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Problems and Prospects of Rural Electrification in Poor Countries: The Case of Songo Songo Wayleave Village Electrification Scheme in Southern Tanzania

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Abstract

This study investigates the problems and prospects of rural electrification in poor countries with the case study of Songo Songo Wayleave Villages Electrification Scheme (WVES) in Tanzania. WVES is one of the incentives of the project to the affected villages. However, this service will be provided commercially. This study examines the implication of this decision of providing electricity commercially in villages with deep and pervasive poverty. The socio-economic status of the communities, the demand, willingness and ability to pay for electricity services has been analysed. Findings show that although willingness to pay is high, the ability to pay (actual demand) is very low by the majority of the respondents; suggesting that application of TANESCO commercial tariffs to the project area would be a disincentive to many villagers. This decision will also have cost implications to the TANESCO's installed facilities. It is recommended that special credit be provided to facilitate rural communities in WVES. Also, policy and decision makers should encourage production of broader range of renewable energies and production of micro-hydro energy sources that are both economic and affordable to rural communities.

1. Introduction

Tanzania is one of the poorest countries in the world, with 36% of her population living below basic needs poverty line. Poverty remains predominantly a rural phenomenon, although the number of poor in urban areas is also growing fast. In both rural and urban areas the poor typically earn low incomes, lack capital and human assets, they are less educated, of ill health, and have large families (URT, 2005).

Except for Temeke District, other districts in the study area[1] are characterised by deep and absolute poverty. Households under poverty line (i.e., earn less than one dollar per day) are 46%, 48% and 53% for Mkuranga, Rufiji and Kilwa, respectively. About 40% of children in this area are stunted. Other poverty indicators include low education of only 50-65% literacy rate, and over 200 per 1000 under-five children death rates. This area also has limited health facilities of between 21-40 compared to over 50 facilities in many parts of the country. Most of the households have no access to improved water supplies, which makes water-borne diseases a chronic problem in the area. Over 99% of residents depend on fuelwood as source of cooking energy; and the same percentage use kerosene for lighting.

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[1] Village wayleave electrification scheme.

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1.1 Rural electrification (RE) in developing countries

The importance of rural electrification (RE) in the development process is recognised in a number of studies (Munasinghe, 1990). Although low electric consumption is not a cause of poverty, the lack of available electric services correlates closely with many poverty indicators (Reddy & Reddy, 1994). The prospects for income generating activities that can help break the cycle of poverty often rely on the availability of efficient energy such as electricity. Government resources devoted to the electrification of rural areas have achieved several social and economic goals, such as increased productivity in agriculture, improvements in the quality of rural life, and the augmentation of rural industrialization, among others (Munasinghe, 1986).

According to the Human Development Index (HDI) of the UNDP (1998), modest increases in per capita energy consumption of the poorest countries can lead to tremendous improvements in the quality of life of the people living in these countries, and the vice versa. Energy is directly related to the most pressing social, environmental, economic, and security issues which affect sustainable development (poverty, jobs, and income levels). Modern fuels and appliances allow households to reduce their exposure to smoke from biomass cookers and heaters (Howells et. al., 2005).

Despite the fact that electricity has been universally acknowledged as one of the most important propellants for community and national development, rural areas, the world over, are characterized by low levels of connectivity to the energy (Ketlogetswe et al., 2007). Rural electrification is not advancing in many developing countries. In Tanzania, only 1% of the rural population has access to electric services (TANESCO, 2002). In Botswana the overall level of electrical connectivity is only 12%. Similar rates have been reported in Ethiopia (13%) (Teferra, 2002); while in Eritrea 98% of the rural population and 20% of the urban residents do not have access to electricity (Habtetsion & Tsighe, 2002). In all these countries, almost all electrified centres are urban, with rural areas as well as most small rural towns being largely un-electrified. Studies in Uganda show that despite the ten-year comprehensive programme on country electrification programmes, only 1% of the rural population is connected to the national grid (Karekezi & Kithyoma, 2002). These rates are very low compared to other developing regions such as Asia and Latin America, where many countries record rural electrification level as high as 70% (ibid).

Biomass is a primary source of energy, accounting for 92% of the total energy use in Tanzania. High usage of biomass is mainly due to the inability of households to buy commercial forms of energy; and the lack of access itself especially at household level. Widespread inefficient production and use of traditional energy sources pose economic, environmental, and health threats (Douglas et al., 1996). Firewood or charcoal has a negative impact on the health of household members, especially women and children when burned indoors. Numerous children are poisoned from ingesting paraffin, and several people have been burned from fires triggered by paraffin stoves and lamps (Howells et al., 2005). Studies show that lighting using kerosene can be twice as expensive as electricity, and up to 19 times less efficient per

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lumen of output than fluorescent lights using electricity as the energy carrier (Reddy, 1994). The reliance on biomass fuels results in reduced agricultural productivity by depriving the soil of recycle nutrients that would have been available from tree crop residues; and could be a case of deforestation and desertification in some areas (Cecelski, 1995).

Poor and inadequate access to clean, reliable and affordable energy is now considered a major concern for sustainable development (Ailawadi & Bhattacharyya, 2006). The provision of low cost and reliable electricity supply is critical for the growth and development of African countries (Mkhwanazi, 2003).

1.2 Energy policies in Tanzania

The overall policy goal for energy sector of 1992 and its revised version of 2000 is to meet the energy needs of the Tanzanian population, and of the socio-economic and social sectors through a diverse range of strategies aimed at supporting the goals of social equity, rural and industrial development, and environmental sustainability.

Currently, TANESCO is the main supplier of electrical energy. It is a state owned company and currently a monopoly in supplying electricity in the country. The existing installed generating capacity of TANESCO is 793MW, comprising of 561MW hydro, 202MW thermal, and 30MW isolated diesel stations (TANESCO, 2003). In addition, there is a project involving the conversion of 112MW gas turbine plant at Ubungo running on liquid fuel from Songo Songo gas fields. Further, there are some local generating stations run by Missionaries and NGOs based on micro hydro, photovoltaic, and diesel power units.

Presently, the population with access to electricity is less than 8% with 46KWh per capita energy consumption of the electricity users (TANESCO, 2002). Biomass is a primary energy consumption accounting for 92% of the total energy use in the country. Industry, mining, and commerce account for over 60% of commercial energy consumption in the country. Replacing wood with hydroelectricity as a fuel could help reverse the trend of environmental degradation and provide the scope for diversifying village economic activities, without further damaging the environment (Mackay, 1990).

1.2.1 Rural electrification in Tanzania

Rural electrification (RE) programmes seek to maximize both economic and social benefits. RE intends to supply reliable electricity to district towns, other small towns, villages, and development centres and agro-based industries with priority given to electrifying district headquarters. Since 1992 the department of RE under the Directorate of Operations is responsible for rural electrification programmes and projects. Despite the period of more than 15 years, rural electrification in Tanzania has remained very low. Financing of rural electrification has been difficult, and to high extent depends on the foreign assistance under concessionary terms (TANESCO, 2002).

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1.3 Market price, electricity supply and the poor

Economic theories suggest that significant increase in efficiency occur with less regulation and distortion through subsidies and taxes (Freshwater et al., 1998). They particularly argue that electricity subsidies are particularly a problem as they leave many utilities economically crippled, unable to finance the extension of the services to rural areas (Douglas et., al, 1996). However, studies also show that electricity markets do not function efficiently in many developing countries, particularly in rural areas, where nearly 2 billion people do not have electricity or access to modern fuels such as oil and gas which threaten to dampen economic growth, hobble development, and keep living standards low (Burnes et al., 1996). Social electrification, particularly rural electrification, is not viable if it is provided at pure market rates without other means (Gaunt, 2005). Studies in the transition countries show that increasing electricity tariffs to cost-covering levels has been a very sensitive issue (Dodonov et el., 2004). It is widely claimed that increments in electricity tariffs impact negatively on the poor. But donor agencies and utilities providers' argue that electricity tariffs should be cost-reflective to ensure sustained development of the sector, and that the majority of the poor would not be negatively impacted (Ailawadi et el., 2006).

The average household demand for commercial electricity is low and the rural poor have limited financial resources for payment (WI, 1998). Unless energy can be produced and delivered more cheaply, it will remain beyond the reach of many poor in the developing world. There is consensus that poor and inadequate access to clean, reliable and affordable energy is now considered a major concern for sustainable development (Ailawadi et el., 2006).

1.4 The Songo Songo Project Wayleave Village Electrification Scheme (WVES)

The Songo Songo Gas to Electricity Project (SSTEP) encompasses a gas gathering and processing plant at Songo Songo island in Kilwa District to Ubungo Dar es Salaam, about 200km. The WVES is a socio-economic project sub-component which is part of the SSTEP designed to provide community services in the Songo Songo project affected villages. The project covers three regions and four districts of Dar es Salaam (Temeke district), Coast (Mkuranga and Rufiji districts), and Lindi (Kilwa district). The project involves a provision of grid power by building generation stations in selected seven townships of Kilwa Masoko, Kilwa Kivinje, Utete, Ikwiriri, Kibiti, Bungu and Songo Songo Island. As one of the incentives of the project to the surrounding communities, electrification services will be provided to local communities but at commercial or TANESCO tariffs. The project covers 49 villages with a population of about 353,058 persons, and about 78457 households (URT, 2003).

Theoretically, the proposed WVES will have a significant positive impact on people's health and income. Yet modern fuels are costly for income-poor households, and often carry their own external costs (Freshwater et al., 1998). Earlier studies by TANESCO show that demand in the study area is still very low. Customers in the study area are on TANESCO Tariff 1, which is for low consumption users. This TANESCO Tariff 1 is cross-subsidized, for most users in the area pay less than US$0.03/kWh. Information also shows that the electric market has stagnated in

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villages, including towns of the project area (TANESCO, 2003). The financial forecast for this project (WVES) indicates that a tariff of around US$0.14/kWh will be required for the electricity users, which are about five times of the current rates. Other costs include the charge of Tsh400,000 (approx. US$400) for connection. It is likely that only a small proportion of the population will afford to pay this new proposed rate. There are also costs related to house-wiring which are also considerable, with equipment installation and inspection costing around US$250. Still further, there are indirect transaction costs related to communication, transport, and time.

Although a study by IRA (2004) shows that households without electricity pay a reasonable amount for kerosene for lighting equivalent to households with electricity payments, the ability to mobilise the savings needed to connect and pay monthly/weekly lumpsums is highly doubtful.

TANESCO's business plan of 2003 shows that the company collects around US$40,000 of sales revenue annually in Kilwa Masoko; and around US$45,000 in Ikwiriri, the only two areas with diesel converted electricity currently, while the operating costs show that in Ikwiriri the cost of running the two sites is US$350,000. The total losses in 2000 and 2001 in Kilwa Masoko were around US$360,000 and US$300,000, respectively; and around the same in Ikwiriri (TANESCO, 2003). This loss is not likely to be recovered in the new proposed tariff of US$0.1.

While this electrification system is seen as an incentive for the communities affected by the project, it is not clear how many people will actually benefit at the proposed commercial rates. There is a concern that the proposed TANESCO commercial tariffs, where the demand is already very low, will be highly price sensitive; and may lead to losing of even the few customers who are already connected. If only a few residents in the project area are to receive benefits from this development, they will have little reason to cooperate in protecting new facilities in their localities. This may threaten the sustainability of the project.

Nevertheless, there is no empirical evidence to support or counter-argue this concern. This study examines the implication of providing commercial electricity services in villages with deep and absolute poverty. It focuses on analysing the socio-economic profile, demand, willingness, and ability to pay for the proposed WVES electrification scheme in the districts of Temeke,[2] Mkuranga, Rufiji, and Kilwa. The reason for the choice of the study area is twofold. One, the study area has been assured of electrification services, and funds have been allocated for the installation of power generation at different stations. Two, the project area is perhaps one of the most deprived areas in the country in terms of socio-economic development, and therefore the study gives an interesting case study on how such policies could work. We hope that the results from this study will help to provide inputs for policy intervention regarding the whole issue of rural electrification schemes and affordability in the country.

[2] Temeke is the only district out of four with *well off* to do households but only one village follow under this district

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2. Study Methodology

The main objective of this study is to document socio-economic characteristics of the study area, and the people's ability to pay for commercial electricity services. Specifically, the study will describe the socio-economic characteristics of the study area, and investigate demand, willingness, and the people's ability to pay for electricity services. At the end the study will draw policy implications of the findings, and provide recommendations.

Both secondary and primary data were collected from different sources. Secondary data were collected mainly from previous studies, literature review, and official reports covering the study area. Primary data were collected from the villages that will be receiving electricity. Twelve villages (24.5%) were selected randomly from the 49 villages under the project. In each village, about 2.5% of the households were selected randomly for interviews, making a total of 608 households. The total of the households per district was 152.

Data were collected using different methods including participatory rural appraisal, focused group discussions, household survey, and field observations. Structured and semi-structured questionnaires, and checklist tools were used to collect the data. Data were collected on economic activities, housing quality, ownership of assets, income and expenditure levels, sources and type of energy for cooking and lighting, cost of energy, demand for electricity, ability to pay, and willingness to pay for electric services.

Apart from household surveys, we also conducted village meetings in 22 villages (48.9%) in the project area. The aim of these meetings was to gather qualitative information on socio-economic activities. The village meetings also investigated the demand and ability to buy electric power. Most of these consultation meetings were relatively well attended, involving up to more than 150 people in some villages.

Data were analysed using Excel and SPSS, and the findings have been summarised in tables and figure.

3. Main Findings

3.1 Economic Activities

Except for Temeke district, agriculture is the principal source of livelihood in all the villages in the project area, where dependency on agriculture is over 85% on average; compared to 36.7% for Temeke. In 1994 dependency on agriculture was 69% and 64.5% for Lindi and Coast regions, respectively (MEM/HBT AGRA, 1994). There is an increasing trend of dependency on agriculture as a principal economic activity. This might have occurred due to a number of reasons, including the opening up of the southern areas; and accessibility to markets following the opening of the Rufiji Bridge. The factors affecting economic activities and consumption patterns will have an important impact on electricity demand and consumption (Lin, 2003).

Other significant sources of income include petty trading, wage employment, and various business undertakings. These activities are especially important for Temeke district in Dar es Salaam Region. Fishing and casual labour are also practiced, but

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only by a small proportion of the respondents, with the exception of Songo Songo Island where fishing is the principle economic activity. Generally, income from these economic activities is low to modest.

3.2 Annual incomes

Studies show that the average household demand for commercial electricity is low, and the rural poor have limited financial resources for payment (WI, 1998). In this study, total average annual incomes per household ranged from just over Tsh2,000,000 for Temeke district and Rufiji, to just about Tsh700,000 for Kilwa. Mkuranga district had the lowest income per household per annum of about Tsh600,000. Based on these figures, per capita income levels are also very low in all the districts. These are about Tsh125,248, Tsh122,969, Tsh117,128, and Tsh98,236 for Temeke, Rufiji, Mkuranga, and Kilwa districts, respectively. These levels are much lower than the national per capita income, which is about US$250, and may influence demand for electricity.

3.3 Quality of houses

The quality of houses could be one of the factors for a household to have or not have some interest in installing electricity facilities. Households with good quality houses may be interest in installing electricity than those with poor quality houses. In this study, the quality of houses are summarised in Table 1.[3] Overall, the quality of houses is bad according to many respondents in the study area. Only 32% of the households' respondents had houses roofed with corrugated iron sheets, while 32.5% had walls made of concrete/burnt bricks, and 47.3% had floors of cement or tiles.

Table 1: Quality of houses (%)

	DISRICTS				
	Temeke	**Mkuranga**	**Rufiji**	**Kilwa**	**Overall**
Iron sheet/tiles roof	80.6	6.7	19.7	21.1	32.0
Bricks (concrete or burnt or bricks)	100	0	21.7	8.4	32.5
Floor (cement, concrete, tiles)	88.9	33.3	50.3	16.8	47.3

Source: Survey data

3.4 Sources of energy for lighting

The major source of energy for lighting is kerosene, which is used by over 95% of the respondents in all the districts. Electricity use is very limited, and is only found in Temeke,[4] Rufiji (3.2%), and Kilwa (1.1%).

Electricity connection is showing a declining trend in some of the districts. In 1994, for example, 2.2% of the residents in Kilwa district were connected to electricity but by 2007 only 1.1% of the respondents had their houses connected to electricity. This

[3] The quality of houses was judged as good if it is roofed with corrugated iron sheets, has a wall made by burnt or concrete bricks and a floor of tiles or cement.

[4] Although in the project area there was no village with electricity.

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decline may be associated with increased population in the area which does not match the electricity demand. Nationally, however, the population being connected to electricity is expanding, and if connection costs are reduced and other related facilities are available at affordable prices, more people will opt for this source of energy. While kerosene is relatively cheaper even for the very poor, electricity is extremely expensive even for the relatively well to do (Kebede et al., 2002).

3.5 Source of Energy for Cooking

Fuel wood is by far the major source of energy for cooking. Except for Temeke district, the dependency on fuel wood ranged from 79% of the respondents in Rufiji to 100% for the respondents in Mkuranga. The use of charcoal is significant in Temeke district (36.1% of respondents). Although charcoal-making activities are quite significant in Kilwa, Mkuranga and Rufiji, most of it is channelled to the Dar es Salaam market, suggesting that dependence on charcoal for cooking is high even in cities despite the relatively well distributed electricity supply. Modern cooking fuels can provide significant health, productivity, and environmental benefits. Yet spontaneous fuel switching does not occur to the extent often hoped for (Heltberg, 2004).

3.6 Total monthly expenditure on energy

Table 2 summarises energy costs by villages under the project in the four districts. Information on energy is examined mainly on three areas: cooking, lighting, and connecting to the electrical appliances. Energy for cooking is on the average of Tsh27,226 per month (mainly fuel wood, charcoal, and kerosene). Willingness to switch to electricity depends on the electricity factors (price, voltage, and outage frequency) (An et al., 2002). Energy for lighting is Tsh4768.8 where majority use kerosene and very few use electricity and candles. Dry batteries are the main source of energy for electrical/electronic appliances, and cost about Tsh5313. Although findings on this study show that on average many houses pay between Tsh33,337 to Tsh47749 for energy per month, this amount of money could be difficult to raise at once to pay for electric bills.

Table 2 Expenditure on energy per month

	DISTRICTS				
	Temeke	**Mkuranga**	**Rufiji**	**Kilwa**	**Average**
For cooking					
Fuelwood	6554	1233	2231	1220	2809.5
Charcoal	26557	22344	23222	21667	22197.5
Kerosene	4334	1554	1766	1222	2219
Sub-Total	**37445**	**25131**	**27219**	**24109**	**27226**
For lighting					
Kerosene	1002	5544	5443	5654	4410.75
Candles	655	200	344	233	358
Sub-Total	**1657**	**5744**	**5787**	**5887**	**4768.8**
Other energy sources					
Dry cell batteries	8647	5263	4000	3341	5312.75
Total	**47749**	**36138**	**37006**	**33337**	**37307.5**

Source: Survey data

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3.7 Demand, willingness and ability to install and use electricity

3.7.1 Demand of electricity

Demand is a consumer's desire and willingness to pay for goods or services. The economic concept of demand is related to the willingness and ability of consumers to pay for goods or services. The main objective of a willingness-to-pay study is to find out people's willingness to pay for a service, while that of the ability to pay study is to identify the true demand for a socially acceptable service.

Although there are many factors that affect the quantities of goods or services demanded, the price of the goods is an extremely important factor in installing electricity (Holtedahl & Joutz, 2004). According to the 'Law of Demand' (if all other factors remain equal), the higher the price of a good, the less people will demand that good. In other words, the higher the price, the lower the quantity demanded (Investopedia, 2007). Because of the importance of price, economists use the term 'demand' to refer to the relationship between alternative prices of goods or services and the quantities of these goods or services that consumers would be willing and able to pay for in a given period of time. In general, electricity demand is mainly determined by two important factors: tariff, and GDP (Bereket, 2002).

In this study, around 57.3% of the households expressed willingness to have electricity services in their households (Table 3). The willingness to have electricity at their homes indicated several reasons including house illumination, small agricultural industrial processing factories, carpentry, etc. However, when it comes to ability (the actual demand) to pay for electricity, less than 22% of the respondents said they had the ability to pay the costs. Most of the respondents able to pay for electricity facilities come from Temeke District (48.6%). In the other three districts the respondents able to pay for electricity were less than 15%.

Table 3: Willingness and Ability to pay

	DISTRICTS				
	Temeke	**Mkuranga**	**Rufiji**	**Kilwa**	**Overall**
Sample size	152	152	152	152	608
Willingness to pay	97.2	83.3	84.1	84.7	57.3
Ability to pay	48.6	13.1	14.3	13.2	22.4

Source: Survey data

3.7.2 Income and ability to pay

Figure 1 summarises the relationship between income levels and ability to pay for electricity at commercial rates. Generally, the ability to pay for electricity is related to income levels. No respondents in the income category of below Tsh50,000 was able to pay for electricity services, while about 5% of the respondents at income levels between Tsh50,001 and Tsh365,000 had the ability to pay for electricity services. About 17% of the respondents in the two categories of income levels of between Tsh365;001 to Tsh500,000 and Tsh500,001 to Tsh1,000,000 said they were able to pay for electricity costs at commercial rate. However, the highest respondents came from an income category of above Tsh1,000,000 who were 37%.

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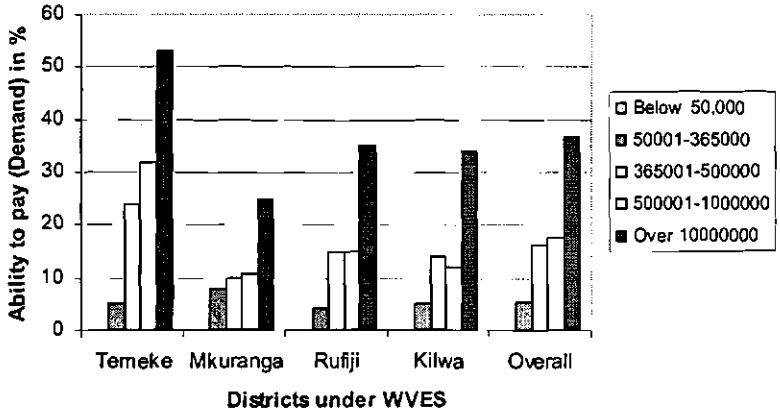


Figure 1: Income (Tsh) and ability to pay (%)

Source: Survey data

This suggests that the efforts for rural electrification should go hand in hand with the efforts of increasing rural incomes through enhancing agricultural productivity and stimulating non income generating activities.

3.7.3 Reasons for lack of affordability

Table 4 summarises the reasons provided by the respondents for not being able to install electricity in their homes. In a multiple response question, respondents were asked why they cannot afford to install electricity facilities. Over 95% of all respondents said the cost was too high for them; 53.2% said they could not use the service because of the poor quality houses they own. On the other hand, about 15% said they had other more pressing issues than electricity; 11.7% said they did not know how to apply for the services; and 5.2% said they had other reasons such as having no houses.

Table 4 Reasons for lack of affordability

	DISTRICTS				
	Temeke	**Mkuranga**	**Rufiji**	**Kilwa**	**Total**
Sample size	152	152	152	152	608
High cost	94.6	96.2	96.7	97.0	96.1
Poor house	11.1	66.7	49.7	85.2	53.2
Have other more pressing issues	2.8	15.0	15.9	23.4	14.3
Too bureaucratic and time consuming process	2.6	16.4	12.5	15.1	11.7
Other (specify)	0	5.0	8.0	7.8	5.2

4. Conclusion and recommendations

4.1 Conclusion

Rural electrification has been a priority agenda of the government of Tanzania for more than two decades. However, the pace of RE has been rather slow. The average household demand for commercial electricity is low, and the rural poor have limited

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financial resources for payment (WI, 1998). Although many people in the country have a desire to install electricity services in their homes, the cost and availability to pay for the service have been the main deterring factors. In this study, the main economic activity by the majority of the respondents is agriculture, which is seasonal. As a result, the current electrification by the Songo Songo WVES project in the villages affected by the project is unlikely to reach the majority poor. The main reason is that people in this area are very poor, and therefore paying more than Tsh300,000 for electrification, and about Tsh10,000 per month for lighting is beyond their reach. While the willingness for electrification is high, the actual household demand (ability to pay) for the service is low because of limited financial resources.

4.2 Recommendations

It is proposed that special credit innovations be provided to allow rural communities install electricity facilities. The terms and conditions of local financial institutions are the major constraining factors on the ability of local communities' access to credits (Marandu, 2002). Lack of awareness, high initial costs, uncertainty of savings, and non-availability of credits are some of the major barriers (Reddy & Shrestha, 1998).

Rural energy policies that emphasize a broader range of renewable and target income-generating activities are likely to yield greater benefits to the rural poor than the current policies that rely on the grid power options only (Karekezi & Kithyoma, 2002). Emphasis should also be focused on microhydro energy sources. Experience in Norway shows that microhydro generators for producing electricity are both economic and affordable (Mackay, 1990).

It is further recommended that the formation of independent electrification co-operatives that are allowed to generate and distribute electric power and set their own tariffs be encouraged (Ilskog et el., 2005). Solar power is a particularly attractive option for countries with abundant sunlight and a poorly developed rural grid electrification system like Tanzania. The costs associated with these technologies, once prohibitive, have decreased significantly over the past decade (Burnes et al., 1996)[5].

Emphasis on rural electrification should also be on off grid electrification. Rural off-grid electrification can provide an alternative solution at lower cost, particularly as costs of off-grid technologies is low (Martinot & Reiche, 2000).

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[5] Surprisingly, all villagers refused to have solar power from the project because of what is argued to be limited user value. They wanted gas power so that they could do also other economic activities such as carpentry and small scale processing industries.

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