Social, cultural and policy issues of the application of remote area off-grid photovoltaic

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Abstract

Globally, the PV market is growing rapidly with a total installed capacity of more than 100GW at this time. Many of the existing PV electrification projects fall short of expectations by not meeting their objectives. A lot of these projects have not taken into account the social and cultural issues of the community, nor its future development. Experience from other programs suggested that, to implement a solar PV system, the people have to understand and accept its reliability compared to the unreliability of the grid. Cultural acceptance is a “must” to make the project work successfully over a long time, thereby improving the project’s sustainability. It is emphasised that we should include community participation while working on electricity access. If the community is not involved, people will not take on projects to support them as their own. It is also important to define a community, its characteristics and limits, and to identify the local legitimised decision-making process. An analysis of the community’s perspective would help our understanding in developing project. This paper explains the social, cultural and policy issues of remote area PV applications in the light of current projects in developing countries.

Keywords: Solar PV, Social, Cultural, Off-grid, Remote area, Policy

1. Introduction

For over a decade, solar home systems (SHS) have been promoted by many as the best solution for providing access to electricity in rural areas of developing countries where supplying electricity from the grid is not a practical option [1]. More recent experience in China, India and Bangladesh has verified that solar PV has become the least-cost and environmentally-preferred option for increasing access to electricity for rural households and small enterprises [2]. The developmental organizations, like the World Bank, which support and fund the projects dealing with access to energy, are in favour of PV application for remote communities. Despite all of these benefits and supports, the uptake of solar PV for providing access to electricity is low.

The reason of this low uptake is neither simple nor straightforward. An attempt to make an understanding of the underlying issues related to low uptake of solar PV was made by Urmee T. (2009), where the author analysed the reasons for some solar PV programs with limited or no success[3]. It has been indicated that while many PV programs have been implemented in developing countries, only a small proportion appear to have been successful [4-7]. The number of issues involved are large and the situations in which they are planned and implemented are complex and varying, as does the cultural, social, economic, geographic and political circumstances in which these programs are being delivered. This makes the development of a comprehensive program impossible to produce [8]. It also means that research on program successes and failures needs to be grounded in specific cultures, politics, institutions and history [9].

The explanations for the lack of success and the non-sustainability of the earliest programs are widely accepted. These tended to be technical demonstrations rather than comprehensive programs undertaken with the intention of being either sustainable or replicable. They were not successful as they relied totally on funding from donor organisations or governments to cover the upfront capital costs of the systems while ignoring or overlooking the vital question of how ongoing operational, maintenance and replacement costs would be met. Many of those projects were considered to be failures due to poor technical performance, poor attention to the needs of users and the local conditions [9]. The lack of success and the non-sustainability of those early programs is said to have resulted in disillusionment on the part of international donor organisations. Confidence was lost with renewable energy rural electrification programs in developing countries which resulted in a withdrawal of donor and government funding [10].

Many governments and policy makers continue to lack confidence in the ability of SHS to provide reliable and affordable electricity. Although information on the success of programs is often difficult to obtain, evidence does exist suggests that many of the SHS programs undertaken to date have indeed met with limited success [7]. The technical design, delivery and short-term success of PV systems are well understood and eminently achievable. However, the long-term sustainability of off-grid PV systems, as explained by many case studies, presents significant challenges. Therefore, the definition of a ‘sustainable project’, and what factors determine the ‘success’, need to be well understood.

This paper explains the ‘soft’ (social, cultural and policy) issues of sustainable remote area PV applications in developing countries.

2. Sustainability issues for rural electrification and solar PV

The concept of sustainable development was first 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. Sustainable development is defined as “development that meets the needs of the present, without compromising the ability of future generations to meet their own needs” [11]. It involves economic, social and environmental development such as protection, conservation and preservation with appropriate technology; which includes administrative sustainability by ensuring that there is the capacity for programme development and implementation [12]. Researchers later on concluded that these dimensions alone cannot possibly reflect the complexity of current society and need a fourth pillar named culture[13].

Figure 1 shows a concept of sustainability and its links with post carbon society. The conceptual framework of ‘post carbon futures’ is being used in an increasingly broad range of settings to emphasise the importance of systemic transformations leading to ‘a world in which we are no longer dependent on hydrocarbon fuels, and no longer emitting climate-changing levels of carbon into the atmosphere'[14].

In pre-carbon society much emphasis was given on the technology development, partly on economy, policy and environment but none on social and cultural issue (figure1). Ideally we need to enter into a post carbon society where we should manage to reduce carbon emission to zero for energy production. In a post carbon society social and cultural issues need to be taken care of in order to make energy supply more sustainable.

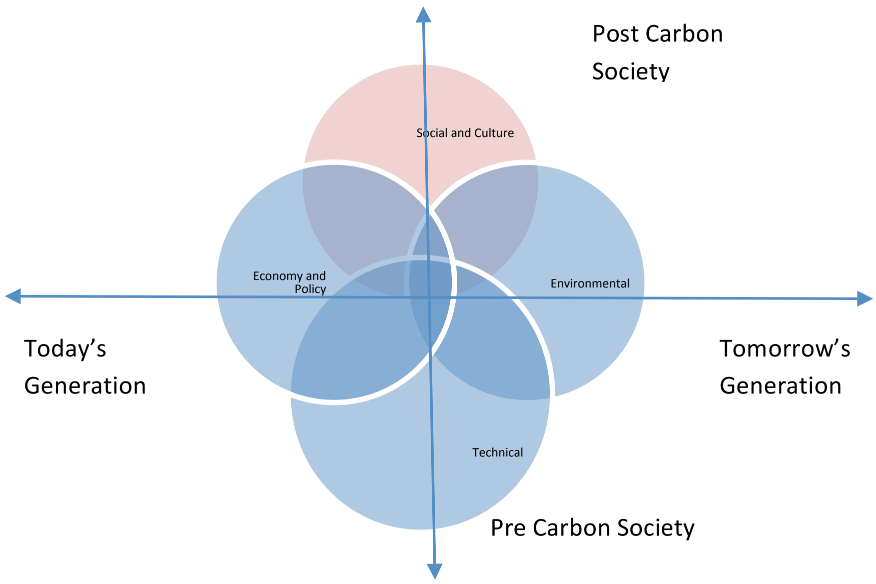

Figure 1: Pre and Post-carbon society and sustainability pillar.

It is necessary to pause at this point to define what is meant by the terms "sustainable" or "unsustainable". A sustainable program is one that is self-funded or capable of continuing without the continued injection of funding support from government or donor organisations, meets users' expectations and has no or minimal environmental impact [3]. Program success measures the long-term impacts of the program, while sustainability refers to the capacity of the program to continue into the future. For the purposes of this paper, the term "successful" is used to describe a program where the systems are working and are reliable, program objectives are met, and the participants are satisfied [15]. A successful program results in anticipated benefits and significant increase in the number of installed systems over time. Sustainability in electrification programs, however, is more than just the interconnectedness of the economy, society, policy and the environment but is also affected by the technology deployment. Figure 2 shows a simplified model of energy sustainability.

The relationship between "sustainability" and "success of a solar PV program" depends on a number of factors including socio-economic and cultural context of the program area, applicable RE policy measures, and reliability of PV systems [16]. This paper presents sustainable energy issues for solar PV considering three dimensions: social, cultural, and political dimensions and how they are impacted or influenced by the electrification.

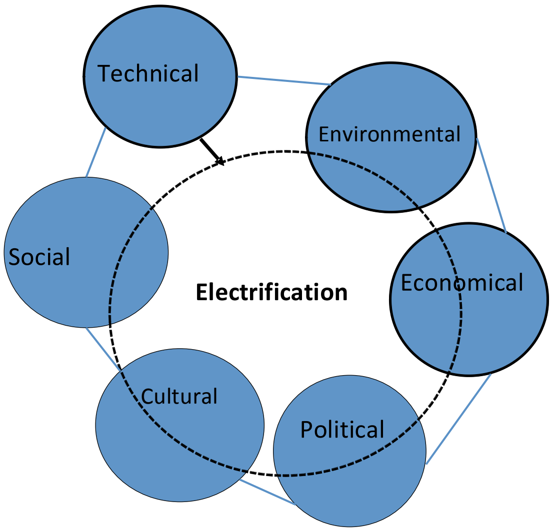

Figure 2: Simplified model for energy sustainability

3. Issues and Challenges of sustainability of PV projects

Several studies have investigated the sustainability of PV systems in recent years. The experiences from the earlier World Bank/GEF/IFC projects on solar home systems in developing countries summarise the main challenges associated with sustainability of PV program as a business model, rural electrification policy and local capacity building [4, 17, 18]. 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 [19]. According to James et al (2002), a sustainable solar PV electrification should address the affordability of the users who need to develop a financing infrastructure, build the capacity of the users and local people and empower them [20].

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 [21, 22]. Despite the need for electricity, people are waiting for the grid electricity, which may not be supplied in their life-time. Experiences from Mexico show, that user interaction is a more critical problem for adoption of PV as compared to cost, efficiency, or other purely technological issues. According to this study, the user's attitude determines the success or the failure of the program, and it is important that he/she must understand the very special characteristics of PV power and must play a role in operating and maintaining the system [23].

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 [24]. This increases the sense of ownerships among the users and strengthens the program sustainability. The Solar Electrification 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 [25]. In most of the programs implemented in rural areas of developing countries, general lack of awareness was found to be a barrier to sustainable promotion of PV electrification [26]. It was found that the load capacities of SHSs were not properly communicated to end users. Users were not informed about the limited hours of usage of solar lighting systems. These systems were designed to accommodate only minimal lighting loads [27]. Users expected grid supply power quality and capacity to meet cooking demands and to provide unlimited lighting. The resulting end-user dissatisfaction led to many refusals of payment. Another study reveals the fact that a user's attitude determines the success or failure of the project [15] and so it is important to make sure to create users' ownership of the program.

The explanations for the lack of success and the non-sustainability of the earliest programs are widely accepted. These tended to be technical demonstrations rather than comprehensive programs undertaken with the intention of being either sustainable or replicable. They were not successful, as they relied totally on funding from donor organisations or governments to cover the upfront capital costs of the systems while ignoring or overlooking the vital question of how ongoing operational, maintenance and replacement costs would be met. Many of those projects were failed, due to poor technical performance, poor attention to the needs of users and the local conditions [9]. The lack of success and the non-sustainability of those early programs is said to have resulted in disillusionment on the part of international donor organisations. Confidence was lost in renewable energy rural electrification programs in developing countries, which resulted in a withdrawal of donor and government funding [10].

More than 9000 SHSs (45 W_p each) in Zimbabwe were installed in rural homes, health centres and schools by the end of 1997, and this was considered a means of improving the quality of life for the rural people while minimizing carbon emissions [20]. Due to lack of accountability, there was not even sufficient information available to establish how many systems remained operational, as no monitoring was carried out.

The case studies described above are not isolated cases and have led to a poor perception of PV technology in many areas. Anecdotal evidence in Malawi states that 50% of PV systems fail within a year of their installation. According to the above discussion, the critical success and failure factors that have contributed to the success of RE projects in a developing country are given below [9, 15, 17, 22, 24, 28-35]:

Success factors:

- The presence of an approved policy for the renewable energy sector as a whole;
- Well-established, efficient, institutional arrangements for planning and implementation of RE projects/programmes;
- Available and supportive financial systems;
- Community participation;
- Project identification and prioritization according to the needs of the beneficiaries;
- Project financing tied up fully in advance for the smooth flow of funds for implementation;
- Locally available capability, and resources of the area;

- The training needs identification and provision of capacity building assistance ahead of launching a programme;
- Continuous capacity development and support throughout the life of the project;
- Availability of knowledge support from reputable academic or technical institutions.

Failure factors

The major causes for the failure of renewable energy projects are:

- Lack of an exclusive Renewable Energy Policy Statement or Act;
- Inefficient technology selection for the project or programme leading to the choice of immature technology or an unreliable implementing agency or machinery supplier;
- Non-inclusion of the total impact of the project on the local community environment at project planning stage;
- The technology development efforts do not take into account the consumers' traditional ways of obtaining that service;
- Lack of adequate preparation including capacity building before launching a large RE programme; and,
- Lack of effective coordination mechanisms among stakeholders (project/programme implementers, users and private agencies).

4. Social, Cultural and Political Sustainability of PV project Development

Technological developments need to remain aligned with the social, economic, institutional and environmental needs and constraints of rural communities as explained in section 3 in the light of different project experiences. It is important to consider that the engineering approach must go beyond the technical sphere when developing sustainable energy solutions.

Among the socio-economic barriers that make the challenge of sustainable energy development complex, and which often contribute to the failure of renewable energy projects, include inadequate regulatory frameworks, lack of financial support mechanisms, political risks, inadequate institutional capacity to implement projects, limited awareness and appreciation of the potential role of renewable technologies in sustainable development, and lack of community participation. Various studies on renewable energy models, which show that socio-political factors play similar roles to economic and technical factors in terms of sustainability of renewable energy projects, especially solar PV programs [36, 37].

Social and cultural sustainability involves interaction with the community regarding program design, installation, and in particular its engagement, participation, ownership and the accountability of the local users. An approach of achieving sustainability in these areas would be to enhancing community participation in every stage of the project. We need to understand the community while working on electricity access. If the community is not involved, people will not take projects as theirs. The cultural acceptance is a must, to make it work for a long time, and to avoid failure, thereby improving the project's sustainability.

To ensure community participation it is important to understand what we mean by this. Community participation is about:

- Engaging local people.
- Understanding community's energy needs and energy use patterns to provide improve energy service.
- Identifying and understanding the community (their culture, religion, ethnicity, and so on) and issues need to be considered (Particular interests/habits/ways of living).

Figure 3 shows an example of how community participation can be included in sustainable project development.

Figure 3: Elements of community participation for a sustainable project

Therefore, before ensuring participation from a community, it is important that the basic starting points are identified, such as defining the community, its characteristics and limits, for instance heterogeneity; locally legitimized decision making process (identify the leader etc.). This would help our understanding (e.g. how a community without electricity look at the topic and what they expect) on process of community contribution to the project. So, the scope of the project has to be defined by the project implementer to the community. Choosing the community wisely and understanding their culture is important. A new technology can be demonstrated to the community which may help in their decision making. Technology need to approach to the community in a way that the process is legitimised by the community and create ownership.

The capacity or willingness of governments and donor organisations to provide funding and government policies and policy priorities are important catalysts of political sustainability of PV program, which depends on regulation and implementation of policies. For example the Fijian SHS program is implemented within the context of a uniform electricity tariff policy [22]. Such policies have been adopted by many governments over the past one hundred years, and many governments, including state governments in Australia, continue to do so [38]. The question, therefore, is not whether a uniform tariff policy is appropriate or not but how it will be funded and what are the implications of this for a SHS program. In the case of the Fijian SHS program it places severe constraints on funding which in turn has major impacts on the program and its capacity to be expanded. This policy also has a flow-on effect into the institutional, administrative and other spheres, as the objective is achieved by governments having to retain ownership of the SHSs and users paying a monthly fee for the system [22].

Political influence on grid extension has distorted the PV market. An example of this was the first SHS project in Bangladesh undertaken in 1995 where the total project cost was US$1.77M. The project involved installing electric lighting powered by batteries in approximately 900 households in Narshingdi, a riverine island community, and three solar charging stations to recharge the batteries. Due to some political influences, the villages were later connected to the national grid, which led to discontinuation of the PV program. So, having an appropriate public policy framework and a national renewable energy policy that support renewable rural electrification projects, in particular, is important.

Local policies could interfere with (or complement to) national policies and could interact with each other. Therefore, understanding this dynamic is important when designing policies and coordinating policy development. For PV, the risks and rewards will be determined by the geography, technology, activity, and policy. Understanding whether economies of scale are local or global and whether the benefits are focused on the entire system or on one particular element (for example, wafer manufacture) may also determine the effectiveness of the policy and its extended effects on the PV market development. Research grants might have a stronger impact on technology breakthroughs, while certain designs of tax incentives could focus support on more local issues, for example, by encouraging the development of project development, construction or installation skills.

5. Conclusion

The use of PV to provide an off-grid electricity supply has proved attractive to Governments, NGOs, International Agencies and users. This paper spotted some lights on current thinking on sustainable approaches to rural electrification using PV. Most of the social issues mentioned in the literature can be solved by increasing community participation in the project. The significance of “community participation” has been explained in this paper. Policy initiatives also have a major role to play in the spread of PV technology into the market. Identifying and using the local legitimised decision-making process will enable active community participation and hence ensure sustainability of the project.

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