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Better or worse? The role of solar photovoltaic (PV) systems in sustainable development: Case studies of remote atoll communities in Kiribati

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ABSTRACT

The Republic of Kiribati, formerly known as the Gilbert Islands, is a Micronesian (One of the three groups of islands in the Pacific. The eight territories that make up Micronesia are Commonwealth of the Northern Mariana Islands, Federated States of Micronesia, Republic of Kiribati, Republic of the Marshall Islands, Republic of Nauru, Republic of Palau, Territory of Guam and Territory of Wake Island. The other two groups of islands in the Pacific are Melanesia and Polynesia) country in the Pacific. The energy sources utilised in Kiribati include petroleum products, biomass, solar energy and wind power. Solar energy was introduced in Kiribati in the early 1980s (Wade H. Survey of RESCO projects – prepared for OPRET, Fiji Department of Energy, 2003; p. 36). Currently, it makes a very insignificant (less than 1%) contribution to the total annual primary energy supply (South Pacific Regional Environment Programme (SPREP). Pacific Islands Renewable Energy Project (PIREP) – Pacific Regional Energy Assessment (PREA) 2004. Kiribati national report, Vol. 5, 2005). Solar energy in Kiribati is used mostly in the form of solar photovoltaic (PV) technologies for the provision of lighting and electricity.

This study examines the role of PV technologies in the sustainable development process in Kiribati, with particular reference to remote atoll communities. Initial results from on-site surveys carried out are reported in this paper. These surveys have sought to identify the reasons why people use or do not use PV systems.

1. Introduction

The provision of energy services has often been justified on the basis that it results in economic and/or social development. In developed countries (or modern societies), the increase in per capita energy consumption has been regarded as a measure of economic development. In most developing countries (especially in rural and remote communities), lack of access to energy services is seen as an obstacle to development.

Over the past two decades, many developing countries have attempted to sustain and improve their energy services through a number of approaches such as the introduction of modern forms of energy supplies, restructuring power utilities and educating communities about energy supply systems [3].

In countries, with adequate solar radiation, PV technologies have been chosen as the best energy option for areas that are not covered by the centralised power grid. PV technologies were introduced in Kiribati in early 1980s [1,2]. Over the last two decades, the number of PV systems in Kiribati has increased. The applications of PV technologies in Kiribati include:

- lighting: indoor (in houses and community halls), outdoor and street lights.
- pumping water in villages and schools; and
- powering electrical devices: communication devices (phone, fax machine and citizen band (CB) radio), torch, fan, refrigerator and radio.

This study attempts to examine the role of PV technologies in the process of sustainable development in Kiribati, with particular reference to rural and remote communities. The objectives of this work sought to address the following two questions:

1. In what ways have the PV systems already in place contributed to the development of the communities in the outer atolls of Kiribati? and
2. Have PV systems been a reliable and viable alternative in the remote atoll context (of Kiribati) within which it operates?

The first part of the paper gives an overview of the assessment criteria used. The section that follows presents the case of SHSs on Abemama Atoll and its role in the sustainable development process of the rural and remote communities. Finally, conclusions from this initial analysis have been presented.

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2. Assessment criteria

The results presented in this paper are based on data collected through field surveys carried out in Kiribati during August and September of 2006. To address the objectives of this study, an inter-related approach as shown in Fig. 1 was used (adopted from [4]).

In this approach, both the effect of the PV technologies on the lives of the people and the influence of the people on the viability of the PV technologies were assessed. Ten indicators were identified and used to structure interviews for the following three groups of households:

1. households with an SHS;
2. households with an SHS in the past (but without one currently); and
3. households that have never had an SHS.

Participants in groups 2 and 3 were targeted in order to illustrate the differences between the households with an SHS and those currently without. A total of 102 participants were recruited from two different atolls (Abemama and North Tarawa Atoll) in Kiribati. These two atolls are in the Gilbert Group[1] which lies to the west of the country (Fig. 2) [5].

3. Case study of Solar Home Systems (SHSs) on Abemama Atoll

The major focus of this study was SHSs. In addition to the SHSs, other PV systems that were encountered on the atoll were also considered.

This section presents the case of SHSs on Abemama Atoll. Forty-three participants were recruited from five different villages. Of these 43 participants, 26 had an SHS, one had an SHS in the past (but did not have it at the time of the interview) and 16 never had an SHS. Sub-sections 3.1–3.4 present the results obtained using four indicators – suitability, affordability, technological capability and livelihood diversification.

3.1. Suitability

One of the main concerns of any technological innovation for rural livelihoods should be the extent to which the technology is able to meet the needs of the people. Need (or requirements) here is understood in terms of the suitability of the technology in the given context. This indicator was used to assess the ability of the SHSs to meet the immediate needs of the people.

Approximately 52% ($n=26$) of the households needed an SHS for lighting. Most of the households did not specify a reason for which they needed lighting. For the ones that specified a reason, some of them were:

1. brighter light;
2. light for children to study at night;
3. light for cleaning fish at night; and
4. light for security purposes.

A further 35% of the participants thought that it was cheaper to have an SHS than other forms of lighting such as kerosene lamps, petrol and/or (diesel) generators.

For the remaining households (13%), some of the reasons for having an SHS included:

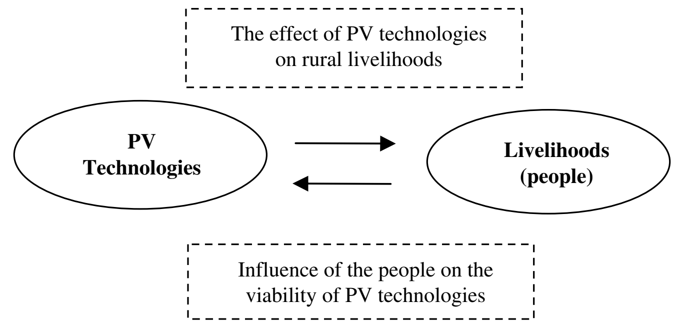

Fig. 1. PV technologies and the people: an inter-related approach.

1. convenient form of lighting;
2. safer form of lighting; and
3. purchasing second hand solar panels at a reasonable price.

One of the participants mentioned that the SHSs did not provide the flexibility of carrying the light around which is possible with a kerosene lantern. The villagers often use a kerosene lantern to travel from one village to another at night. A kerosene lantern is also used during the fishing trips.

3.2. Affordability

SHSs are expensive devices and the cost is recognised as one of the main barriers for its use. This indicator was used to assess the capacity of the target users to afford the acquisition and maintenance of SHSs.

In terms of cost/funding, the SHSs on Abemama Atoll belonged to one of the following three categories:

1. *Private systems*: the users owned the system and therefore met both the acquisition and maintenance costs;
2. *School systems*: the systems were part of a school community. The users did not pay any fee for this system. The cost for these systems were met by a catholic mission; and
3. *Kiribati Solar Energy Company (KSEC) systems*: the users rented the system from KSEC for which they paid an up-front cost (AU$50) and monthly fee (AU$9) [6]. The up-front cost and the monthly fee cover half of the cost of the KSEC SHSs and the remaining 50% of the cost is subsidised [6].

Of the households that had an SHS, seven were privately owned, four belonged to a school community and 15 were rented from KSEC.

Five private SHSs were owned by a relatively affluent part of the population (government officials, policemen, seamen, and small business owners) and one was owned by a person residing in the urban area with a second home on the atoll. Only one private system was owned by an ordinary villager.[2]

At the time of the visit, the system that belonged to the ordinary villager was not working and the family was using a kerosene lamp for lighting. The system had not been working for two weeks. The family did not take any initiative to have the system repaired due to the costs that would be involved.

Table 1 summarises the responses from the participants regarding the up-front cost and monthly fee they had to pay for the SEC systems.

[1] Kiribati consists of 33 atolls divided into three groups: Gilbert, Phoenix and Line Islands.

[2] A villager with whose only source of income is copra and fishing (in some cases).

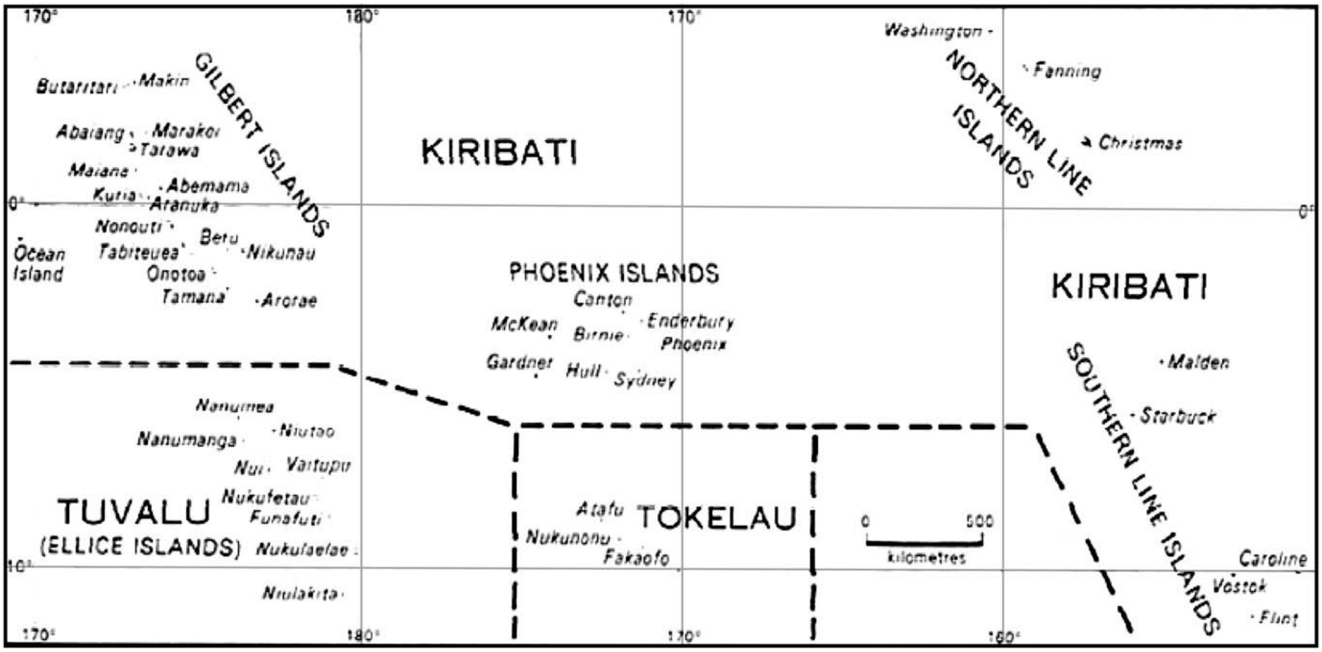

Fig. 2. Map of Kiribati and other neighbouring territories (Tuvalu and Tokelau) in the Central Pacific.

The difficulties in paying the up-front costs and the monthly fee by a lot of users confirm affordability of SHSs as a major concern in this community. The problem of affordability of monthly fee was not caused by the size of the household income. In most of the cases, the households used to spend more than AU$9 per month on kerosene and/or diesel (and/or petrol).

A significant cost constraint for the people in this case was that for the SHSs, the fee was paid in relatively large amount(s) while kerosene and/or diesel (and/or petrol) could be purchased in small amounts for a little cash on a daily basis. There were no banks or money saving mechanisms on the atoll which was the main factor affecting the ability of the households to pay the monthly fee.

3.3. Technological capability

SHSs consist of sophisticated and delicate components requiring a certain level of expertise for installation and maintenance. An SHS is a self-contained energy technology (production, conversion and distribution takes place in the household) which makes it more sensitive to maintenance. This indicator was used to assess the know-how of the users to install, operate and maintain the technology. Fig. 3 shows the different ages of the SHSs that were considered in this study.

Most (approximately 65%) of the SHSs in this study were about two years old. Based on the age of most of the systems, the components should have been functioning since most were well within their working life spans.

At the time of the visit, 73% ($n = 26$) of the SHSs were working, 19% were not working at all and for 8% of the systems, one lamp was not working.

Approximately 54% of the participants said that they had experienced some problems in the past. The main problem was the malfunction of the bulbs and the second most common problem was the malfunction of the batteries. In most of the cases, (approximately 64%), the participants said that they did not know what the problem was. In some of the households, the batteries were kept under the bed, near the kitchen fire and amidst open containers holding kerosene and other combustible materials.

For the privately owned and the school systems, the users themselves were responsible for the maintenance. For the KSEC systems, the users were not involved in any service or maintenance of the system. The service and maintenance of these systems were done by the KSEC technicians. There was one technician to look after all the KSEC systems on Abemama Atoll. If any maintenance was required, the users could either contact the technician by going to his village, or wait for one of his

Table 1
Participants response to monthly fee and up-front costs

	% of participants
Easily able to afford both the up-front cost and monthly fee	40
Difficulties in paying the up-front cost but easily able to afford the monthly fee	7
Difficulties in paying both the up-front cost and monthly fee	53
Difficulties in paying monthly fee	66
No difficulties in paying monthly fee	27
No difficulties in paying the monthly fee before but have difficulties now	7

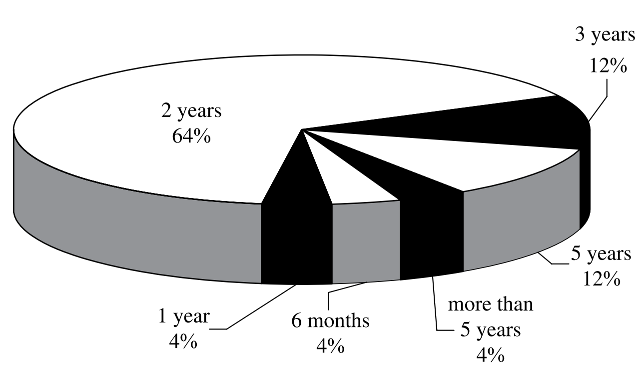

Fig. 3. Different ages of SHSs considered in this study.

routine visits. KSEC technicians visited the households once per month to check the acid level in the battery, measure battery voltage, clean the panel if necessary and make a visual inspection of the system installation.

Due to the lack of communication facilities, informing the technician was one of the major constraints on the atoll. The users often had to wait for the technician's routine visits. Sometimes the problem was fixed within a day or two and at other times it took as long as a month. The task of sustaining these SHSs requires more resources than those currently available. It is not enough just to know how to switch on the lights but also to have a basic understanding of the system.

3.4. *Livelihood diversification (income generating activities)*

This indicator was used to assess the effect of SHSs on peoples' options and choices for income generating activities. Copra was the main source of income on Abemama Atoll. Copra harvesting is non-seasonal, therefore the income remained consistent throughout the year. The income, however, varied from one household to another. Some households earned AU$20 per week whereas others earned as much as AU$100 or more per week. Fishing was another source of income for households that had refrigerators and were able to store fish.

For approximately 62% of the households, SHSs had not contributed to the income generating activities in any way. For the remaining 38%, SHS had helped in income generating activities in the following ways:

1. baking bread at night;
2. cleaning fish at night;
3. making mats at night;
4. making strings at night;
5. opening a shop at night;
6. selling fish at night; and
7. selling tobacco at night.

SHSs in these communities have had a very modest impact on the level and type of income generating activities. Most of the productive activities in these communities were labour intensive and used no source of energy at all. Due to the availability of the longer daylight hours, a lot of the activities were done during the day itself. The main use of the SHSs for income generating activities was by the shop owners for lighting.

4. Initial conclusions

SHSs are often portrayed as a reliable technology which is able to satisfy basic energy needs, easy to operate and maintain, and a means of promoting small-scale income generating activities. Such views have become so pervasive that they are hardly questioned. In the rural and remote communities in Kiribati, there were people with different attitudes towards the SHSs.

The main need for SHSs was for lighting. One of the most important findings in this study was that SHSs could not be afforded by a lot of the households even when the costs were heavily subsidised. Affordability in many circumstances was at the expense of diverting income from other needs.

In terms of technological capability, most of the users did not have any technical knowledge. The users should have limited knowledge to maintain the SHSs and a good support service should be provided. The prospects for income generating activities were not promising. SHSs have a very modest impact on income generating activities for ordinary villagers. It was mainly useful to shop owners for lighting at night. SHSs may be an inappropriate technology in such communities if the objective is to link it to income generating activities.

It cannot be automatically assumed that SHSs are a universal strategy for improving livelihoods by increasing income generating activities. It provides basic lighting and electricity needs but may not be a viable option for enhancing household income in such communities.

The results from the remaining indicators and for the rest of the PV technologies considered in this study will be presented in other publications arising from this work.

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