ENERGY FOR SOCIAL TRANSFORMATION:
A Study of the West Nile Region of Uganda

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ABSTRACT

This Paper presents the results of technical, financial, environmental and management feasibility studies into the provision of reliable, sustainable and environmentally-friendly supply of electricity to the north-west corner of Uganda, called the West Nile Region – a region that is highly populated by comparison with the average population densities of the country and whose location is of both strategic and economic importance in that it serves as a gateway to the Democratic Republic of Congo and the Central African Republic in the west and to the south of Sudan in the north.

The study examines various possible options for supply of electricity to the region and concludes that the optimal mode is through micro/mini-hydro power plants to be built on the 19 potential sites along nine principal rivers that drain the five districts comprising the region. It presents the current situation of supply of electricity in the region. This is followed with a detailed study for the implementation of the site at Olewa – the site nearest and with sufficient capacity to supply the current largest load centre in the area, which are the Arua Municipality and its environs. Due to the close similarities amongst those sites, it is argued that the data and findings pertaining to the Olewa one can easily be extended to the others, which thus makes this study beneficial and of direct relevance for the whole region. The paper then proceeds to discuss some of the foreseeable transformations that are likely to emanate from availability of adequate and reliable electricity supply in the region and ends with concluding remarks and recommendations.

1. INTRODUCTION

In Uganda, up until November 1999, generation, transmission and distribution of electricity in the Country was an exclusive monopoly and mandate of Uganda Electricity Board (UEB), conferred by a 1964 Act of Parliament. In executing this mandate, it was expected that UEB would discharge its due social responsibility to the people of Uganda, as a wholly Government-owned parastatal, and therefore deliver electricity to all the corners of the Country. Unfortunately, and for all sorts of reasons, even as we write today, this was not to be. After nearly four decades of existence, and despite the Country's immense hydro potential for the generation of electricity, the parastatal has hardly been able to cover 2% of the population's electricity needs. Its effectiveness and financial performance has for years been anything to talk of. With its inadequate and erratic supply of electricity, a reform of UEB Board and the rest of the Country's electricity power sector became not only desirable and necessary, but also inevitable.

Against this background, the Ministry of Energy and Mineral Development had to embark on the evolution of the required strategy for this reform, starting in the mid-1990's and culminating into the repeal of the of the 1964 Act and passing of a new Electricity Act in November 1999 [1].

The enactment of the 1999 Electricity Act did not only end UEB's nearly forty years of monopoly over generation, transmission and distribution of electricity in the country, but also liberalised the sector and provided the impetus and created opportunities for involvement of private initiatives in the generation and distribution of electricity, in particular.

One part of the country that has remained poorly supplied with electricity during all the years of UEB's monopoly over generation is the north-west corner, called the West Nile Region. By its location, this is a region that provides a gateway to the other countries of Central Africa, such as the Democratic Republic of Congo, the Sudan, the Central African Republic, Chad, and so on. In this situation, numerous products, such as beverages, cooking oils, soap, plastics, cigarettes, etc, that are produced or manufactured in the south of Uganda and have extensive markets in these countries inevitably pass through this gateway. With an extremely poor network of roads linking it with the south, and these roads becoming impassable, especially during the rainy seasons, the industries producing the afore-mentioned products would naturally be willing to re-locate their factories in the region, provided reliable and sustainable power was available. The vast quantities of tobacco and coffee grown in the region would not have to be transported over long distances down south for processing and addition of values, had it not been due to the lack of adequate and reliable electricity to run processing plants in the region.

Although there are diesel generators that UEB presently runs to provide electricity to some of the major urban areas of the region, these cannot be sufficient incentives for processing plants or manufacturing industries to relocate, let alone start, given the difficulties associated with fuel imports and the costs involved. A large and reliable generation facility is clearly the only way forward.

The project in the present feasibility study is thus meant to begin to address some of these issues by

providing, on private initiative basis, energy to a region that is not connected to UEB's grid. Conceptualised within the framework of the on-going process of liberalisation and privatisation of the electricity sector in the Country, it takes into account the on-going unbundling of UEB's business into the separate units of generation, transmission and distribution, as well as the impending sale of the businesses of the units to concessionaires.

For the actual execution/implementation of the Project, the District Councils of the region, in the spirit of decentralised governance in the Country, have already teamed-up with private individuals to float a Company called ***West Nile Power and Utility Company Limited*** to exploit the possibility of individuals and/or communities producing power through their own initiatives, as is now possible with the new scenario [2].

2. THE SOCIO-ECONOMIC SETTING

To grasp the importance of the feasibility study, it is essential to take a look at its geographical and socio-economic setting.

The West Nile Region comprises the districts of Adjumani, Arua, Moyo, Nebbi and the most- recently created one of Yumbe, with an estimated population of around 1.5 million people. Of this population, an estimated only 80,000 live in the urban areas, with 40,000 in Arua Municipality - the largest and fastest growing urban area in the region, 20,000 in Paidha - the second largest urban area in the region and largest in Nebbi District, and the rest 20,000 in the two municipalities of Adjumani and Moyo, and in the combined urban centres of Yumbe, Koboko and Rhino Camp. The majority of nearly 1.4 million people of the region thus live in the rural areas [3].

The West Nile Region has several agro-ecological zones, ranging from dry-land savannah to highland tea and coffee zones. Historically, coffee, tea, tobacco, cotton groundnuts and sesame (simsim) have been the most important cash crops. The other economic activities have included oil milling and fishing. Prior to 1979, it was one of the country's most developed areas. Major military and political disasters during the period from 1979 to 1986 set the region back considerably. More than half the population ran into exile during this period and were only able to return at the beginning of the 1990's.

With a decade and half of relative peace and stability now, most of the agricultural activities have been revived. Rehabilitation of some of the infrastructure has taken place with assistance from various agencies, particularly non-governmental organisations (NGO's). The region's economic base has grown significantly. Growing of coffee, tea, cotton, grain, sesame and tobacco are all up in the rural areas. The next logical step would therefore have been to set up major plants for the processing of these farm products. Lack of adequate and reliable supply of electricity has, however, rendered this impossible.

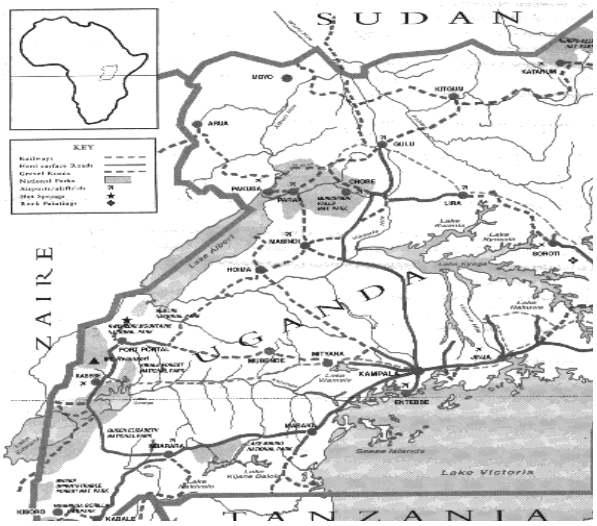

Figure 1 – The West Nile Region

The urban centres, for their part, are booming with various commercial activities, including hotel/restaurant service, trading, grain-milling, carpentry, brick-making, welding, coffee-processing, and so on. A number of small and medium enterprises exist in some of the larger municipalities, such as Arua and Paidha. For the delivery of social services to the people, the districts have such institutions as hospitals, schools, water works stations, administration offices, etc. Unfortunately, all these activities and institutions currently depend on supplies from expensive diesel generator sources or other traditional forms of fuels for their energy needs.

The health centre, schools, water works, and administrative institutions, likewise, dependent on either supplies from private diesel generator sources, or have to operate within the four hours when there is grid electricity from UEB's diesel generators.

The quality of social services would have been much more superior with adequate and reliable supply of electricity. The health and education centres would have been able to operate for longer hours, with better performance or outputs. Our assessment is that only the availability of adequate and reliable supply of electricity will remedy these situations. It is against this background that the feasibility study undertaken here was thus commissioned.

3. THE FEASIBILITY STUDY

The Feasibility Study covers four sections, namely, Technical, Financial, Environmental and Institutional Management issues [4]. The object of the Technical section, incorporating feasibility level studies and the Olewa Power Project Design, was to establish the

power demand and potential in the entire region, and to carry out the actual design of the site at Olewa, selected for first implementation up to the point of operation. The section on the financial issues provides an analysis of the profitability of the power generation venture for the selected site and then discusses the likely impacts of the operationalisation of the Olewa scheme on the domestic, commercial and institutional activities in areas to be supplied from the site. The section on the environmental impact assessment provides a general assessment of the physical, socio-economic, socio-cultural and ecological implications of the Olewa Power Project, and recommends the necessary mitigation measures that will be required to overcome any possible adverse consequences of the Project, in accordance with the third schedule of the National Environmental Statute of 1995 [4]. Finally, the section on Institutional Management addresses issues of ownership and management with regard to the implementation of the proposed micro/mini hydro power stations at the various sites in the West Nile Region. Below some of these issues are amplified further.

3.1 Power Demand

A major component of the Technical Study was to establish the power demand in the whole region, as well as in some specific urban centres and institutions.

The total demand for power in the region for the year 2001, based on affordability at the going tariff offered by UEB (US $ 0.05) is established to be about 10 MW, of which 3.6 MW is in the established and gazetted urban areas. This demand changes very little when the tariff is raised by 25% above the going level. If, however, the tariff is dropped by 25%, the scenario changes vastly, and the demand increases by over 200% to reach 20 MW [3].

An estimate of the geographical spread of power demand was also undertaken. The current highest demand is found to be in the Arua Municipality area. Other areas in the region, particularly those in the south of the region in Nebbi also showed quite sizeable demands.

A projection of this power demand into the future was undertaken at annual growth rates of 4%, 3% and 6% for domestic, institutional, and industrial needs, respectively.

At an estimated demand of 20% of the total power allotted to the small industries and commercial activities, the forecast for total power demands presently and five years later were found to be as shown in Table 1.

Table 1 – Summary of NW region Demand

Sector	Demand (MW) and Year	
	2001	2005
Urban Rural	3.6	4.8
	6.2	8.1
Total	**9.8**	**12.9**

Although the rural demand appears to be larger than the urban demand, which may appear rather curious on first sight, this may be explained by the fact that, on one hand, 81% of the direct beneficiaries are actually located in the rural areas, and, on the other, many of the would-be beneficiary processing industries and institutions such as schools, prisons, hospitals and health centres are also located outside the main urban areas.

3.2 Power Potential

An appraisal of the possible methods of reliable and sustainable power supply was undertaken. This included examination of supplies from diesel powered generators, supplies based on bio-mass, supplies based on wind energy, supplies based on solar photo-voltaic (PV) generation, supplies through extension of the existing national grid, and supplies from micro/mini-hydro power schemes. Based on sustainability, local resource base, experience in the technology and costs, the supplies from hydro sources has been proposed [3].

Through analyses of the topographic and hydrologic conditions undertaken in the region, 19 sites have been identified at which power can be generated [3]. The total potential capacity for power generation has been estimated to be 27 MW. This capacity is located on several sites on Rivers Nyagak, Narwodo, Ala, Enyau, Agoi, Kochi, Esia, Amua and Leya.

As run-of-river schemes (i.e., generation without regulation dam) the estimated base potential in the whole region is 5.4 MW at 90% reliability. This, in essence, means that the probability of generating less than that amount is one in ten with the run-of-river approach.

The rivers in the area tend to show quite marked seasonal variation flows, with the severest months of low flows being January, February and March. For the other nine months there are high flows, which on average are greater than 30-40% of the average annual flow, compared with the low flows, which are about 10-15% below the average.

In the absence of funds to construct regulation dams, there is a good case to have an installed capacity of 3-4 times of that based purely on the run-of-the river scheme. In fact, the study established that run-of-river schemes are advisable at the start of the power development program in the region, when industrial activity will be low. When the industrial activity picks up, then the base capacity can be raised, and reliability

increased, through the provision of regulation dams. In these circumstances, a phased development of power supply to match availability of the capital (funds) is preferable.

3.3 The Olewa Scheme

Of the 19 potential sites, the site at Olewa, on River Enyau in Arua District, was selected and adopted as a number one priority for detailed design and implementation for the following reasons:

a) It is the closest site to the present biggest load centre (Arua and its environs),
b) Its output of 1500 KVA for the most of the year, closely matches the current demand in Arua (i.e. 1400KVA) at the present tariff
c) The consumers and the distribution network already exist, so that the provision of power 24 hours daily could realise almost immediately the potential to generate funds for reinvestment in the power sector in order to either upgrade the power output to 6 MVA through the construction of a regulation dam, or the development of the next site in the line-up.

The scheme is designed to consist of a weir across the river, with limited storage for daily regulation. Open channel/low pressure pipe, about 4000 meters long, will carry water to their forebay tasks. A 1.2-meter diameter steel penstock 1200 meters long will carry the water to the powerhouse. Two turbines and two generators, each rated 750KVA, are to be installed to give the installed capacity of 1500 KVA.

The power will then be transmitted to Arua, 26 kilometres away, through a 33-kV overhead line. In Arua, the voltage will be dropped to 11kV and fed into the already existing UEB network.

The total cost of implementation is estimated at 5.6 million USD, and the work can be carried in 18 months. The basis of civil works costs is the current construction rates quoted by various contractors for similar works in the country. The plant and equipment costs are based in quotations made by various suppliers and manufacturers.

3.4 Financial Analysis

The operation, maintenance, staffing and depreciation costs for the generation and the transmission system are estimated at US$ 353,000 per year. The break-even sale price for the kWh would be US$0,027. If the kWh were to be sold at the current UEB tariff (US$0,05), the Olewa Project would realise a surplus of around US$ 300,000 per year. This would allow a recovery of the invested capital in less than two years, which is an extremely short recovery period. This surplus could then be used to increase the power output by reinvesting in the construction of a regulation dam at the site or for reinvestment in the development of the next site, located not very far down on the same river. There are other economic benefits of the project that will be discussed below under the caption of Foreseeable Transformations.

3.5 Environment Impact Assessment

The physical environment will be affected very little by the project due to the run-of-river scheme approach. There will be some loss of agricultural land (estimated at 5 ha) that includes the land for the route of the canal, power house site, and access to the river in the access road for the site. There are some impacts on the social environment: restricted access to the river in the area of the open canal, social dislocation from the contractor's activities, etc. Definitely, all these are very minor when compared with the benefits of the Project. In any case, mitigation methods have been included in the design and contract procedures [4].

3.6 Institutional Management Matters

A poll, using a survey questionnaire, was conducted in the region to find out about the population's willingness to invest in the area of power generation, as well as to establish which organisation and method of management they would wish to operate the system. The outcome was 100% positive in terms of the population's willingness to invest in power generation, for they apparently identified energy as being the engine of development. Besides the individual peoples, the respondents also suggested that the other stakeholders be the administrations in the five districts comprising the West Nile region. As for management, they preferred a structure that would to some degree incorporate the role of shareholders alongside those of a professional team of managers.

The poll further enquired about billing strategies, revenue policy and investments, and established that most people would wish to have a pre-payment system for collection of revenues and that the profits from the operations of the first site at Olewa be reinvested into the development of the next site in order to increase the availability of power in the region.

3.7 Establishment of an Independent Power Producer (IPP)

The poll also enquired about how the people of the region would wish to operationalise the power development schemes, especially the first one at Olewa. Of the several proposals that were floated, the establishment of a public liability utility company as an Independent Power Producer (IPP), in which the people would participate through purchase of shares, was preferred. This proposal was viewed as one that will take into account all views that were collected in the course of the institutional surveys. It would enable all the stakeholders to participate to extents proportional to their financial commitment, keep the long-term program objectives in focus and take into account the direction of the government reform policies for the energy sector.

The main stress in the people's response is that the proposed IPP Company that would own and operate the power generation facility should be an open-ended investment company that would allow for purchase of shares by the population.

4. FORESEEABLE TRANSFORMATIONS

Development of the rural energy sector should enable it to make its due contribution to bringing about economic and social transformation of the rural areas. It will facilitate a significant change in both the quality of life of rural households and the financial viability/operational modality of rural enterprises. Acceleration of rural electrification will facilitate significant rural non-farm incomes. With the provision of sustainable, reliable and affordable power, we foresee transformations in the sectors of the rural health, education, rural investment, rural enterprises, rural agro-processing and the set-up of small industries to produce soap, plastics and beverages, etc.

4.1 Rural Health, Sanitation and Educational Sectors

Rural health facilities, ranging from district hospitals to sub-dispensaries, require, but do not always get, energy services for basic functions such as lighting, vaccine refrigerators, and disinfecting and sterilising medical equipment. They would certainly benefit from the provision of hot water to wash laundry, such as bed sheets, instead of relying on chemicals used with cold water. In addition, they would also benefit from the supply of clean pumped water. The secondary schools, on the other hand, require energy services not only for lighting, but also to offer information-communication-technology (ICT) and vocational education, in addition to their requirements for laundry and cooking. This is thus an area where some benefits of commercially-oriented rural electrification can reach even those groups of the rural population who are unable to benefit directly from the electrification process.

4.2 Rural Investment Sectors.

Lack of adequate and reliable electricity supply has seriously constrained any investments into the region. Availability of adequate and reliable electricity supply will certainly facilitate the establishment and spread of telecommunications infrastructure and computer networks, including Internet, into the rural areas. And since the areas where commercially oriented rural electrification is feasible are also likely to be the areas where telecommunications and computers are likely to be of a high priority, we foresee chance of transformation here.

4.3 Rural Enterprises

The small and medium enterprises that are currently supplied with power from expensive diesel generators and other sources would certainly benefit immensely from the availability of adequate and reliable power. In particular, we foresee such *motion-intensive* enterprises such as grinding mills and carpentry workshops, among the top candidates that would switch to electricity at the earliest availability of electricity from hydro sources. Others that are *heat-intensive*, such as brick making, initially might not find it economical to switch to electricity, and thus continue to use traditional wood fuels in their operations, but this would only be a matter of time. The overall impact would be to increase the productivity of these small and medium enterprises, with consequent benefits likely for increased employment opportunities and earnings. Likewise, producers of beverages and manufacturers of soap and plastic products, which have extensive markets in Democratic Republic of Congo and the Sudan, have been unable to shift and relocate their plants in the region due to lack of adequate and reliable supply of power.

4.4 Agro-Processing Enterprises.

Potential investors have abandoned their plans to set up agro-processing enterprises in the region because of a lack of power. So we foresee that just the availability of power in the rural areas would change the entire scenario and give a boost to rural-based agro-processing. Further, existing agro-processing rural enterprises involved in activities such as coffee hulling, maize milling, tea processing, cotton ginning, oil pressing and sugar processing and tobacco curing would also likely benefit from an acceleration of rural electrification.

4.5 Environmental Benefits

With reliable and sustainable supply of electricity, the dangers of forest depletion, and the associated environmental degradation will be kept in check. This is because those connected to the network would be in positions not only to have electric lighting but also to use electricity for cooking purposes.

4.6 Gender-related Benefits

We also foresee benefits in gender-related areasas some of the possible transformations that availability of reliable electricity would induce. These include:

a) easing of labour-intensive domestic chores, e.g., saving time and energy of women collecting firewood,
b) introduction of low technology and labour-saving devices, such as mortars, local cooking facilities,
c) creation of income-generating opportunities for women, such as baking, sewing, food-preservation, etc.

5. CONCLUSIONS

The central role that electrification can play as an engine for the development and social transformation of rural areas is today well-recognised in developing countries. The present feasibility study has established that not only is reliable, sustainable and environment-friendly supply of electricity from micro/mini hydro sources is technically viable for the West Nile Region,

but that such ventures would also be financially profitable.

Basing on the current power demand and the available hydropower potential in the region, the feasibility study proposes a phased development, starting with the Olewa site, which is the nearest to the current largest load centre. The study establishes that, with an already existing distribution network in the main load centre and requiring only 26 kilometres of transmission line, 18 months is all that would required for the implementation and operation of the Olewa scheme. The capital required would be in the region of 5 – 6 million US dollars. Within two years, the surplus from the 1500-kVA Olewa venture would also be available for either quadrupling the output through construction of a regulation dam, or reinvestment into the next neighbouring site.

With the ongoing reforms in the Uganda's electricity industry, and the establishment of the Rural Electrification Fund, it is hoped that the findings of the study and the projects therein will find the necessary support for funding.

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