THE CHALLENGES OF RURAL ELECTRIFICATION IN SUB-SAHARAN AFRICA

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INTRODUCTION

The current lure of most of the able bodied segment of the population by the bright lights of the city and its promise of a better life has not always been the rule in Sub-Saharan Africa. In the pre-colonial times with the exception of the civilizations of Old Ghana, Mali and Songhai which flourished in the fourteenth, fifteenth and sixteenth centuries, there is very little recorded urban living in Sub-Saharan Africa except with regard to old towns on the East African seaboard. It can threfore be argued that the urbanization in Old Ghana, Mali and Songhai was on account of the contact with the Northern African countries through the gold and salt trade across the Sahara Desert while the urbanization in the towns such as Mombasa, Lamu, Malindi and Zanzibar was on account of the sea trade with the Arabs and the Europeans on their way to India and China.

URBANIZATION AND AFRICAN CULTURE

In more recent times one can cite at least two instances that indicate that the love for urban living is rather recent. In Kenya in the 1950s the colonial government undertook two important strategies to contain the Mau Mau rebellion in Central Kenya. The first step was the consolidation of land and secondly the movement of people into properly planned villages which in fact would have been future towns. The villagisation programme was intended not only to offer protection to the population against the Mau Mau freedom fighters but also to cut off the supply of food from the local population to the Mau Mau freedom fighters.

Individuals were allocated the consolidated land and were supposed to work on it during the day and retire to the villages at night. The villages lasted as long as the reign of the colonial government. On attainment of political independence virtually all the individual farmers moved to live on the individual land holdings citing that it was un-African for several families to live close together.

If the villagisation programme in the 1950s had succeeded it would have been very easy to distribute electrical power in Central Kenya to day. Unfortunately this is not the case and individual peasant farmers live on their individual holdings which have continued to be subdivided making it quite difficult and expensive to distribute electrical power to the small holdings unless they are close to concentrations of human population.

Another case of failed villagisation is the Tanzanian case. Immediately after the attainment of independence in the early 1960s the Tanzanian Founding President Mwalimu Julius Kabarage Nyerere espoused the virtues of socialism and for almost two decades while he held power most of Tanzania went through the motions of persons and even whole families being moved to live communally in so called Ujamaa Villages which was a replication of the practices in the communist states.

The advantages of villagisation were obvious. Services such as education, water , electricity, telephone, security and even health could be administered to the population easily and economically. However the Ujamaa Villagisation programme in Tanzania notwithstanding that it was implemented by fellow Africans failed drastically just as the villagisation programme implemented by the colonialists had failed in Central Kenya a decade earlier on.

The dilemma and paradox of the Rural Electrification Programme in the Sub-Saharan Africa is reasonably clear. While the able bodied and economically active youth continues to be lured by the bright lights of the cities, his father the peasant farmer refuses to live in the villages and small towns which could easily be provided with services and probably stem the alienation between father and son through the migration to the cities.

THE SOCIAL COST OF UNPLANNED MIGRATION TO THE CITIES

With perhaps the exception of South Africa, most of Sub-Saharan Africa continues to be primarily agricultural. The movement of young persons to the cities largely deprives the rural areas of the productive labour that is essential to food production and hence aggravates the poverty levels which are already reason for worry.

In the cities, the migrants put on un-reasonable pressure on existing services such as water and electricity in addition to overloading the environment. The overloading of the environment is in many instances symbolized by unplanned urban settlements or slums.

Thus a youth leaves the village attracted by the affluence and bright lights of the city only to end up living in the slums where the quality of live is even lower than in the village but having tasted city life he is too proud to go back. In this way the youth inadvertently becomes a an important link in the spread of the menace of HIV-AIDs from the the cities to rural village and hence aggravates the economic fortunes of the village.

THE RURAL ELECTRIFICATION IN KENYA

The Rural Electrification Progrmme is a government sponsored programme primarily intended to spur development in the rural areas in Kenya. It was conceived about the 30 years ago when it was realized that the youth were immigrating to the urban areas not only to seek gainful employment but also in pursuit of an alluring lifestyle characterized by bright light of the cities.

Thirty years ago only about 10 percent of the Kenyan population of 7 million people lived in the urban areas. To day about 30 percent of Kenya's 30 million total population live in urban areas while the balance live in rural areas.

One would therefore be tempted to conclude that the Rural Electrification has failed on account of the rising percentages of urban dwellers coupled with the rising numbers in absolute terms. However things are not that simple and all this needs to be viewed in terms of what the situation would have been if the Rural Electrification Programme was not in place.

At independence in 1963 there were virtually no slums in Kenya. Urban living was carefully controlled by the colonial government and nuisance bye-laws made it impossible for an African who was not employed in the urban formal sector or in the households of Asians and Europeans to live in the cities. The advent of independence brought with it special challenges. No longer could the African be controlled to remain in the native reserves by his fellow brothers using the dehumanising PASS-LAWS used by the colonial government and these had to be revoked for political reasons. One of the outcomes of this policy is the Kibera Slum in Nairobi, Kenya. It is the largest slum dwelling in Sub-Saharan Africa. It is estimated to harbour no less than 700,000 people.

The Rural Electrification Programme was also intended in the long run to stem the tide of the rural-urban migration as well as encourage urban-rural migration of retirees. The programme has the objective of spurring the entrepreneurial non-farm activities in the market centres and small towns in the rural areas.

The ministry of energy is responsible for policy formulation on Rural Electrification and is the custodian of the funds on rural electrification while the Kenya Power and Lighting Company [KPLC] is the executing agency which operates on purely commercial lines. The Kenya Power and Lighting Company is owned 51 per cent by the government of Kenya. Every district of the 70 districts in Kenya gets an allocation of funds for Rural Electrification from the Ministry of Energy. The District Development Committee receives and prioritizes requests from interested persons or groups of persons from the relevant district and then forwards the prioritized requests to the Ministry of Energy for funding.

By 2003 the cumulative total of the consumers connected to electricity supply under the programme stood at 87,125 while the cumulative total investment was of the order of one billion US $ [1]. Below is a description of one of the recent projects that form part of the programme.

Rural Electrification in Western Kenya

AFD is currently funding the extension of the medium voltage electrical networks [237km of 33kv and 151 km of 11 kv] with the construction of transformer stations [150] as well as low voltage extensions to connect selected large consumers [2658 connections] like tea processing plants, markets and social infrastructure such as high schools and health centres.

This Kenya shillings 820 million project has been contracted by the Ministry of Energy to Kenya Power and Lighting Company [KPLC] the latter being the executing agency. Project completion is expected by the end of 2004.

The project targets Western Kenya near the border with Uganda and includes the districts of Bungoma, Kakamega, Busia, Siaya, parts of Nandi and Kisumu. Selection of the districts was based on economic and technical criteria.

After completion the Kenya Government [the owner of the rural electrification assets] shall be responsible for financing subsequent extensions of the low voltage through the Rural Electrification Fund [2]

As seen from the above example cited in the Daily Nation Newspaper, a part from district centred rural electrification projects, some times the government does implement cross – district projects especially where it involves network reinforcement.

Currently the government is engaged in implementing a total of 223 rural electrification projects in different parts of the country with the support of development partners.

TECHNICAL CHALLENGES OF RURAL ELCTRIFICATION

The main challenge of rural electrification programme to the power engineer is therefore the designing of an electrical distribution system for a dispersed population. The system should however also be cost effective, relatively stable ,affordable and environmentally inoffensive.

Secondly is the ability of maintaining such a system so as to provide an acceptable level of power availability efficiently and cheaply.

One of the important technical considerations taking into account the phenomenon of system voltage variability so much observable in third world countries is the proper estimation of the centre of load so that the medium/low voltage transformer can be placed as closely as practicable possible to this point so as to avoid extreme falls in the end line voltage.

The second important point to take into account is the balancing of the various phase voltages so that one phase does not become unduly loaded while the others are running light. The issue of load balancing is easier said than done. Except in tea and coffee processing plants where three phase equipment may be in abundance most of the other loads in the rural areas largely consist of single phase loads that might vary in magnitude from one consumer to the other.

The challenge to the electrical power distribution engineer is therefore in combining the various loads and to ensure that eventually there is very little or negligible imbalance in the various phases by applying appropriate diversity factors. This calls for experience into the lifestyle of the consumer and their patterns of power use.

ECONOMIC CHALLENGES OF RURAL ELECTRIFICATION

Provision of electrical power is expensive not only in the developing countries but also even in the developed world since it requires a large capital outlay in the long term and returns are not immediate. The providers of electrical power from the mains need therefore to decide on how best to finance such an undertaking.

The Rural Electrification Programme aims at subsidizing part of the initial capital outlay to the consumer while leaving him to meet the running expenses in terms of consumption monthly bills.

Most of the rural electrification burden has fallen on the government supported by donors who see rural electrification as part of the overall economic development and as a vehicle for poverty alleviation. On account of the dispersed habitation patterns due to cultural preferences discussed earlier on, the rural electrification projects have as their targets selected large consumers such as tea and coffee processing plants, markets and social infrastructures such as schools, hospitals and health centres.

RURAL ELECTRIFICATION THROUGH PETROL AND DIESEL GENERATING PLANT

Electrical power provision through mains grid is largely uneconomic for dispersed pastoralist communities and especially when concentrations of human populations are far in between. For such concentrations of human populations largely marked by political and administrative centres the alternative of diesel and petrol generating sets become realistic.

These alternatives however cannot always be realized because of the high capital costs of the generating sets relative to the incomes of some of the persons in the general population who subsist on the value of less than one American dollar per day. The recent increases in the middle of 2004 of the international crude petroleum prices has resulted in the movement of crude oil prices from the 30 US$ to the 50 US$ range per barrel. These prices increases have translated to about 1US $ per litre pump price largely on account of the high taxation of petroleum products by the governments in the Sub-Saharan Africa region.

The above indicates how unpredictable the running costs for petroleum based generating sets can be. It is therefore important that they be used only where application characteristics give no alternative.

Such applications include the electrification of hospitals away from the mains grid and where power loads of the order of 100kva would be required. Other applications would include the electrification of District administrative centres where power requirements of the order of 50-100 kva would be necessary. Similar arguments can be advanced for standby sets for mains failure in airports.

For vaccine centres in pastoralist areas and for small health centres, petrol generators of the order of 5 kva would do.

Table 1. below depicts the capital costs of various rated petrol and diesel generating sets in Nairobi, Kenya

RURAL ELECTRIFICATION THROUGH PHOTO-VOLTAIC SOLAR PANELS

Virtually all the countries in Sub-Saharan Africa are within the tropics except a few places in Southern Africa. As such the countries are blessed with good solar intensity-of the order of 200 lux per square metre throughout the year round.

The widespread use of mobile phones brought about by the advances in solid state battery technology through the use of Lithium and the accompanying liberalisation of telecommunications in the region in recent times has resulted in the demand for electrical power since mobile phones must be recharged every two to three days. The liberalisation of telecommunications sector has also resulted in the increased purchases of radio and television sets by the better to do.

The most convenient choice of power source for such applications where there are no mains electricity has been the photo-voltaic solar panel. Thus where incomes permit such as in cash crop growing areas that are economically better off, the TV is replacing the radio while the photo- voltaic solar panel is replacing the lead acid battery as the power source for the TV as well as general house lighting.

The photo- voltaic solar panel at present represents the best immediate hope for Sub-Saharan Africa. The present state of the solar electric technology is adequate to cope with the immediate needs as far as the current demands by the Information and communication technology is concerned.

Although the photo-voltaic solar panels are still very expensive relative to the prevalent incomes of the general population in the region, the solar panels are rather attractive on account of their very low running costs and are considered a good bargain for information, communication technology applications by those who can afford them. They are as well considered adequate for limited house lighting especially used in conjunction with low thermal /high light intensity light fittings that have come to the market with advances in lighting technology.

As noted earlier on Sub- Saharan Africa still remains largely dependent on agriculture for its economic advancement. Thus for any technology to have a big effect on the lives of the general population it will have to impact on agriculture. The mobile phone is already having this effect at the marketing level but there is need of a technology that will impact on agricultural production.

Africa continues to rely heavily on rain fed agriculture. Whereas this is quite alright for the equatorial region which experiences rains throughout the year, the tropical region is subject to the vagaries of the weather characterized by heavy rains and flooding at times and lack of rains and drought at other times.

By and large the photo-voltaic solar panels still provide relatively low power relative to the needs of an agricultural community .Thus not until improvements in the photo-voltaic cells and battery technology make it possible to provide electric power of the order of 1-5kw at affordable prices will solar technology have become of age in Sub-Saharan Africa.

Table 2. shows the capital costs of various rated Kyocera solar panels in Nairobi, Kenya.

TABLE 1-Capital costs of Generating sets [4]

KVA	2	3.7	5	6	10

US $	750	1437	1500	2000	9750	20	27	14125	20625	10625	12250	50	100

TABLE 2- Capital Costs of Kyocera Solar Panels [5]

Watts	40	50	60	70	80	120
US $	206	256	300	344	381	569

RURAL ELECTRIFICATION THROUGH WIND ELECTRICITY GENERATORS

Although the incidence of harness able wind is quite good especially at the coast, the wind generator has not been attractive for a variety of reasons.

The wind electricity generator although it on average provides more power than the photo-voltaic solar panels the low power needs of the majority of the consumers coupled with the relatively higher capital costs of wind electricity generating sets and environmental considerations have meant that the wind electricity generator will continue to be mainly attractive for communal applications e.g the powering of a remotely located communal water pump or by isolated relatively well to do farmers

CONCLUSIONS

Although Sub-Saharan Africa is home to some of world's largest rivers and it has high hydro-electrical energy potential, social-economic and political disintegration has meant that the full benefits of grid interconnection across countries and regions has not been fully tapped.

The industrial revolution was largely facilitated by the availability of cheap and abundant coal [6]. After the second world war the world's energy sources shifted increasingly towards oil and natural gas With the worlds production of oil and natural gas expected to peak within a decade or so, the reliance of electrical power based on oil cannot be counted on.

Until such time as Africa moves in step with the rest of the world by establishing regional trading blocks and also moving towards political as well as economic integration through which electrical power interconnection may be possible, cheap electrical power will continue to be a distant dream. The establishment of the African union, a continent wide political organization gives symbolic hope to the people of Africa.

It is therefore necessary that the Rural Electrification in Africa continues to take a multi prolonged approach whereby, hydro electrical power, solar electrical energy, wind electrical energy as well as fossil based electrical energy continue to play a relevant part.

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