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PROBLEMS AND PROSPECTS FOR HYDROPOWER DEVELOPMENT IN AFRICA

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1. INTRODUCTION

Over 430 million people out of Africa's total population of 650 million people, live under conditions of endemic poverty (World Bank African Development Indicators, 1997). The roots of this situation are varied and numerous. The solutions that have been tried since the middle of the 20th century by Africans with the support of their developmental partners such as the World Bank and other international development agencies, have been even more numerous albeit with very little success as Africa continues to stay poor and underdeveloped as we enter the 21st century.

The New Partnership for African Development (NEPAD) Initiative is a new approach for Africa's development initiated entirely by African leaders with a common shared vision and conviction of purpose and destiny to address the developmental problems of Africa.

One of the major areas of focus for NEPAD is energy as a means of solving the problem of poverty. It is estimated that even though Africans constitute approximately 10% of the world's population, the total primary energy consumption of Africa is only about 3% of the total world primary energy consumption (BP Statistical Review of World Energy 2002). This, however, does not include fuels such as wood, peat and animal waste which constitutes the principal source of energy for Africans. Africans are therefore deprived of the use of commercial and efficient sources of energy, which play a significant role in the development process. The paradox of this situation is that Africa is endowed with significant energy resources, which have remained largely undeveloped. One of such sources of energy is hydropower, which currently supplies nearly 20% of the world's electricity.

There is the general view that hydroelectricity is the renewable energy source par excellence, non-exhaustible, non-polluting, and more economically attractive than other options. Although the number of hydropower plants that can be built is finite, only a third of the sites classified world wide as economically feasible are tapped. (*World Energy Assessment, Energy and the challenge of sustainability, 2000*.)

Hydropower plants emit much less greenhouse gas than do thermal plants. Greenhouse gas emissions of hydropower are caused by the decay of vegetation in flooded areas and by the extensive use of cement in the dam construction. Unfortunately there are negative local impacts of the use of rivers, social as well as ecological, and these are gaining importance as people become aware of how those impacts affect living standards.

Most renewable sources of energy including hydroelectricity generation are capital intensive but have lower operational costs than thermal and nuclear options. This initial cost is a serious barrier to rapid growth in energy use in developing countries where most of the untapped economic potential is located.

2. OBJECTIVES AND SUMMARY

This paper examines the problems of hydropower development in Africa and focuses on designing concrete strategies and policies for the development of the hydro potential in Africa under the auspices of the NEPAD Initiative. The paper has 10 sections. The first section, Section 1, introduces the paper whilst this section, Section 2 provides the objectives of the paper and summarizes the contents of the remaining sections; Sections 3 to 10.

Section 3 gives an overview of the African Power Sector in general. This section describes the spread of electricity generation and consumption in the sub regions of Africa. Section 4 presents the current status of hydropower development in Africa and identifies existing hydro production capacity which are operational on the continent and the contribution that this existing hydropower infrastructure makes in meeting the electricity needs of the various countries.

Section 5 evaluates the potential contribution of hydropower to meeting the energy needs of Africa. It examines the potential of small hydropower and large hydropower resources in Africa. Section 6 looks at the development of hydro projects. In line with the regional nature of NEPAD, the potential sites are examined from a regional and sub regional perspective and include regional transmission projects, which are essential in the development of the generation projects. Section 7 examines the environmental and social concerns relating to hydropower development in Africa and identifies measures that can address these concerns. Section 8 discusses the process of procuring funding for hydropower projects implementation as well as the cost-effectiveness and viability of the projects. The section evaluates the availability of financing from multilateral institutions such as the World Bank and presents some experiences in the sourcing of funds from the Bank and other multilateral and bilateral institutions. Section 9 outlines concrete strategies and provides an Action Plan for the development of hydropower in Africa by NEPAD. The concluding section, Section 10, summarizes the major problems facing hydropower development in Africa as well as the proposed strategy to resolve the identified problems in order to achieve the NEPAD energy objectives.

3. OVERVIEW OF THE POWER SECTOR IN AFRICA

Africa's power sector is dominated by a few countries, namely South Africa in Southern Africa, Egypt and Morocco in North Africa and Nigeria in West Africa. The northern and southern regions alone provide 82% of Africa's power generation. Five countries (Egypt, South Africa, Libya, Morocco and Algeria) provide the bulk of this. Other significant contributors are countries like Egypt, the Democratic Republic of Congo, Mozambique, Nigeria, Zambia, Morocco and Ghana each with installations of over a 1,000 MW.

Africa's electricity consumption is expected to grow at a rate of 3.4% per year over the period 1999 to 2020, even though NEPAD is targeting an economic growth of 6% per annum, which would require higher growth rates in electricity supply. Fuel wood constitutes Sub Saharan Africa's principal source of energy. Only 10% of the population has access to electricity and in the rural areas only 7% of the population benefits from electricity services. Currently, the per capita consumption of electricity in Sub Saharan Africa is about 450 kWh as compared with about 600 kWh for South East Asia and the Pacific, about 1,300KWh for the Latin America and Caribbean and about 2,800 kWh for Europe and Central Asia.

African countries are making serious efforts to increase access through various means including the linking of their power systems and the creation of power pools. Examples of these are the South African Power Pool, the proposed West African Power Pool and the Mediterranean Power Pool.

The South African Power Pool (SAPP) was created in 1995, to link Southern African Development Community (SADC) member states into a single electricity grid. The national utilities currently participating in the SAPP are Angola's Empresa Nacional de Electricidade (ENE), the Botswana Power Corporation (BPC), the DRC's SNEL, the Lesotho Electricity Corporation (LEC), Malawi's Electricity Supply Commission (Escom), Mozambique's Electricidade de Mocambique (EDM), Namibia's NamPower, South Africa's Eskom, the Swaziland Electricity Board (SEB), Tanzania Electric Supply Company (Tanesco), Zambia's ZESCO, and Zimbabwe's ZESA. SAPP's coordination center is located in Harare, Zimbabwe.

The power systems of Togo Benin and Ghana and La Cote d'Ivoire are linked in an interconnected grid. Nigerian and Niger are also interconnected. A power pool is under consideration to link all the 14 ECOWAS countries, creating the West Africa Power Pool,

In Northern Africa, a Mediterranean Power Pool is also planned to interconnect the power networks of North African countries with the Middle East & Southern Europe.

4. CURRENT STATUS OF HYDROPOWER IN AFRICA

4.1 Installed Capacity of Hydropower

The total installed hydro capacity in Africa is about 20.3 GW with a total hydro production capability of about 76,000 GWh/year (2001 World Atlas and Industry Guide – International Journal of Hydropower and Dams). As Table 4.1 shows, a comparison with the Gross theoretical hydropower potential of about 4,000,000 GWh/year indicates that the current production from hydropower plants in Africa is about 20% of the total potential.

Table 4.1- Summary of African Hydropower Development

Gross Theoretical Hydropower Potential (GWh/year)	Technically feasible Hydropower Potential (GWh/year)	Economically feasible Hydropower Potential (GWh/year)	Installed hydro capacity (MW)	Production from hydro plants (GWh/Year)	Hydro capacity under construction (MW)	Planned hydro capacity (MW)
4,000,000	1,750,000	1,000,000	20,300	76,000	>2,403	>60,000

Appendix A provides a detailed listing of the installed and potential hydro capacity in Africa.

4.2 Regional Distribution of Existing Hydropower Developments

Of the total 20.3 GW of hydropower currently installed in Africa, about 23% is located in North Africa, 25% in West Africa and the remaining 51% located in South/Central/Eastern Africa. Countries with installed capacity of more than a 1,000 MW have a total installed capacity of about 13 GW comprising 65% of the total hydropower installed capacity of Africa. These countries are Egypt, the Democratic Republic of Congo, Mozambique, Nigeria, Zambia, Morocco and Ghana. The remaining 45 African countries account for 35% of the total installed hydro capacity. This is shown in Table 4.2 below:

Table 4.2 -Countries with major hydropower developments

Country	Subregion	Installed Capacity (MW)
Egypt	North Africa	2,810
Dem. Rep. of Congo	Central Africa	2,440
Mozambique	Southern Africa	2,180
Nigeria	West Africa	1,938
Zambia	Southern Africa	1,634
Morroco	North Africa	1,205
Ghana	West Africa	1,072
Total		**13,279**

The countries with the highest developed hydro capacity are dispersed throughout the Africa region. There are 2 such countries in North Africa, 2 in West Africa, 1 in Central Africa and 2 in Southern Africa. The hydropower scheme in these countries are among the largest of such schemes in the world. Egypt's Aswan Dam on the Nile has the largest catchment area of any dam; the Kariba dam on the Zambezi River between Zambia and Zimbabwe currently has the world's largest reservoir capacity, at 180 billion cubic meters and the Akosombo dam has resulted in the formation of the world's largest reservoir in terms of surface area (8,500 square kilometers).

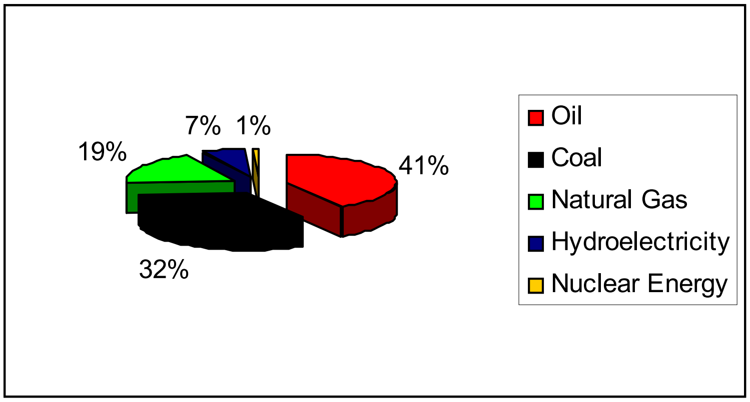
These major hydropower developments in Africa were planned in the 1950's as public sector projects to provide the basis for the industrialization and sustainable economic development of the countries involved. Traditionally, they have been developed as multi purpose schemes providing other benefits such as domestic and industrial water supply, protection against droughts and floods and irrigation. These non-power benefits have been made possible through the investment in hydropower development. For example, the Aswan High Dam, which was built in two phases between 1960 and 1970, has over the 32 years of operations, provided Egypt, with its water and energy needs, protected the Nile river course, improved navigation, preserved agriculture during periods of drought, thereby contributing significantly to the economic and social development of the people of Egypt. (Address by Professor Kader Asmal, Chair of WCD; Summary Report, Large Dams and their Alternative in Africa and Middle East; Experience and Lessons learned). The Akosombo Hydro Project, completed in 1965, provided all of Ghana's electricity needs until the mid-nineties. It has improved navigation, provided water for irrigation and increased fish yield among other benefits.

Another hydropower development, the tri-nation Manantali project, built with the aim of providing water not only for energy but also for irrigation and navigation in Mali, Mauritania, Senegal. This project was to serve as an example of the benefits of cooperation among riparian countries in the planning and optimal development of hydro resources. But this project has stalled because of political problems among the sponsors.

4.3 Contribution of existing hydropower development to Africa's energy needs

According to the BP Statistical Review of World Energy for 2002, out of Africa's total primary energy consumption of 280.6 Million tonnes of oil equivalent (toe), hydroelectricity contributed only 18.3 Million toes, which was less than 10%. Figure 4.1 below indicates the contribution of different fuel sources to Africa's energy consumption for 2002.

Figure 4.1 – Africa's Energy Consumption in 2002



The total primary energy consumption of 280.6 million toe does not include biomass mainly in the form of fuel wood, charcoal and animal dung which is the principal source of energy in Sub Saharan Africa as stated indicated in Section 3.

Classification of Hydropower Plants

Hydropower plants can be classified as large, medium and small, depending on the capacity of energy that can potentially be generated. Plants above 500 MW are generally considered large. Plants between 500MW and 10MW are considered medium sized. Below 10 MW they are considered small sized hydro plants. Small hydro plants

are further classified as mini (500 kW to 10 MW) micro (10 kW to 500 kW) and pico (less than 10 kW). Figure 4.2 below illustrates this classification.

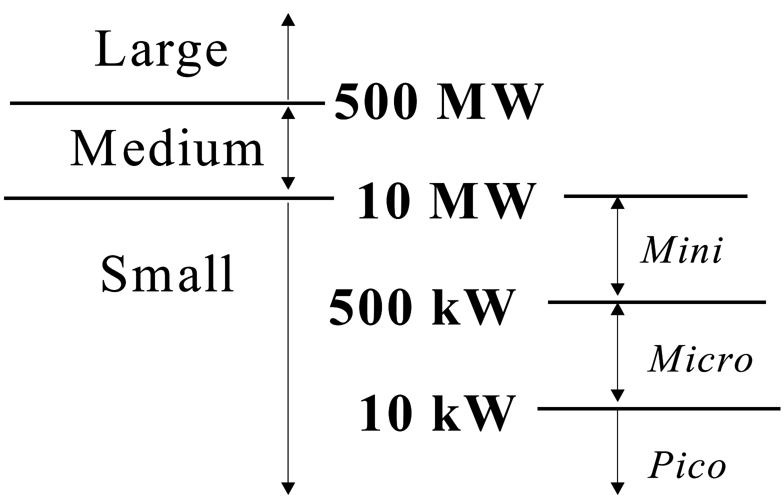


Figure 4.2. Hydropower classification

4.4 Hydro Potential of Africa

Of Africa's technically feasible hydropower potential of 1,750,000 GWh/year, only

4.3% has been exploited (2001 World Atlas and Industry Guide – International Journal of Hydropower and Dams). Whereas China, India, and Brazil, also have large hydroelectric potentials, these potentials are matched by equally large power demands. But in the case of Africa, the location of hydro resources and the demand for power are poorly matched. In Africa, few have access, consumption level is low, industrial and commercial developments are practically non-existent. The result is a lack of demand for electricity to economically justify rapid exploitation of the vast hydro potential. The opportunity is therefore available for the development prospects of small hydro to be considered as a means of building up the demand for electricity in Africa.

In 2001 out of a total installed hydroelectric capacity of about 20.3 GW, in Africa, only 0.3 GW were from small-scale plants (less than 10 MW). This is about 1.5% of total hydro installed capacity in Africa. For the world, as a whole small hydro capacity is 3.5% of total installed capacity. Africa therefore needs to examine further possibilities for exploiting its small hydro potential.

5. POTENTIAL CONTRIBUTION OF HYDROPOWER

5.1 Overview

Hydropower promises enormous contribution to boosting the energy base of the continent. This stems from the fact that the continent has an abundance of hydro resources as shown in Section 4.

Small hydropower potential constitutes an insignificant proportion of the technically feasible hydropower potential in Africa. They are however useful in supplying remote areas of the rural populations where it is established that they have competitive advantage over wind, solar and other sources of electricity.

It is however the large hydropower resources, which would in fact be exploited economically to meet the bulk of Africa's demand for electricity. Where large hydro projects cross boundary lines or can service cross border markets they have to be looked at as regional projects.

5.2 Small Hydropower

Because of its potential to service the energy needs of the dispersed rural population, small hydro cannot be ignored as an option for meeting part of the future energy needs of Africa. The capital requirements for small hydro are generally lower than for large scale hydro power development. The modular nature of small hydro technologies allow even the poorest countries to begin a phased energy investment programme that does not strain their national financial resources or draw funds from other basic needs. However, many utilities prefer to develop large hydro projects because they are considered easier to manage. Investments in hydro have therefore concentrated mainly on large hydro dams.

So in spite of the favorable prospects for small hydro, very little of it is developed. For example in Zambia, although the estimated potential for small hydro is 45 MW only about 4% is exploited.

Ghana also has carried out a number of studies on small and mini hydro sites to establish their feasibility and develop policies on how to incorporate these into its energy mix. In a study by the Architectural and Engineering Services Corporation, (AESC) 14 sites studied were all adjudged to be economically viable. ACRES International who in 1991 reviewed the work of AESC and found that at least 6 out of the sites they reviewed were technically feasible and economically viable. But none of these sites in fact developed.

Appendix B contains information on Ghana's experience and attempts to exploit small hydro resources.

Significant effort has also been made by NGOs working with various stakeholders in Africa to demonstrate that small hydro can supply much needed energy to remote rural communities. Zimbabwe and Mozambique have some experience in this field and the main constraint identified have been financial management and particularly the tariff environment within which the projects have been developed.. A point of concern, however is that the cost of hydro generation based on micro hydro technology is prohibitive particularly for rural industries with low output due to low demand conditions.

In both Zimbabwe and Mozambique it was observed that rather than look for appropriate means of supplying target communities across the country, there was a tendency to look to the grid as the only source of supply. This however tends to delay extension of electrical services to these rural communities.

5.3 Large Hydropower

Planned hydropower capacity in Africa is about 60 GW, of which about 75% is within the INGA complex on the Congo River in the Democratic Republic of Congo (DR Congo). DR Congo has the highest potential for hydropower development with a technically feasible potential of 77,400 GWh/year, out of which only 7.5% has been developed.

This and similar projects can best be developed as regional projects. The focus is therefore expected to be on large hydropower developments, which would be regional projects. To fully develop the potential of these regional projects would require establishing transmission grids in a phased manner to provide facilities for evacuation of the energy produced by the different hydropower plants as they come on line and also create the demand on the plants to accelerate their full utilization and expansion. These phased developments should lead, ultimately in the long term to an Africa wide transmission interconnected network. In the medium term sub-regional interconnected networks should be pursued aggressively. For example, out of the interconnected grid established between Benin, Togo, Ghana and La Côte d'Ivoire to exploit the hydro resources of

Akosombo on a subregional basis, plans have now been made for a West African Power Pool (WAPP) to cover all 14 ECOWAS countries.

NEPAD can stimulate the growth of the West African grid system by setting up arrangements to help in the management of the existing system and its extension to other countries in the sub-region. This way NEPAD can play an important role in bringing into being the WAPP. The WAPP will expand the power market for West Africa and create opportunites for major hydro power development to be undertaken.

6. DEVELOPMENT OF HYDROPOWER PROJECTS

6.1 Regional Generation Projects

INGA

The next tranche of the proposed development of the proposed INGA hydropower scheme involves an initial construction of a transmission line from the Democratic Republic of Congo (DRC) through the Southern Africa grid system to South Africa. Later stages envisage the development of a continental electricity grid backbone to include a transmission line running northwest, from INGA through Gabon, Cameroon and the West African countries into Morocco, through which surplus electricity can be exported to Europe. A third route conceived is a 3,500 kilometer transmission line from INGA to Egypt passing through Chad and Sudan. This line has a potential to supply the Middle East and Europe through Egypt.

At present the hydro capacity planned by one study to be installed at Inga is about 43 GW, to be developed as a run of the river facility on the Congo River.

NEPAD’s short-term infrastructure plan includes the $5.5-million Grand Inga Integrator Study, to assess the viability of the project, which continues to be regarded as one of the most important projects necessary to develop Africa’s economy.

Other Generation Projects

Although INGA in DRC and Cahora Bassa in Mozambique are significant existing regional generating facilities, several other projects, with a regional focus, are also being considered and developed.

Namibia and Angola are considering the development of a hydroelectric facility on the Kunene (Cunene) River that would provide electricity to both countries. Two possible sites for the dam are being considered, Baynes and Epupa Falls. The proposed facility would have a generating capacity of about 360 megawatts (MW) and provide power to the Angolan, Namibian and South African grids.

South Africa and Namibia are sharing in the potentials of the recently inaugurated Maguga Dam, Swaziland's largest public works project, which will benefit all three nations. The Maguga Dam, the fourth largest in Southern Africa, will provide much needed irrigation water for agricultural schemes, create employment in tourism initiatives centered around the fresh water lake, and provide power from a hydroelectric plant. It would lessen Swaziland's dependency on South Africa, where 90% of the country's electricity is imported from. The Kafue Gorge Lower (KGL) hydroelectric station, south of the Zambian capital Lusaka, is expected to have a capacity of 750 MW. The Zambian Government plans to export the vast majority of the power produced to Zimbabwe, Botswana and DRC. KGL, which is expected to cost $500 million, will be the second-largest generating facility in Zambia. The Kafue Gorge Upper power plant currently has a generation capacity of 900 MW. Construction of the Kafue Gorge lower plant is currently planned to start in mid 2003 and take five to seven years to complete.

In West Africa, the Bui Hydro plant is at an advanced stage of project preparation and is expected to add 200 – 400 MW to the existing power system. When completed it is expected to provide power to Burkina Faso, Togo and La Cote d'Ivoire

A 250MW private hydroelectric power plant project is planned to be built at the Bujagali site, Jinja, in Uganda. The Bujagali power station requires an estimated investment of $530 million. Construction of the plant began in January 2003 and is scheduled to take 44 months to complete. The power generated will be sold to neighbouring countries.

In Malawi, a new hydropower development, the $130-million Kapichira Hydro-Electric Plant was commissioned in 2003. The 64 MW plant is connected to the national power grid. An additional 64 MW is expected to be added.

6.2 Regional Transmission Projects

As pointed out earlier, associated with these large hydropower projects are transmission interconnections necessary to evacuate the electricity to consumers across sub-regions. A significant SAPP accomplishment was the completion of the Matimba-Insukamini interconnector linking Eskom and ZESA in October 1995. This interconnection initiated the first linkage of system operations between the northern and southern electrical systems in the Southern Africa region. The northern system is primarily composed of ZESA (Zimbabwe), ZESCO (Zambia) and SNEL (DRC), while the southern system is primarily Eskom (South Africa), BPC (Botswana) and Nampower (Namibia). The effect of the interconnections is that countries are able to source electricity in bulk at cheaper prices and then redistribute it nationally. Plans to connect the power grids of Angola, Malawi, and Tanzania with other SAPP member grids are in varying stages of development.

Zambia and the DRC are to upgrade their current 220-kilovolt regional interconnection to a much higher transmission level to allow other SADC countries to tap INGA's energy supplies. Zambia's Copperbelt Energy Corporation (CEC) and DRC's SNEL will undertake upgrading the project that includes construction of a new 220-kV line between Chingola in Zambia and Karavia near the southern DRC city of Lubumbashi. In addition to the new transmission line, the two countries also plan to repair the existing 220-kV line to significantly raise the amount of hydropower that can be transmitted from DRC to Southern African countries.

In July 2000, the Motraco power supply project was completed. The 400-kV line crosses Swaziland and links Arnot via Barberton and Komatiport to Maputo, supplying power to BHP Billiton's Mozal Aluminum smelters. The project is a joint-venture between EDM, Eskom, and SEB. The 400-KV line also provides additional capacity to Swaziland.

The Zambia-Tanzania Interconnection Project involves construction of 420 miles (700 kilometers - km) of 330-kV transmission line, 360 miles (600 km) on the Zambian side and about 60 miles (100 km) on the Tanzanian side. The proposed line will be able to supply up to 200 MW of power at an estimated cost of $153 million.

Namibia's and Botswana's electricity utilities, NamPower and BPC, have agreed to build a cross-border transmission line of 150-mile (250-km), 132-KV overhead transmission line. The line is scheduled to be completed by September 2003.

A 220-kV transmission line is being built between Windhoek in Namibia and Walvis Bay in South Africa scheduled for completion this year. In August 2002, Eskom announced it was undertaking a feasibility study on a $1-billion project to build a power transmission network to connect the power grids of several of its Southern African neighbors. The study would determine the viability of building an integrated power grid linking Angola, the DRC, Namibia and South Africa.

In West Africa there are plans to develop the 230 km 330-kV Aboadze - Volta transmission line to connect Ghana’s Takoradi Thermal Power Plant in the west of the country to the main load center of Accra-Tema in the east. This line will serve as a principal component of the proposed West African grid network, which will run from Nigeria to Cote d’Ivoire. It would eventually cover all ECOWAS countries and will form the basis for the West African Power Pool.

7. SOCIAL AND ENVIRONMNETAL ISSUES RELATING TO HYDRO-POWER

The construction of dams to create reservoirs for hydropower developments always results in changes in the natural ecosystem of the area within which the river is located. To ensure that these projects are beneficial to society, it is important to assess and manage the social and environmental impacts of such developments.

7.1 Environmental and Social Issues

Environmental issues that arise with the development of hydropower projects are many and varied. These issues need to be carefully examined, studied and dealt with in order to ensure the viability and sustainability of the project.

In Ghana, significant environmental and social issues were faced with the development of the Akosombo Lake on the Volta River for hydropower generation and other multi-purpose uses. The creation of the Lake and the regulation of the floodwaters of the Volta River brought in its wake numerous negative impacts on the lives of the communities living upstream and downstream. The major impact was socio-economic arising from the dislocation and resettlement of about 80,000 people from about 740 villages. Different ethnic groups with a wide linguistic diversity lived within the flood basin. This tremendously compounded the problems of resettlement. The resettlement effort also represented a formidable and physically challenging task due to the nature of the basin that was inundated. The basin was not only large; it was isolated, difficult to access and had minimal infrastructure. The basin was also unhealthy with insect-borne diseases like malaria, river blindness, and sleeping sickness and water borne diseases like bilharzia. Incidence of some of the water borne diseases like bilharzia and hookworm increased.

A positive health impact, which arose from the development of the Akosombo Reservoir is the eradication of river blindness caused by the simulium fly, associated with fast flowing water. Other positive impacts are the creation of opportunities for development of extensive navigation on the reservoir and the explosion of fishing activities.

7.2 Mitigating Environmental and Social Concerns

In order to properly mitigate the environmental and social concerns of hydropower developments, the following lessons learnt from the Akosombo hydropower development in Ghana should be applied.

<u>Need for Continuous Planning and Assessment</u>

There is a need for detailed and extensive studies during the planning phase long before implementation time. These studies will have to be intensified during implementation and the results used to modify the plans. With environmental data gathered before and during construction and filling stage, it was possible to plan mitigation and eradication measures, to monitor and assess changes in the ecosystem. Such planning should not be static but be adjusted as new conditions arise. In spite of initial and environmental and social studies before start of construction when it came to actual implementation the information available was found to be inadequate. This is how VRA found itself compelled to provide its dislocated people with uniform core houses not related to the value of their properties affected; or failing to clear from the reservoir areas tree stumps scattered all over the lake creating serious hazards to navigation or failure to provide for settlers and riparian communities to share in the benefits of electricity. The lesson here is that there is need for continuous planning and evaluation in order to implement a satisfactory program to mitigate any negative effect of hydropower developments.

Need for Post Implementation Monitoring

One observation today is that over 30 years after relocation, the settler population, adjacent communities in which the settlers were relocated and downstream communities in the lower Volta, are, by and large dissatisfied. During project development, efforts were made to enhance public awareness in the project and involve local communities in aspects, which affect them. These were done partly through discussions at the legislature, at special purpose committees, incorporating as many stakeholders and interested participants as possible, and through public education campaigns in the local communities. In spite of all these preparations and efforts, people relocated still feel that they have not been adequately provided for. They feel that urban communities and industries have taken more of the project benefits in the form of cheap electricity while they the locals are left with the bane of public health problems, and inadequate compensation. Some have suffered reduced farm incomes and others reduced fishing incomes.

Resettlement

- Time is a critical factor in the development of river basins. Policies for resettlement and compensation should be developed well ahead of dam construction.
- All persons adversely affected by the formation of the reservoir should be properly and appropriately compensated in cash and in kind. The resettlement costs should cover all inundated properties including houses, farms and public facilities and a well-archived evidence of compensation maintained. In addition, all land encumbered for resettlement should be appropriately compensated and proper legal title is given to each individual resettled family for houses allocated and farmlands.
- This is essential to prevent and minimize post construction claims and also to avoid later conflicts between the host communities and the settlers as the experience of the Akosombo and Kpong projects show. The lessons learnt in handling the social impact of Akosombo and Kpong hydro projects will be applied in planning for the Bui Hydro project. People directly affected who should be targets of intensive consultation, detailed planning of mitigative and improvement measures should be the following: communities to be displaced by the project, communities in the watershed areas and the riparian communities and communities downstream of the dams.

Environmental Impact

- With regards to the environments, Hydropower is a globally benign renewable energy. It is green energy when compared with the fast growing fossil fuel now being built to supply the bulk of the electricity demand over the next twenty or so years. Hydro plants do not produce the large quantities of green house gases which caused global warming and major climatic changes. Hydro projects on the other hand affect local ecosystem. It is important that every effort is made to cause only a minimum change in the existing bio-diversity. Programmes should therefore be developed to ensure effective mitigation of environmental effects. Environmental costs should always be factored into costs of producing power and reflect in the price of electricity. Currently, as part of the Volta Development, considerable resources are deployed for the clearing of tree stumps in the lake, maintenance of a dredger to cut a channel through sandbars at the estuary and physical clearing of weeds on the Kpong head pond to name a few on-going programmes. Opportunities are created to offset some of the environmental disturbances. Tropical reservoirs create conditions for waterborne diseases such as bilhazia to increase. Irrigation, urban water supply navigation, fishing and other development activities can contribute to improve the lives of affected comminites.

Afforestation

- To protect the integrity of the lake, measures should be taken to check de-forestation by protecting the original forests. In the case of the Bui Project, this is of extreme importance since the lake to be formed will be located in a protected environment. VRA already has considerable experience in addressing afforestation problems due to ongoing work in combating these problems on the Volta Lake. A number of measures currently employed by VRA are the planting of tress and the construction of fire belts.

One of the lessons learned is that after implementation there is a tendency for Developer's fatigue to set in. Once people were relocated and power started to be produced, the enthusiasm which characterized the initial socio-economic activity waned when this should have been the time for such activities to have been accelerated.

The developmental objectives are funded on the basis of economic and financial cost benefit analyses but these do not adequately incorporate social and environmental implications. Every effort should be made to widen the cost and benefit studies. The other factor is that the beneficiaries of the development activities are not necessarily the same as those communities, which are immediately affected. For example, the benefits of electricity and irrigation may go to urban communities and industries whereas it is the local community which gets exposure to bilharzia and whose livelihoods are disrupted. Modern thinking is that those who sacrifice must be fully compensated by those who benefit.

Since it is not easy to fully define these costs and the distribution of the benefits, it is better to err on the side of generosity to the local communities. To achieve this calls for a continuous assessment on the sharing of benefits and assessment of costs.

8. PROCURING FUNDS FOR IMPLEMENTING HYDROPOWER PROJECTS

8.1 Trends in Financing for Hydropower

Hydropower projects in Africa over the last half-century have been undertaken with public financing supported by loans raised from multilateral and bilateral public sources. The World Bank has featured very prominently in this effort. The World Bank contributed significantly to financing the Akosombo Hydropower Development in Ghana, the Kainj Hydropower Plant in Nigeria and the Owen Falls in Uganda.

Today, there is a severe shortage of public finance for power development both at the level of African Governments and from the World Bank and other multilateral and bilateral aid agencies, which had supported hydro dam development in the past.

This position has led to an increased interest in contribution of private sector finance to hydropower development. This contribution may take the form of loans raised from commercial banks and other private financing agencies or equity investment by private entrepreneurs in power development. IFC for instance after 1990, approved financing for several private hydroelectric projects between in developing countries. Africa, however, has attracted very little interest from private financiers in hydropower development.

Both the World Bank and the bilateral agencies have established policies to encourage participation of private sector finance in the power sector of Africa. But the risks normally associated with hydropower are such that in the context of Africa they pose challenges which deter private capital. These risks include technical, economic, commercial, environmental and social risks associated with hydro development.

Other risks include:

- Hydrological uncertainties,
- High upfront capital investments which often require long gestation periods,
- The risks of cost overruns and time slippage,
- Negative public perception about hydro projects in general.

8.2 Current Challenges facing Hydropower Financing

Financing for hydropower projects have to contend with the following challenges:

- Competition with other development projects, such as projects for health and education etc.
- Impact on macroeconomic situation
- Political challenges
- Regulatory Challenges

- Negative perception arising from population displacement and destruction of agricultural lands, insects, animals major changes in the
- Destruction of the ecosystem and the change in the biodiversity,

9. STRATEGIES AND ACTION PLAN TO MEET NEPAD INITIATIVE ON ENERGY

9.1 Role of Hydropower in Africa's Energy Policy

Given the significant hydropower potential identified above, the role of regional hydropower is to reduce cost of electric power and provide a sustainable source of electricity. An example is the development of INGA to provide substantial backbone to electricity capacity in Africa at cost levels substantially low and competitive. This will in turn stimulate industrial developments and help reduce poverty.

Another role is the use of small hydro developments to extend electricity service and increase electricity access to remote areas whilst at the same time building an industrial base and technical skills for small and medium scale industries.

9.2 Short Term Action Plan

- Will require proper policy framework, pricing, tariff environment,
- Improving the technical and managerial capabilities of the institutions

9.2.1 Objectives

- Need to improve existing hydro capacity
- Advance the development of the regional projects identified.

9.2.2 Action Plan

Establish a Committee on Hydro Power Development, which will have Task Forces to carry out the following functions:

1. Map out the existing facilities and identify opportunities for improving their performance.
2. Identify centers of excellence within each sub region, which serve as training centers for sharing of experience.
3. Work with Regional Economic Commissions (REC) and appropriate institutions at the national level to undertake the necessary tasks in the project development process. Part of the tasks should be:

o Advancement of Identified Regional Projects, namely Mepanda-Uncua Hydro Power Plant and Grand Inga Integrator (establishment of Project Development Task Force to work with RECs, sub-regional power pools and multilateral funding agencies including regional/sub-regional banks like AfDB and SADB)

o Finance Facilitation of Country Projects including Improvement of Existing Facilities. As part of this, half-yearly forum of Utilities and Project Developers can be organised in collaboration with UPDEA and AfDB.

o Policy Development at Sub-Regional Levels (establishment of Policy Development Task Force to work with national energy policy agencies, RECs, sub-regional/regional networks of energy experts and the initiatives developed as part of the World Summit on Sustainable Development (WSSD)
o Establishment of the proposed African Regional Energy Commission (AFREC) to institutionalize actions mentioned above

9.3 Medium to Long Term Strategies and Action

9 3 1 Specific Objectives

- Implement identified projects (Inga, Mepanda Uncua, etc)
- Identify and implement other regional project
- Build capacity for small and medium hydro project

9 3 2 Actions

Operationalise AFREC, within which the hydro committee would operate, to continue implementation of the short term actions and the following medium to long term actions,

1. work with key organizations especially the RECs and national energy agencies to harmonize regulatory frame works and establish power pools;
2. Work with the RECs and appropriate institutions at the national level to undertake the tasks necessary to implement the projects identified; these tasks would include detailed engineering design, preparation of tender documents, construction and commissioning.
3. set up a fund to facilitate the development of small to medium hydro projects to which corporate entities could apply.
4. publish an annual of hydro power projects in Africa, which would provide information on new projects, status of on-going works
5. Support and collaborate with hydro power research centers and networks.

10. SUMMARY/CONCLUSION

In summary, this paper has identified the main problems facing hydropower development in Africa as:

- Lack of finance
- Low access of the population to electricity

Given the low demand for electricity in Africa today, and the lack of access there are bright prospects for the development of hydropower. A summary of the concrete strategies developed to support actions that will enhance access and Attract finance into the country include:

- In the short term, the rehabilitation and operational improvement of existing hydro projects by NEPAD through a Committee on Hydropower Development
- In the long term it is proposed that NEPAD works closely with country Regional Energy Commissions.

APPENDIX A – Data on the Hydropower Situation in Africa

Country	Gross Theoretical Hydropower Potential (GWh/year)	Technically feasible Hydropower Potential (GWh/year)	Economically feasible Hydropower Potential (GWh/year)	Installed hydro capacity (MW)	Production from hydro plants (GWh/Year)	Percentage of electricity produced from hydro	Hydro capacity under construction (MW)	Planned hydro capacity (MW)
Algeria	12,000			280	500	2	-	700 (p-s)
Angola	150,000	90,000	65,000	290	1,000	56	780	<16,500
Benin	1,676	<1676		67	170	89		250
Botswana				-	-	-		-
Burkina Faso	>600	n/a	216	32	125	35	-	3
Burundi	>6000	>1500	1,500	43	147	100		36
Cameroon	294,000	115,000	103,000	725	2,423	99	-	600
Central African Republic		2,800		19	81	99	-	20
Chad	>150	150		-	-	-		6
Comoros				1	2	13		n/a
Congo		>50,000		89	352	>90		180
Congo, DR	1,397,000	774,000	<419,210	2,440	5,350	99	4	43,000
Cote d'Ivoire	46,000	>12,400	12,400	614	1,800	60		334
Egypt		>50,000	50,000	2,810	11,450	20	65	193
Equatorial Guinea				1	2	11		n/a
Eritrea				-	-	-		n/a
Ethiopia	650,000		260,000	398	1,600	97	297	705
Gabon	>80,000	80,000	32,500	168	830	72		n/a
Gambia				-	-	-		-
Ghana		10,600		1,072	5,169	71		400
Guinea	26,000	19,400	14,500	127	414	60		104
Guinea-Bissau		300	300	-	-	-		
Kenya	>30,000	8,860		675	4,100	67	60	n/a
Lesotho	n/a	n/a	n/a	79	200	98	-	24
Liberia		11,000		-	-	-		-
Libya				-	-	-	-	-
Madagascar	321,000	180,000	49,000	105	510	72	42	350
Malawi		6,000		283	800	99	64	365
Mali		>5000		50	243	54	104*	52
Mauritania				61	26	18	30*	n/a
Mauritius		150		59	134	6		-
Morocco		4,700	4,000	1,205	2,350	18	90	450 p-s
Mozambique	50,000	37,647	31,717	2,180	11,548	94	-	2,000
Namibia	9,000	>8645	8,645	240	854	98		350
Niger		1,300	1,300	-	-	-		125
Nigeria	42,750	32,450	29,800	1,938	6,986	43	64	4,850
Reunion				125	500	61		n/a
Rwanda		330		27	110	100		27
Sao Tome and Principe				6	-	-		-
Senegal		4,250	2,050	-	-	-	66*	-
Seychelles				-	-	-		
Sierra Leone		6,800		4	24	n/a	70	50
Somalia		600		5		6		
South Africa		n/a		668	904	0		n/a
Sudan		19,000	1,900	303	1,000	40	-	40
Swaziland	3,800	560	300	44	191	99	19	n/a
Tanzania	39,447	20,000	1,789	377	1,748	85	180	>1000
Togo		1,700		4	6	12		n/a
Tunisia	1,000	250	160	64	100	1	2	20
Uganda	>17,500	(>2000MW)		276	1,600	100	320	800-1000
Zambia	52,460	28,753	11,000	1,674	7,782	100	60	>2000
Zimbabwe	18,500	17,500		670	3,000	25	85	>800
Total	4,000,000	1,750,000	1,000,000	20,300	76,000		>2,403	>60,000

n/a= data not available (but greater than zero); p-s=pump storage

Source: World Atlas on Hydropower and Dams - 2001

APPENDIX B -- Ghana Small Scale Hydro

Until late 1997 and early 1998, virtually all of Ghana's electricity was produced from two hydro dams at Akosombo and Kpong, which have a combined installed capacity of 1,072 MW. It is estimated that Ghana may have the potential for additional 2,000 MW of hydropower.1 About 1,205 MW of this total is expected to be produced from proven large hydro sources while the rest will come from medium to small hydro plants.2 According to Odai [1999], about 70 SHP sites have been identified in Ghana. Appendix 2 contains a list all identified SHP sites in Ghana.

Preliminary studies to assess the SHP potential of Ghana began in 1979 under the auspices of the then Architectural Engineering Services Corporation (AESC) – now AESL.3 About 40 potential small hydro sites were identified based on analysis of available data including topographical sheets. Later, under a Ghana-India Technical Co-operation Agreement, funds were released for the development of the first pilot SHP schemes at a site near Likpe-Kukurantumi on the Dayi River, in the Volta Region. Unfortunately, this project was never completed.

Then in 1982, the Government of Ghana issued new guidelines for the energy sector. This included plans to develop SHP schemes up to 500kW to provide decentralised electric power to isolated rural communities. To achieve this objective, the Ministry of Fuel and Power (as it was then called, now MME) commissioned AESC to carry out a systematic assessment of SHP potential in selected regions in Ghana. The selected regions were those that did not feature in the medium term plans for extending the national electricity grid. In December 1985 and December 1986, the AESC, in collaboration with the Technical Division of the then Ministry of Fuel and Power, completed interim reports on Phase I and Phase II of the micro-hydro component of the 'Ghana Energy Project'. The two phases cover an assessment of 14 potential SHP sites, markets for the power to be generated, preliminary layouts and sketches, as well as cost and benefit estimates.

Following the AESC studies, ACRES International, in 1991 - under the National Electrification Planning Study (NEPS), carried out another study, which covered the following areas:

- A review of the studies undertaken by AESC. This review included analysis of basic data (hydrology, plant parameters, layouts) as well as the assessment of the feasibility and attractiveness of the considered sites;
- An economic assessment of three representative projects;
- An extrapolation of the representative projects in order to assess the small hydro

[1] Ampofo, K. (1998)
[2] Akuffo, F. O. (1998)
[3] AESL stands for Architectural Engineering Services Limited.

potential of Ghana;

- Development of a work plan for the future comprehensive inventory of Ghana's small hydro potential; and
- An outline of technical and technological problems related to investigations, engineering construction, and operation & maintenance (O&M) of SHP projects in Ghana.

ACRES International investigated 16 small hydro sites in their study –14 of them were carried over from Phase II of the AESC study – and two sites were newly identified. Table B.1 contains characteristics and potential output of SHP sites studied in Ghana while Figure B.1shows the location of studied SHP sites.

Table B.1: Studied Mini-Hydro Sites

No	Mini-hydro Project	River	Heads (Gross) (m)	Installed Capacity (kW)	Potential Output at Site (MW h)
1	Wli Falls	Nuboi	264	325	10,747
2	Nuboi River downstream of Wli Fall	Nuboi	38	45	1488
3a	Tsatsadu Falls I (Falls only)	Tsatsadu	54	100	3343
3b	Tsatsadu Falls II (rapids below falls)	Tsatsadu	38	70	2340
3c	Tsatsadu Falls I+II	Tsatsadu	92	170	4683
4	Menusu	Menu	7.5	65	2178
5	Ahamansu	Wawa	6.2	125	4201
6	Dodi Papase	Wawa	9.2	210	7015
7	Asuboe	Wawa	6	100	3340
8	Sanwu Falls	Sanwu	80	20	701
9a	Nworannae Falls A	Nworannae	24	12	560
9b	Nworannae Falls B	Nworannae	40	20	933
10	Randall Falls	Pumpum	16	4	422

11	Fuller Falls	Oyoko	15	7	698
12	Kokuma Falls	Edam	27	60	1751
13	Nkoranza	Fia	4.3	35	981
14	Maaban	Kwasu	12.2	15	604
15	Buomfoum Falls	Ongwam	18.5	10	292
16 a	Wurudu Falls A (falls only)	Wurudu	39	30	668
16 b	Wurudu Falls B (falls & lower rapids)	Wurudu	60.5	45	1003
17	Likpe-Kukurantumi	Dayi (V/R)		400-600	

Sources: ACRES (1991)) & Ampofo (1998)

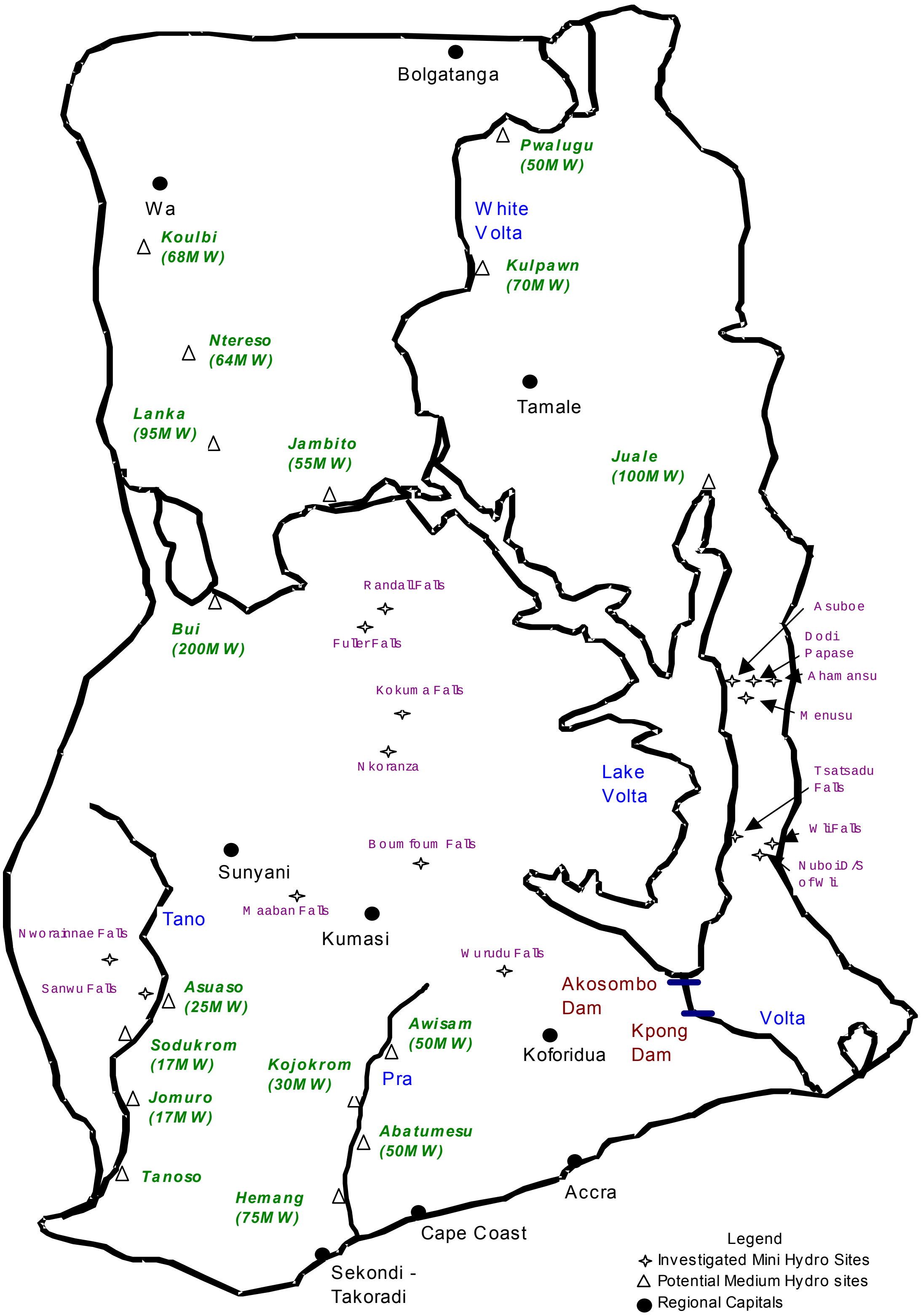


Figure B.1 Map of Ghana Showing Identified Medium and Small Hydro Sites

The number of potential viable and implementable sites was then estimated for several scenarios – minimal (cautious), maximal (optimistic) and medium. Under these assumptions, the small hydro potential of Ghana was assessed as contained in Table B.2 below.

Table B.2: Estimated Small Hydro Potential of Ghana

			Scenario		
	Unit	Typical SHP Project	Minimum	Medium	Maximum
Number of Plants envisaged	**-**	**-**	**15**	**30**	**50**
SHP Plants Sized for Supplying Isolated Consumers					
Installed Capacity	**kW**	**75**	**1125**	**2250**	**3750**
Potential Output	**MWh/yr**	**600**	**9000**	**18000**	**30,000**
Output absorbed by Isolated consumers	**MWh/yr**	**240**	**3600**	**7200**	**12000**
Savings in diesel fuel	**10^6L/yr**	**85**	**1275**	**2550**	**4250**
SHP Plants Sized for Connection into Grid					
Installed Capacity **Of which: firm**	**kW** **kW**	**275** **75**	**4125** **1125**	**8250** **2250**	**13750** **3750**
Output	**MWh/yr**	**1360**	**20400**	**40800**	**68000**
Of which firm[1] (to local consumers)	**MWh/yr**	**240**	**3600**	**7200**	**12000**
Secondary	**MWh/yr**	**1120**	**16800**	**33600**	**56000**
Savings in fuel Conventional fuel (6000 cal/g)	**t/yr**	**335**	**5025**	**10050**	**16750**

Source: ACRES International, 1991

When considered as simple run-of-river projects, sized to provide power to rural communities not connected to the national grid, the aggregate SHP potential of Ghana was estimated to be around 1.2 MW installed capacity for the minimum scenario and 4 MW installed capacity for maximum scenario. However, this installed capacity could be increased considerably if the SHP plants could be connected to the national electrical grid, which would absorb the excess energy output. Under this scheme, the SHP potential of Ghana, for the same sites, was estimated to be around 4 MW installed capacity for the minimum scenario and 14 MW installed capacity for the maximum case scenario.

Based on this assessment, ACRES International [1991] described the SHP potential of Ghana as “modest”. They concluded inter alia that the development of small hydro in Ghana “could only have a marginal effect on the overall fuel and energy balance of Ghana. They however pointed out that the SHP technology could play a very important role in widening the implementation of rural electrification programmes thereby accelerating the incorporation of otherwise isolated communities into the mainstream of economic and social development.”