economic, social and environmental development such as protection, conservation and preservation with appropriate technology. Studies concluded that these dimensions alone cannot possibly reflect the complexity of current society and needed a fourth pillar named "culture" [5]. An off-grid rural electrification program can be said to be sustainable when it meets the basic principles of Sustainable Development. The requirements for a sustainable rural electrification program would thus need to, at the outset, satisfy the following – (i) technical sustainability, (ii) economic sustainability, (iii) institutional or governance sustainability, (iv) environmental sustainability, and (v) social and cultural sustainability.

The relationship between "sustainability" and "success of a RE program" depends on a number of factors including socio-economic and cultural context of the community, relevant RE policy measures, and reliability of RE systems [6]. In this paper, three dimensions – social, cultural and political dimensions of sustainable energy issue for RE electrification are discussed and explained.

Several studies have investigated the sustainability of solar Photovoltaic (PV) systems in the past. The experiences from the earlier World Bank/GEF/IFC projects on Solar Home Systems (SHSs) in developing countries summarise the main challenges associated with sustainability of PV program as a business model, rural electrification policy and local capacity building [7–9]. Mulugetta et al. (2000) shows that a sustainable energy development programme requires a multi-pronged intervention, which is well-coordinated with a clear view of specific engagements beyond the donor commitment period [10]. According to James et al. (2002), a sustainable solar PV electrification should address the affordability of users who need to develop a financing infrastructure, build the capacity of users and local people, and empower the village people [11]. Other studies reveal that lack of awareness among prospective users, unavailability of different models catering different users need, and limited dissemination of solar PV lighting systems [12–14]. Experiences from Mexico show that the users' attitude determines the success or the failure of a program, and it is important that the user must understand the very special characteristics of PV power and must play a role in sound operation and maintenance of the system [14,15].

Another study suggests that maintenance of a PV system done by the users has impacted more on program sustainability than maintenance by the supplier or implementer [16]. This increases the sense of ownerships among the users and strengthens the program sustainability. The Solar Electrification program in Limpopo Province and Eastern Cape in South Africa faced many difficulties because it did not give proper consideration, at its inception, to local community needs, expectations and capacity development [17]. In most programs implemented in rural areas of developing countries, lack of awareness about the technology was found to be a barrier to sustainable promotion of PV electrification [18]. It was found that the load capacities of SHSs were not properly communicated to the end users, that is the users were not informed about the limited hours of usage of solar lighting systems [19]. Users expected grid supply power quality and capacity to meet cooking demands and to provide unlimited lighting. Thus, end-user dissatisfaction led to many payment refusals. Another study reveals the fact that users' attitude determines the success or the failure of a project [20] and so it is important to make sure to create users' sense of ownership of the program.

Many government-funded Micro-Hydro Systems (MHSs) have been established in remote areas, but the performance of these projects is not well-documented. One of the issues emerged from this research is the observation that, like other renewable energy projects and programmes, MHS projects constructed for remote rural electrification have high up-front cost, so they tend to be constructed with finance provided by public grants (government funds) or from non-government organisations (NGOs). Once installed the responsibility for operation and maintenance is often handed over to the community, and eventually the project fails because the community would not have the maintenance budget [21]. Furthermore, donor-funded MHS projects are planned and executed within timeframes designed to meet the needs of the donor rather than those of the communities.

Another study [22] undertaken to assess impacts and sustainability of small-scale renewable energy projects in developing countries, suggests a set of recommendations to improve the long-term sustainability of such projects. With Millennium Development Goals (MDGs) as the reference case, the study identified a number of social issues that should be considered in developing and implementing a project. These include, for example, involvement of users in project development; use of energy systems for productive uses; and development of sense of ownership among the users. The barrier assessment by Sovacool et al. [23] identified a number of barriers that inhibited the promotion of SHSs in Papua New Guinea (PNG), including technical, social and political barriers. One of the social barriers was unrealistic expectation from SHS [23]. For example, users even had the expectations that 10Wp system could provide all electricity needs, including operating freeze and air-conditioners. This may have resulted from the limited communications, or inflated benefit description, undertaken by the implemented agency. In addition, social barriers also included the high