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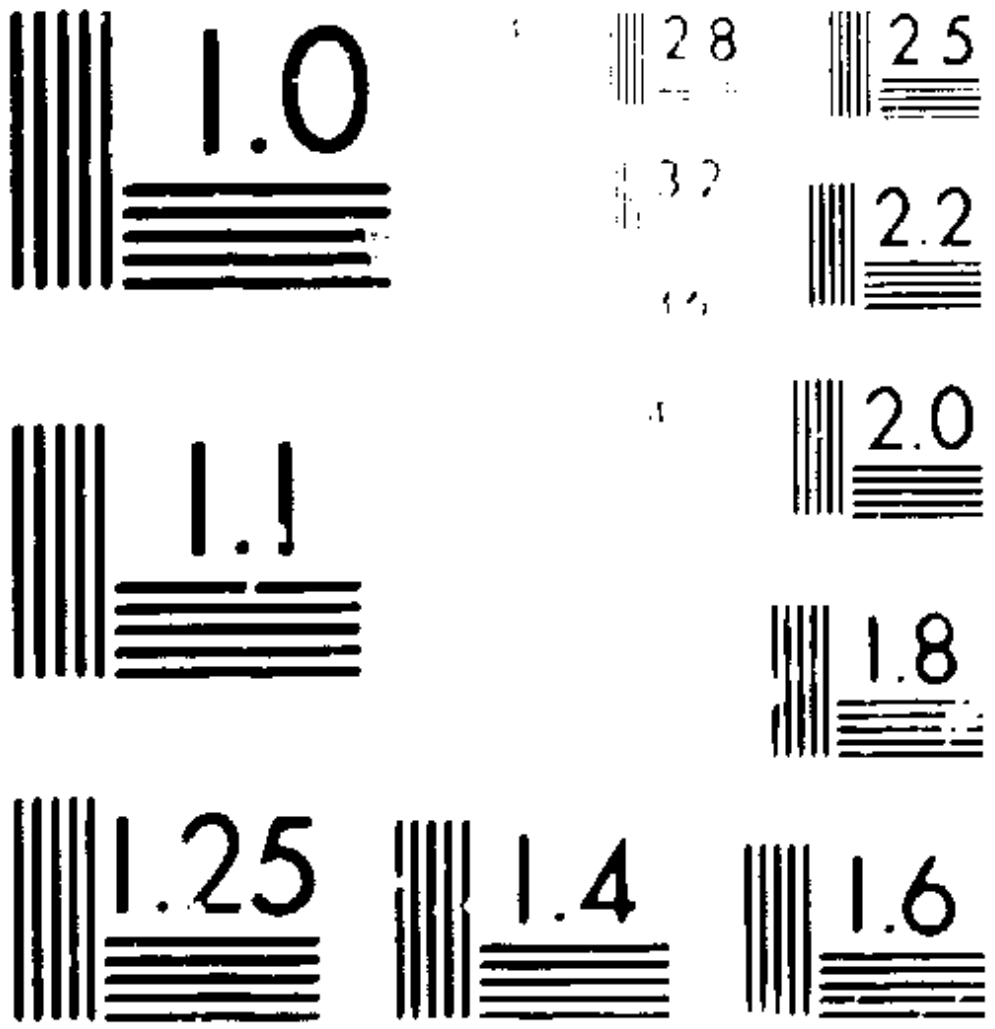

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PROGRESS IN SMALL HYDRO POWER DEVELOPMENT in The Republic of Sierra Leone*

by

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Introduction

Out of a total installed generating capacity of 98MW, only 2.4MW capacity is presently provided by hydropower. Against this background, and given the disproportionately high percentage (35%) of the country's export revenue spent on importing fuel oil notwithstanding the immense hydropower potential, the Government of Sierra Leone is ever more determined to develop its hydropower resources. To accelerate this process, the National Power Authority has been created as an autonomous body with special responsibility to the Ministry of Energy and Power, on all issues concerning the development and management of the country's hydro resources for power generation.

In developing hydro resources, priority is given to sites which have the highest potential for replacing existing diesel plant. Many studies have been done to identify these sites and studies are being further done to determine the feasibility of a few that have the highest prospects for early development.

The first of these proposed schemes is located on the Seli River at Bumbuna. When ultimately developed the installed plant capacity will be 107MW; 2 x 37.5MW of which is scheduled for development in the first phase of construction. The scheme is aimed primarily at reinforcing the Western area electric Power System which contains the capital Freetown, and the main industrial areas. In addition to the Bumbuna project, the suitability of some twenty prospective sites with an installed capacity in excess of 1000MW on final development have been examined with a view to reducing the use of diesel generation at other provincial centres. A summary of these sites is given in the Appendix. Earlier studies for the development of these sites aimed at driving the maximum energy output practically and economically available from each site and also included provision for substantial power availability during the dry months when flow rates are low. Given the current demand for electricity and the prospects for growth, the rivers so investigated are fairly large to be economically developed as small schemes consistent with present demand. Thus with the exception of Bumbuna, other sites are examined with a view to the development of small stations as run-of-river schemes in preference to constructing major stations which in most cases would be capable of very much larger outputs than are required and which involve the construction of large dams. Such run-of-river stations would supply their maximum power outputs during the average of nine months of the year but their outputs would reduce during the dry months and in some cases, necessitate the use of some diesel generation to supplement their outputs mainly during evening peak hours. The aim of these smaller stations would be to reduce expenditure on imported oil, and consequently, the sites that are examined first are those which appear to offer the best prospects of early development at reasonable cost consistent with the greatest practical reduction in diesel generation and, in some cases, avoid the installation of additional diesel driven plant.

CURRENT HYDROELECTRIC PROJECTS.

1. The Bumbuna Project

The Bumbuna scheme was conceived prior to 1972 following a survey of the country's Hydroelectric potential. A consortium of consultants formed to prepare the project have now almost completed detailed engineering studies and pre-qualification advertising is expected in mid-1983. It is expected that advertising for bids will be at the end of 1983 and evaluation of bids should be completed by early 1984. If suitable financing can be arranged in early 1984, it is expected that the scheme will be commissioned by 1988. As mentioned earlier, the scheme is intended primarily for meeting the long-term power demand of the Western area and provincial centres that could be economically integrated into the system. The scheme envisages the construction of a 70 metre high rockfill dam and the installation of 2 x 37.5 MW Francis turbines and associated substations and transmission lines in the first phase. The project was originally estimated at U.S. $370 million of which U.S. $304 million constitutes the foreign exchange component as at June 1981 prices.

2. The Mano-River Project

This is part of the mano-river basin development project and it forms one of many joint projects undertaken under the auspices of the Mano-River Union; a sub-regional economic grouping of Sierra Leone, Liberia and the Republic of Guinea. The project is shared with Liberia and out of a planned installed capacity of 150MW, Sierra Leone's share would be 70MW. This would be far in excess of current demand for the area most likely to use power from this site, given current economic conditions.

3. The Dodo Small-Hydro Project

This scheme is intended to reinforce the Kenema Power supply system. Kenema is the capital of the Eastern province and it is an important mining and agricultural centre. The project is to be derived from a small river, the Bundoye, which has its sources north of Kenema. In spite of its small catchment area, it has a considerable water power potential because of its relatively concentrated and high fall. An initial study recommended a rockfilled dam of 260 metre crest length and 37.5 metres maximum height to create a reservior sufficient to give 100% regulation of the annual flow. A 1.2 km length tunnel and a penstock would lead the water down to the power house where two turbines

each of 9MW capacity, for a gross head of 115 metres were proposed. Since that study was made, it is understood that the People's Republic of China has undertaken to install a small hydroelectric plant at Dodo, some 25km north of Kenema. It is stated that the installed capacity of the station will be 4.0MW during wet weather, and it is assumed that the output would reduce to 600KW during dry months. Work has already started on this site but the completion date is not known.

3. Mawoloko, Moyamba and Gandohun Small Hydroelectric Projects.

The Mawoloko, Moyamba and Gandohun small hydroelectric schemes are meant to reinforce the provincial centres at Kabala, Moyamba and Bo respectively. The proposed Bumbuna Station and associated transmission line routes are remote from these three important provincial centres; and they are not likely to benefit from the Bumbuna Scheme in the immediate future. Realising this, and the attendant plan to gradually reduce the national expenditure on fuel oil imports, the Government of Sierra Leone through funding provided by the Canadian International Development Agency (CIDA) commissioned the Canadian Energy Development Systems International (CEDSI), Incorporated; in January 1982 to do prefeasibility and later, full feasibility studies on the above three sites. If one goes by an interim prefeasibility report on the Mawoloko project which is the first and only report produced so far, then the schemes show prospects of economical feasibility.

4. Micro-Hydroelectric Power Projects

As mentioned earlier, the most urgent need in the power sector is in reducing expenditure on the importation of fuel oil through the phased development of small hydroelectric schemes to replace or supplement existing diesel plant.

Efforts at the Faculty of Engineering in the University of Sierra Leone to investigate sites that offer potential for the construction of micro-hydroelectric stations to supply rural settlements has not yet fully received the backing and co-operation it deserves for a widespread launching of the project. Nothwithstanding the many obstacles, the Faculty is studying the potential of this source of renewable energy in specialised applications in addition to village electrification. One such application that has been highlighted for immediate attention by the small-industries unit of the Ministry of Trade and Industry, is in the development of micro-hydro sites for the manufacture of Sodium Hydroxide through the electrolysis of sea water with a view to reducing foreign exchange expenditure on this

vital base chemical which finds so many applications in our industries. A few sites have been identified in the Freetown Peninsula for this project and feasibility studies are being undertaken by a multi-disciplinary team from the University. It is known that this process has worked elsewhere in many places and information with possibilities for collaboration is being sought from organisations who have had some experience in this field. Other applications do exist and future development of micro-hydropower will be geared mainly towards addressing these applications that have potential for facilitating import substitution or that prove likely to improve the productivity of selected rural areas, through small-scale processing.

ECONOMIC ANALYSIS OF SMALL HYDRO PROJECTS.

Most of the small-hydro potential mentioned above cannot be developed fully and cheaply at this stage to provide a year round firm power supply. Hence for most of these schemes, some diesel supplementation with capabilities to provide full supply will be necessary. Under such conditions, present diesel plants would serve such standby purposes.

Since present generation is by diesel, a major factor in analysing the viability of small hydro projects is the comparison of :-

(a) an all Hydro Scheme
(b) a diesel/Hydro Scheme
(c) an all diesel Scheme

In practically all cases, present diesel generators are very old and vulnerable to technical problems in addition to ever increasing fuel shortages, especially for very remote locations. Hydrogeneration would greatly increase the reliability of supply for 8 to 9 months of the year which would further increase demand and improve the plant utilisation factor in most cases. For all purposes therefore, an all hydro scheme where this is possible, offer the best prospects for economic comparisons.

Three approaches are taken in analysing the economic viability of the hydro-diesel scheme :-

1. Unit cost of energy comparison
2. Net benefit calculation
3. Internal rate of return

The unit cost of energy compares the cost/Kwh of the hydro-diesel scheme against the cost/Kwh of the most likely alternative; an all diesel scheme. The net benefit calculation aims and compares annual cost of the hydro-diesel scheme and the all-diesel scheme over a 25 year period which is assumed to be the expected life-span of a diesel plant. The internal rate of return is the discount rate at which the present worth of the hydro-diesel scheme is equal to the all-diesel scheme. This internal rate of return represents the opportunity cost of the money potentially invested in the project.

Applying these procedures to the three small-hydro schemes mentioned earlier, it has been established that given the present economic conditions, embarking on Small Hydropower development to supplement or replace existing diesel generation is a viable proposition.

CONCLUSION

It is clear that some progress has been made in the development of Small-Scale Hydro resources which until recently has not received the priority it deserves. It is expected that as oil becomes more difficult to acquire because of economic difficulties, this energy resource will gradually assume its importance in the economic development of the country. There is a need for further studies on identified sites to establish a priority list in terms of plants which offer the best prospects. There is also a need to do further studies in establishing an inventory of micro-hydro sites for the electrification of rural industry or more specialised applications.

APPENDIX I

Potential Hydro-electric sites for larger generating stations

The following potential hydro-electric sites have been studied with a view to determining their suitability for development having regard to the energy requirements of towns in their vicinity (Source: UNDP SIL/78-005)

S..e		Maximum possible Installed capacity In M.W.	Comments
(a)	On the Little Scarcies or Kaba River and tributaries in the North Western sector of the country.		
1.	Kambatimbo	101.0	Small scheme producing up to 6.7MW possible
2.	Kuse	9.8	Small run-of-river scheme possible
3.	Maka	23.6	Small run-of-river scheme possible
4.	Mange	38.6	Capable of producing 90MW on completion upstream of storage dams but small run-of-river scheme possible.
5.	Tendeta	50.0	Small run-of-river scheme possible.
(b)	On the Sell or Rokel River and tributaries in the North Central Area.		
6.	Komora	30.0	Access to site difficult but could be developed as a small scheme.
7.	Bumbuna	35.0	35MW initially with potential for 120 MW after completion of reservior at Yiben. The Yiben station could produce 70MW in wet weather but this would reduce to 30MW dry weather.

8.	Rokon	24.0	This output depends on river flow regulation at Bumbuna and a reservoir at Roken, for maintaining dry weather output. Run-of-river station possible with output varying from 1.5MW to 20MW.
9.	Maso	7.0	7MW output reduces to 1.0MW in dry months without storage reservoir of flow regulation upstream. The suitability of the site for a small station is being further examined.
(c)	On the Jong Pampana River and Teye tributaries in the central area.		
10.	Betmai	90.5	90.5 possible but cost of Civil works considered high. Small development producing 4MW appears practical.
11.	Titama	21.7	Small station possible
(d)	On the Sewa River and Bondeya tributaries in the Southern Sector of the country.		
12.	Benkongor I	38.9	Small run-of-river station with much reduced output possible.
13.	Benkongor II	106.7	106.7MW with an increase to 280.6MW if upstream storage considered. Run-of-river station with low output possible.
14.	Bengkongor	26.2	Smaller station producing about 8MW seems feasible.
15.	Goma	17.0	A small station is to be constructed by the People's Republic of China. The installed capacity has been stated as 4MW.
16.	Levuma	11.6	11.6MW could be increased to 65.2MW after flow regulation by upstream reservoirs. Development not attractive at present.
17.	Mamban	6.5	6.5MW could be increased to 33.0MW by flow regulation upstream. Development not attractive at the moment.
18.	Gandohun	19.2	19.2MW could be increased to 75.2MW after construction of upstream station providing flow regulation. Development of smaller station to provide 7MW possible and is being further examined.
(e)	On the Moa River in the South of the country.		
19.	Baraka	37.5	Suitable for development as a run-of-river station to provide minimum of 3.5MW to 5MW during the dry months.
20.	Nyandenhun	12.0	A difficult site to develop economically as small scheme.