THEME 1: SMALL SCALE HYDROPOWER FOR RURAL DEVELOPMENT

PHASE 1 REPORT

June 2004

NBCBN-RE Small Hydropower Development Research Group
Dar es Salaam. Tanzania.

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ACRONYMS AND ABBREVIATIONS

DGHER	General Director of Hydraulics and Rural Energies, Burundi
DRC	Democratic Republic of Congo
DWD	Directorate of Water Development
MWLE	Ministry of Water, Lands and Environment, Uganda
ERA	Electricity Regulatory Authority, Uganda
ERT	Energy for Rural Transformation, Uganda
FBU	Burundi Francs
FDI	Foreign Direct Investment, Uganda
GWh	Giga Watt hour
HP	Hydropower
IGEBU	Geographic Institute of Burundi
IPP	Independent Power Producers
ITCZ	InterTropical Convergence Zone
KenGen	Kenya Generating Company
KPLC	Kenya Power and Lighting Company Limited
Km	kilometre
kW	Kilo Watt
MP	Multipurpose
MW	Mega Watt
N/A	Not Applicable
NEDECO	the Netherlands Engineering Consultants
PCA	Principal Component Analysis
NBCBN-RE	Nile Basin Capacity Building Network for River Engineering
REGIDESO	National Light and Water Supply Company Limited, Burundi
RoR	Run of River
SHP	Small Hydropower Project
Sida	Swedish International Development Agency
STD	Standard Deviation
TANESCO	Tanzania Electric Supply Company Limited
UEDCL	Uganda Electricity Distribution Company Limited
UEGCL	Uganda Electricity Generation Company Limited
UETCL	Uganda Electricity Transmission Company Limited
UEB	Uganda Electricity Board
UNDP	United Nations Development Program
WAPCO	Water and Power Consultancy Services, India based firm
WS	Wabi Shebele, Ethiopian river basin

ACKNOWLEDGEMENT

The research group of Theme I is indebted to the following firms/persons for the provision of data and background information. Their comments as well, have been very helpful in preparing this report.

Tanzania
⇒ Ministry of Energy and Minerals
⇒ National Environment Management Council
⇒ Tanzania Electricity Supply Company Limited
⇒ Tanzania Traditional Energy Development
⇒ University of Dar es Salaam

Burundi
⇒ Geographic Institute of Burundi
⇒ Ministry of Energy and Mines
⇒ Director General of Hydraulics and Rural Energies

Kenya
⇒ Kenya Power and Lighting Company Limited
⇒ Kenya Generating Company Limited
⇒ University of Nairobi

Ethiopia
⇒ Ministry of Water Resources

Egypt
⇒ NBCBN-RE Secretariat: Dr. Sherif Sayed

The Netherlands
⇒ Scientific Adviser to the NBCBN-RE Hydropower Cluster: Prof. Dr. Bela Petry

Rwanda
⇒ Xxxxxx
⇒ Xxxxxx

Uganda
⇒ Ministry of Energy and Mineral Resources
⇒ Uganda Energy Transmission Company
⇒ Directorate of Water Development, Uganda
⇒ Energy Regulation Authority
⇒ Business Uganda Development System-Energy for Rural Transformation

EXECUTIVE SUMMARY

Modern societies strongly depend on reliable, affordable and sustainable energy supplies. In fact, Energy is an obligatory input for most production processes and other economic activities and an essential component of our way of life.

Many of the Nile Basin countries are among the least developed in the World in spite of their important potential in natural resources. They strongly depend on the development of their still very limited energy supply systems, using locally available, competitive and renewable resources--such as Hydropower-- to achieve further steps in their sustainable social and economic growth.

One important aspect of the development of the energy sector in most countries of the Nile Basin is the development of local capacities in planning, design, implementation and operation of Small Scale Hydropower systems and installations aimed at using water resources of moderate dimensions and providing solution at local and sub-regional scale (including development of rural areas). This is the general purpose of the Research Theme 1, established along the definitions given by the NBCBN-RE Conference (Cairo, January 2002) and the Hydropower Cluster launching event (Dar es Salaam, November 2002).

Theme 1 has received the contribution of the member countries Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda. In 1st phase of activities the research team has been focusing attention and activities on the following scope:

- Inventory of data bases and other sources of information related to Small Scale Hydropower in each member country
- Inventory of potentially interesting sites for the development of Small Scale Hydropower installations in each member country
- Inventory of Capacity Building needs related to Small Scale Hydropower in each member country.

A summarized account of the work done and results achieved so far is presented in the Theme 1--Report and corresponding country reports.

In a summary, major achievements so far are the following:

- An intensified collaboration between water professionals of the different countries of the Cluster region.
- For Burundi, about 15 sites were identified as small hydropower potentials suitable for development. These identified small hydropower potentials have about 3 Mw installed capacity. The Burundi report gives details of Hydrological and Meteorological study sources in the country.
- In Tanzania, searched reports and publications give an account of previous efforts by different institutions in the country studying and investigating hydropower potentials, small/micro/macro scale potentials inclusive. A total of about 56 new hydropower sites were found to have been studied at different levels ranging from reconnaissance to pre-feasibility and very few ones studied to a feasibility study level. In all these, an estimated total rough figure of about 200 Mw can be

harnessed from small hydropower potential sites already identified. The report also gives a list of existing developed sites either publicly or privately owned.

- The report from Ethiopia shows that a total of 299 hydropower potential sites have been identified within 11 River basins. The largest river basin in terms of number of hydropower potential sites as well as technical energy potential is Abbay River basin. Abbay River basin has about 79000 GWh/year. This is about 49% of all river basin potential energy in Ethiopia.
- The report from Uganda shows a total of about 23 sites small hydropower sites of about 54MW potential. Most of these sites are located off the River Nile on Non-Nile Rivers scattered around the country (the Nile sites are all large hydro). Of these rivers, only about 25MW has been developed or is in progress of development, though this still represents the large hydro sites of 23 small hydro sites. The smaller ones are scattered all over the country, and potential private investors are being invited to develop them through the ERT program.
- Status for Rwanda and Kenya is contained in their respective country reports.

The following research objectives are planned in a continuation of Theme 1 activities:

- Completion of the inventories started in Phase 1.
- Publication of a Small Scale Hydropower Reference Booklet containing important data and information for every participating country in Theme 1.
- Development of a Design Manual for Small Scale Hydropower for use in the Nile Basin countries.
- Development of feasibility studies for the implementation of a small-scale pilot project in each of the Theme 1 member countries.
- Promotion of training activities within the scope of Theme 1.

1. INTRODUCTION

1.1 Background and Current status

The Small Scale Hydropower Development Research Work as part of Nile Basin Capacity Building Network for River Engineering stemmed out of January 2002 Cairo Declaration on Nile Basin Initiative as one of the Regional Programs to build and strengthen professional and institutional capacity in the Nile riparian countries. This network was meant to be an open forum of national and regional capacity building institutions and professional organizations active in education, training and research. It had the following objectives:

⇒ To make optimal use of existing capacities in the field of river engineering by connecting specialized institutions and experts/professionals
⇒ To enhance and strengthen communication and collaboration among these experts
⇒ To improve the accessibility of education and training in river engineering in the region
⇒ To facilitate and regionalize research on river engineering in the Nile Basin riparian countries by offering opportunity to perform joint researches.

The January 2002 Cairo Declaration was followed by a series of launching seminars/workshops in different countries. Research clusters within NBCBN-RE are **Hydropower Development** hosted in Tanzania, River Morphology hosted by Sudan, Storage and Regulation Works by Uganda, River Intakes Works and Main Conveyance Systems for Water Supply hosted by Ethiopia and GIS and Modelling hosted by Egypt.

First workshop for Hydropower node was launched in Dar es Salaam, Tanzania as a host country in November 2002.During this workshop; two research topics were developed to be:-

⇒ Theme I: Small-Scale Hydropower Development
⇒ Theme II: Hydropower Regional Integration

Second Workshop on Hydropower was also organized in Dar es Salaam in March 2004. It looked at the progress of the research activities and prepared a mid Term report summarizing of all what has been taking place in Stage I. It is in this midterm report where we laid down a framework, which is the basis for this current report.

1.2 Scope

The project was intended to be executed in three Stages i.e. I, II & III:

⇒ **Stage I**: Period between 1st workshop held in Dar es Salaam, November 2002 and 2nd Workshop held in Dar es Salaam, March 2004. The following are main outlines of the Scope within this period of Stage I:
  - Inventory of data bases and sources of Information
  - Inventory of sites for small scale hydropower development

- Inventory of capacity building needs.

⇒ **Stage II**: This is the period between March 2004 (second Workshop held in Dar es Salaam) and June 14, 2004 Cairo Workshop. This phase was meant to intensify all research activities that were already underway in Stage I. It was also meant to consolidate the knowledge base. All these were to bring up a final report to be presented to the Cairo Workshop, June 2004. It is in this period that a progress report (Mid Term Report) was prepared and issued to the Secretariat of NBCBN-RE, which is based in Cairo, Egypt.

⇒ **Stage III**: The period beyond Cairo Workshop in June 2004: This is the period that will take over from where Stage II activity ended. It is at this Cairo workshop where assessment and evaluation of what extent of the objectives has been attained. The future and way forward for this NBCBN-RE network is expected be defined during the Cairo Workshop. Tentatively, the research group made the following deliberations for objectives beyond Cairo June 14, 2004 workshop:

- Each country should zero in on one prospective viable project candidate that has to be studied at all relevant stages for eventual implementation as a pilot project.
- Come out with customized design manuals that can be published for local use and Nile Basin as a whole.
- Come out with a definitive layout for strategies for mobilizing implementation funds.
- Publish a small-scale hydropower data for each Nile Basin participating country.

1.3 Objectives of the Research

Rural Electrification for countries within Nile Basin like any other countries in the Developing World is a major challenge for central and local governments and other investors. The major problem for the rural electrification from either thermal generators or electricity tapped from other distant major electric sources lies on **financial viability**. This is because consumers in our typical villages and rural towns have very low purchasing power thus casting doubts to the investors whether their investment costs shall be recovered on commercial terms. THE CHALLENGE OF TODAY IS HOW TO PROVIDE ELECTRICITY ON CHEAP MEANS FOR RURAL DEVELOPMENT HENCE ALLEVIATING POVERTY. One of the solutions for this problem is to identify small-scale hydropower potentialities in the rural areas and develop them to electrify the rural areas.

1.3.0 Uses of the Research Results

1.3.1. Consequences:

- Hydro-potentials that exist in rural areas shall be known for power harnessing possibilities for rural areas.
- Upon implementation of small hydro schemes in our rural areas, there will be a great reduction on deforestation as a result of cutting down trees for fire wood (this is a major source of energy in rural areas).

- Men and women in the rural areas shall have more time for farming
- Rural electrification shall be incentive for Agro based industry
- Employment opportunities shall be created in the rural areas
- Rural – town migration of people will be reduced as now people will see opportunities to get better life in the rural areas.
- End result of all these: POVERTY ALLEVIATION in the countries within Nile River Basin.

1.3.2 Users of Results: Government energy planners/policy makers and local government authorities and other interested private parties

2 METHODOLOGY

2.1 Organization and Coordination of the Project

Generally, Theme I: Small Hydropower Development Research Project as part of the Nile Basin Capacity Building Network for River Engineering has the following hierarchical levels as shown in figure 1:

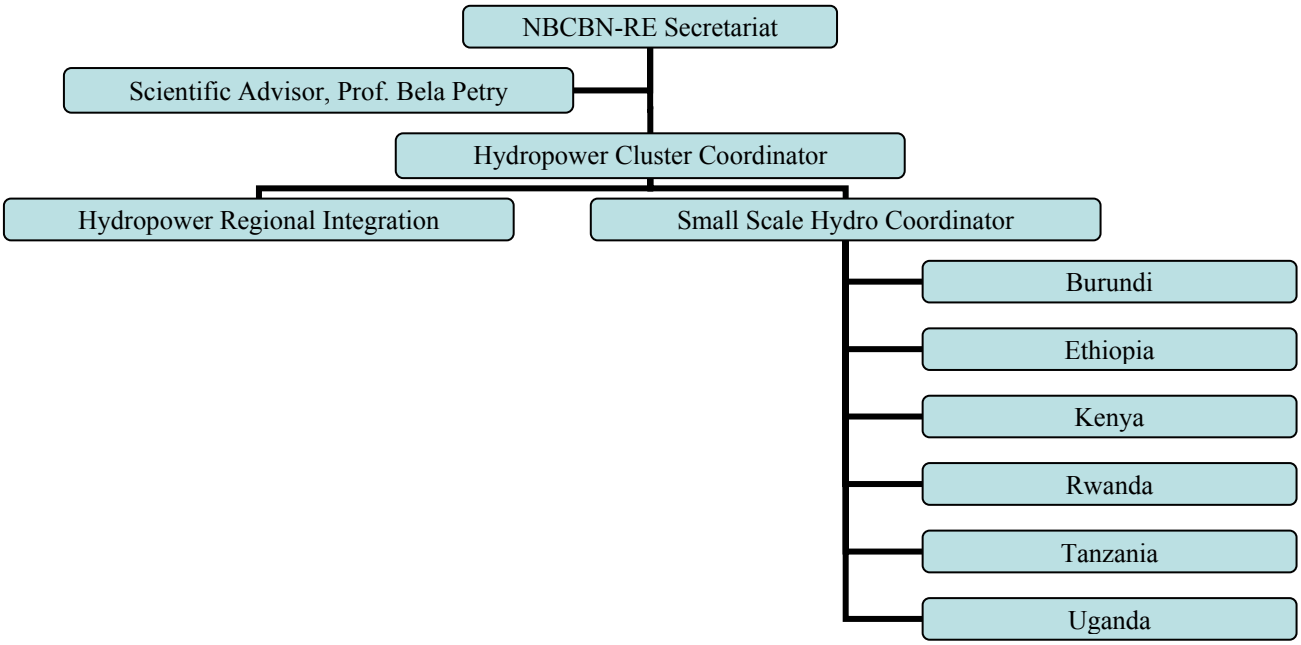


Figure 1: Organizational Chart for the Research Project

The above chart of organization shows the working relationship among the participating member countries and the way the reporting and information sharing was organized. The grassroots levels begin at the national nodes. The node is the basic unit of the network in each country. Its role is the identification and implementation of the agreed NBCBN-RE activities.

Coordinating roles were played by each theme coordinator together the hydropower cluster coordinator. Scientific Advisor had the role of overseeing the quality assurance of the research work.

The role of the NBCBN-RE Secretariat is coordination, facilitation, promotion and Monitoring of the NBCBN-RE activities. Final decision for finance and Workshop/Seminars logistics were being made at Cairo Secretariat Office where the Project Manager is based.

2.2 Organization and Coordination at the National Node Level

As mentioned above in chapter 2.1, the national node, being the basic unit of the network is responsible for identifying and implementing NBCBN-RE activities for the particular cluster research work. It is important to make note that both NBCBN-RE Secretariat and national nodes share responsibilities in ensuring sustainability, mobilization of the resources and information management. Below is a summary of participating members in the Small Hydropower Development Research Group

- RESEARCH TEAM IN PHASE 1:
  - ⇒ Tanzania, the host country for Hydropower Cluster, has the following professionals in the team:
    - Prof. Dr. F. Mtalo
    - Eng. Leonard B. Kassana
    - Prof. Dr. D. Mashauri
    - Prof. Dr. D.J. Chambega
    - Prof. Dr. I.S.N. Mkilaha
    - Dr. C.F. Mhilu
    - Eng. James L. Ngeleja
    - Eng. Leonard R. Masanja
  - ⇒ Burundi: Mr. Ntungumburanye Gerard
  - ⇒ Ethiopia: Dr. Zelalem Hailu
  - ⇒ Kenya: Prof. Sibilike K. Makhanu
  - ⇒ Rwanda: Dr. Museruka Casimir
  - ⇒ Uganda: Mr. Kizza Michael
    Mr. Keneth Muniina

2.3 Execution Framework

Phase I activities were based on three main components as mentioned below:

i. Inventory of Data Bases and Sources of Information
ii. Inventory of Sites for Small Scale Hydropower Development
iii. Inventory of Capacity Building Needs

The inventory of the potential sites for small-scale hydropower development was conducted based on the following approach:

⇒ Conducting desk study for the hydropower potentials
⇒ Review of existing documentations for identification of sites and their locations.
⇒ Data evaluation to establish the potential for each of the identified sites

3. PROJECT RESULTS

3.1 Major Findings

3.1.1 General

In a summary, through an intensified collaboration among multidisciplinary professionals from different countries under the Hydropower Cluster, it is all appreciated by all members that our countries, despite being poor from economical point of view, are endowed with enormous natural resources. These resources if sustainably and equitably managed, these countries should be able to alleviate if not eradicate completely, the poverty among our people. It is truly known that in all Nile Basin riparian countries, poverty is worse in rural and semi-urban areas than towns and cities. Therefore, cities and towns, being major load centers do attract investors of all categories i.e. public and private to invest in projects whose power would be transmitted to the load centers because their funds would be recovered quickly and with profits.

In view of the above, small scale hydropower projects seem to be giving one of the promising solutions for electrifying rural areas and hence increasing economic production. The SHP has the following advantages:

- ⇒ It is quite simpler in design and construction than the larger Hydropower project.
- ⇒ It is simpler to operate than the larger facility
- ⇒ Has very minimal adverse impacts on environment
- ⇒ Has minimum costs for transmission from the generation points to the load centers

By increasing economic activities in the rural areas would reverse the rural-urban immigration of the work force from the rural areas and hence alleviate poverty.

At this stage with efforts that have been done in the past, the research group has inventorised data for:

- ⇒ Potential sites for hydropower development in the rural areas
- ⇒ Sources of such information regarding literatures, investigation reports e.t.c

The group has attempted to identify the strength and weaknesses with respect to Capacity Building in these countries.

3.1.2 Burundi

For Burundi, about 15 sites were identified as small hydropower potentials suitable for development. These identified small hydropower potentials have about 3 Mw potential capacities.

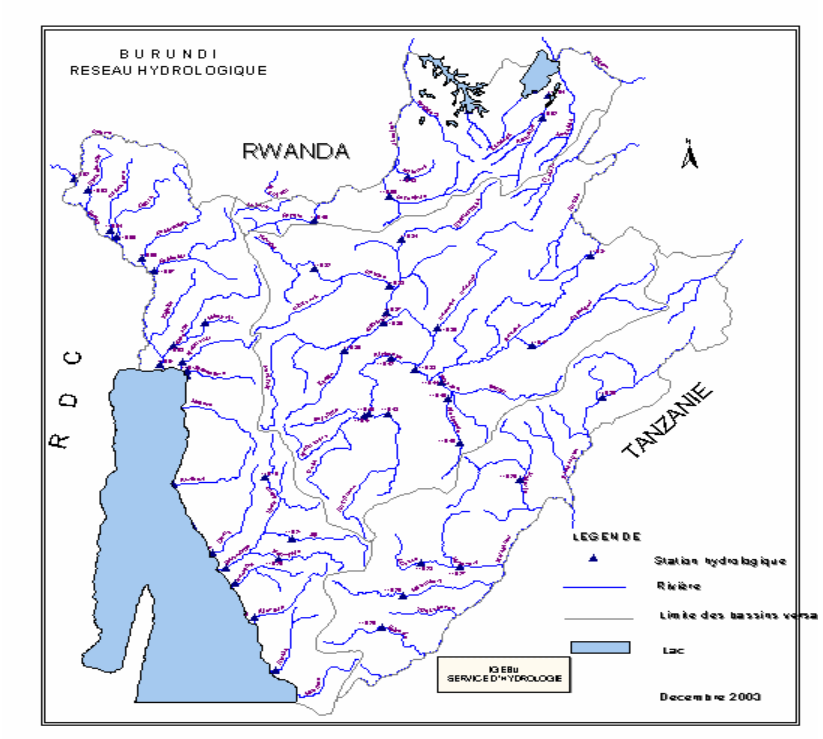


Figure 2: Burundi map showing Hydrological basins

BURUNDI has two major watersheds draining into the following regional basin as shown in the figure 2:

⇒ CONGO River Basin

⇒ NILE River Basin. Many tributaries flow into the Nile River through RUVUBU and KANYARU- KAGERA River inside BURUNDI and KAGERA River outside the country, which in return flows into Lake VICTORIA, feeding from there to the NILE River.

Table 1: The Burundi mean Hydrological Balance of Water Resources is summarized below:

Watershed	Mean discharge National territory (m^3/s)	Imported discharge from Rwanda (m^3/s)	Imported discharge from Tanzania (m^3/s)	Exported discharge to Rwanda (m^3/s)	Exported discharge to Tanzania (m^3/s)
Ruvubu	108		4		-112
Kanyaru	21	25		-46	
Kagera	8	134			-142

The Inventory Work for Small Hydropower in the country indicates that a total amount of about 3 MW is potentially available for power production form 15 different sites. A list of small hydropower sites in Burundi is given in the table 2 below:

Table 2: Inventory of Sites for Small Scale Hydropower in Burundi

S/n	Name of site	Responsible	Name of river	Installed power in mw	Start year
1	Gikonge	Regideso	Mubarazi	0.850	1982
2	Kayenzi	Regideso	Kavuruga	0.350	1984
3	Marangara	Regideso	Ndurumu	0.240	1986
4	Buhiga	Regideso	Ndurumu	0.240	1984
5	Sanzu	Regideso	Sanzu	0.072	1983
6	Butezi	Dgher	Sanzu	0.240	1990
7	Ryarusera	Dgher	Kagogo	0.020	1984
8	Nyabikere	Dgher	Nyabisi	0.139	1990
9	Murore	Dgher	Rusumo	0.024	1987
10	Mugera	Private	Ruvyironza	0.030	1962
11	Kiremba	Private	Buyongwe	0.064	1981
12	Teza	Private	Nyabigondo	0.360	1971
13	Kiganda	Private	Mucece	0.044	1984
14	Gisozi	Private	Kayokwe	0.015	1983
15	Burasira	Private	Ruvubu	0.025	1961

For additional details, please refer to the country report in Appendix A1.

3.1.3 Ethiopia

The report from Ethiopia shows that 299 hydropower potential sites have been identified within 11 River basins. The largest river basin in terms of number of hydropower potential sites as well as technical energy potential is Abbay River basin. Abbay River basin has about 79000 GWh/year. This is about 49% of all river basin potential energy in Ethiopia.

Figure 3: Map of Ethiopia showing Major River Basins

The desk study during this phase I of the research revealed that Ethiopia, a horn of African country is single major contributor of about 85% of the total Nile Water. The nation has 11 major River Basins with a total hydropower potential amounting to 7877 Mw including both large and Small Hydro potentials. A summary of energy potentials and other hydrological parameters are given in table 2 below.

The table 3: River Basins in Ethiopia with Areas, surface Water Resources and Potential Hydropower Sites

S/N	Name of Basin	Area (km^2)	Techn. Potential (Gwh/yr)	75%Dependable Surface Water (Bm3)	HP Potential Sites
1	Abbay	201,346	78,820	51.48	132
2	Wabi Shebelle	202,697	5,440	2.34	18
3	Genale-Dawa	171,042	9,270	4.58	23
4	Awash	112,696	4,470	4.10	43
5	Tekeze	90,001	5,930	5.73	15
6	Omo-Ghibe	78,213	36,560	14.46	23
7	Ogaden	77,121	-	-	-
8	Baro-Akobo	74,102	18,880	8.51	39
9	Danakil	74,002	-		-
10	Rift valley Lakes	52,739	800	4.36	6
11	Aysha	2,223	-	0.57	-
	Total	1,136,182	160,170	97.20	299

Just as an illustration, three tables are extracted from the Ethiopian country report to indicate some of the small hydropower potentials in the following basins:

⇒ Abbay River basin
⇒ Wabi Shebel River basin
⇒ Genale Dawa River Basin
⇒ Awashi River basin

Table 4: Hydropower Identified Projects in the Abbay River Basin in Ethiopia

Power Scheme	Code in the Models	Installed Capacity (MW)	Type of Project
Aleltu	ALEL	418	Reservoir
Anger	ANGA	10	Reservoir
Beles Dangur	BELD	120	Reservoir
Chemoga Yeda	CHEY	630	Reservoir
Dabana	DABA	60	Reservoir
Fettam	FETT	125	Reservoir
Finchaa	FINC	100	Reservoir
Galegu	GALE	5	Reservoir
Gilgel B	GILB	5	Reservoir
Jemma	JEMA	2	Reservoir
Lah	LAHR	1	RoR
Lower Dabus	LDAB	7.5	RoR
Lower Didessa	LDID	300	Reservoir
Lower Dindir	LDIN	20	Reservoir
Lower Guder	LGUD	70	Reservoir
North Chagni	NCHA	5	Reservoir
Negeso	NEGE	10	Reservoir
Nekemte	NEKE	10	Reservoir
Neshe	NESHB	30	Reservoir
Rahad	RAHA	15	Reservoir
Tis Abbay	TANA	60	
Upper Beles	UBEL	382	
Upper Dabus	UDAB	40	Reservoir
Upper Didessa	UDID	100	Reservoir
Upper Dindir	UDIN	30	Reservoir
Upper Guder	UGUD	20	Reservoir
TOTAL		1097	

Table 5: Potential Hydropower sites in the Wabi Shebele River Basin in Ethiopia

No.	Site Name	Power (MW)	Energy (GWH/yr)
1	WS 1	24.8	217
2	WS 2	29.3	213
3	WS 3	26.5	232
4	WS 4	28.1	246
5	WS 5	39.4	256
6	WS 6	29.5	258
7	WS 7	29.7	260
8	WS 8	39.7	348
9	WS 9	39.8	349
10	WS 10	44.8	392
11	WS 11	53.7	490
12	WS 12	39.6	505
13	WS 13	74	655
14	WS 14	75	656
15	WS 15	98	859
16	WS 16	46.5	407
17	WS 17	84.4	430
18	WS 18	85.3	435
19	GL 1	2.6	14
20	GL 2	5.5	28
21	DK 1	40.6	207
Total		936.8	

Table 6: Small Hydropower Sites in Genale Dawa River Basin in Ethiopia

Stream and elevation		Catchment's area (km^2)	Mean annual runoff (m3/s)	Head m	Potential generating capacity (Mw)
Logita	1800	716	14.4	45.5	0.400
Logita II	1800	716	14.4	16.5	0.200
Bonora	1650	438	12.3	30	0.320
Ababa	1550	371	12	29	0.320
Combolcha	2650	304	9.9	15	0.110
Total					1.35

Table 7: Hydropower potential in the Awash Basin in Ethiopia

Site	Hydropower Potential	
	Gross (GWh)	Installed (MW)
Melka Kunture	57	16
Awash III	165	32
Awash IV	167	34
Kesem	20	6
Kebena	12	3.8
Tendaho	69	6
Total		97.8

For further details, the reader is referred to the country report in Appendix A2.

Kenya:
One of the major items that can be extracted from Kenya's report is an identification of a study done on River Nzoia that has the following hydropower potential characteristics as per the table 8 shown below. River Nzoia basin, which lies in The Lake Basin, has five significant hydropower potential areas.

Table 8: River Nzoia Hydropower Potentials in Kenya

N/s	River	Project	Installed Capacity (MW)	Firm Energy (GW.h/yr)	Avg Energy (GW.h/yr)
1.	Nzoia	Hemsted Bridge	60	297	307
2.	Nzoia	Rongai	12	52	72
3.	Nzoia	Lugari	15	62	86
4.	Nzoia	Webuye Falls	30	115	170
5.	Nzoia	Anyika	25	95	125
Subtotal Nzoia			60	297	307

More Details for Kenya will be contained in their respective country report. For some background, the reader is referred to Midterm Report issued in March 2004.

3.1.4 Rwanda: Status for Rwanda is contained in their respective country report in Appendix A4.

3.1.5 Tanzania

Tanzania is currently estimated to have a hydropower potential of over and above 4700 MW largely concentrated in the following River Basins:

⇒ **Rufiji** River Basin, this occupies about 20% of the National total land area. This contributes about 63% of the total hydro potential in the country.
⇒ **Pangani** River Basin: This draws water from Northern highlands and peaks of Mount Kilimanjaro, Mount Meru and Pare Mountain ranges.
⇒ **Kagera** River Basin, this drains into Lake Victoria, the largest lake in Africa, which is the source of Nile River.
⇒ **Malagarasi** River Basin drains into the Lake Tanganyika, the deepest lake in the world.
⇒ **Rumakali** River Basin: this drains into Lake Nyasa, a lake that is located at triple junction of the Great Eastern Africa Rift System.
⇒ **Ruvuma** River Basin: This is a contiguous border river between Tanzania and Mozambique.

Out of all this huge hydropower potential in this nation, only 10% of the potential is tapped. Only 10% of the entire Tanzania population live in towns and cities and is able to access this existing power production whilst 90% of country's population live in rural and semi urban areas and is able to access less than 1% of this clean energy.

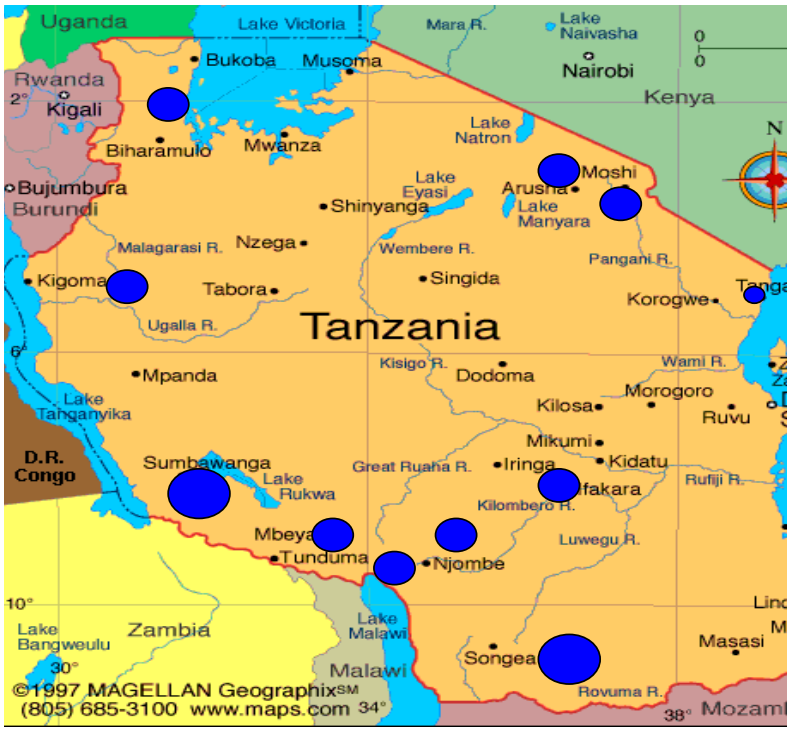
In Tanzania, reports and publications give an account of previous efforts by different institutions in the country studying and investigating hydropower potentials, small/micro/macro scale potentials inclusive. About 56 new hydropower sites were found to have been studied at different levels ranging from reconnaissance to pre-feasibility and very few ones studied to a feasibility study level. See table 9 below for the list of Tanzanian sites. In all these, an estimated total rough figure of about 300 Mw can be harnessed from small hydropower potential sites already identified. The report also gives a list of existing developed sites either publicly or privately owned.

Table 9: List of Small Hydropower Potential Sites in Tanzania

S/n	River Name	Location (Region)	Head for development in (m)	Installed capacity [kw]	Firm capacity (kw)	Average flow rate [m3/s]
1	Yungu River	Mbinga District (Ruvuma)	20	90	80kw	0.5
2	Mbawa River	Mbinga District (Ruvuma)	200	1800	1600	1
3	Luwika River	Mbinga District (Ruvuma)	200	1400	1200	0.8
4	Luaita River	Mbinga District (Ruvuma)	30	190	145	0.6
5	Upper Ruvuma River	Ruvuma	20	2000	1500	6

6	Hanga River	Songea District (Ruvuma)	40	550	420	5.2
7	Lilondo River (Mahanje Mission)	Lingatunda waterfail (Ruvuma)	150	1400	1100	0.75
8	Kibwaka River (Mhangazi River)	Njombe (Iringa)	50	5100	4000	35
9	Malisa River	Njombe (Iringa)	75	1250	1100	6
10	Mbaka River	Kyela (Mbeya)	200-300	8000	4-6	2.5
11	Kiwira River	Kyela (Mbeya)	285	25000	18	15.7
12	Songwe River (Lake river)	Rukwa	20	1000	15.7GWh	10.6
13	Lupa River	Chunya (Mbeya)	50	2800	280	15.7
14	Lukwate River	Chunya (Mbeya)	60	900		1.8
15	Wuku River	Chunya (Sumbawanga	80	2500	2000	3
16	Yeye River		90	2500	1900	2.5
17	Rungwa River		108	50	9	35
18	Lukima River		120	4000	3000	4
19	Msadia/Mfwizi River		120	25000	215GWh	18
20	Mtozi River		40	2400	1700	12
21	Mbede River		50	1240	1080	0.3
22	Mamba River		50	155	135	0.1
23	Filongo River		150	415	360	0.3
24	Mpete River		200	55000	48000	0.03
25	Chulu River	Rukwa	300	850	720	0.3
26	Kirambo River		300	280	240	0.1
27	Muse River		200	520	450	0.2
28	Luiche River		200	1,100	800	0.5
29	Msofwe River		500	4500	3200	0.95
30	Milepa River	Rukwa	450			0.2
31	MBA River	Rukwa	300	1000	770	0.55
32	Kilemba River	Sumbawanga (Rukwa)	300	270	230	0.95
33	Kalambo River	Sumbawanga (Rukwa)	430	80000	58000	30
34	Kawa River	Rukwa	200	2000	1700	2.7
35	Luamfi River	Rukwa	40	1200	1000	9
36	Mtambo River	Mpanda (Rukwa)	40	2400	1700	8
37	Luegele River	Mpanda (Rukwa)	175	15000	11000	15
38	Ruchugi river	Kigoma River	20	1000	859	30
39	Mkuti River	Kigoma River	23	630	420	3.3
40	Himo I and II	Kilimanjaro (Moshi)		945	190	3.3
41	Kihurio SHP I & II	Seseni River, Same District, Kilimanjaro		1740	260	3.3
42	Ndungu	Goma River – Same (Kilimanjaro)		1740	260	3.3
43	Bombo/Gonja	Higilili River – Tanga (Tanga)				0.64
44	Mto wa Simba	Mto wa Mbu (Arusha)	210			2.4
45	Mbulu SHP	Mbulu (Arusha)	450	8100		1.75
46	Pinying river	Loliondo (Arusha)		450	221	0.9?
47	Njombe Falls	Njombe (Iringa)		2000		5.6

48	Kifunga Falls	Njombe (Iringa)		3,600		16
49	Hagafiro River	Njombe (Iringa)		5,000		
50	Kasongenye SHP	Biharamulo (Kagera)		420	840	1?
51	Kaonjuba SHP	Kamwana River – Muleba (Kagera)	90	800	200	1.2
52	Malagarasi SHP	(Kigoma)	80		7,600	16.0
53	Uvinza	Ruchugi River (Kigoma)		1000	850	30
54	Nzovwe SHP	Sumbawanga (Rukwa)		3000	460	0.33
55	Nakatuta SHP	Songea (Ruvuma)	30	7500	2100	61
56	Hainu River SHP	Mbulu Babati (Arusha)	100		3.520	0.48



Legend:

General location of the Small Hydro potential Sites in Tanzania. NB:Size of the sphere represent relative number size of the sites in the region.

River Basin

Figure 4: Tanzanian map showing some Major River Basins with Small Hydropower Sites concentrations.

Small hydro potential in the country as per the undertaken desk study, has been estimated to be about 300 MW drawn from 56 different sites within the above-mentioned river basins. If this cheap energy, which is found insitu i.e near or at rural load centers, is tapped and delivered to rural areas, the outcry of poverty in the rural areas will be greatly reduced. For further details, the reader is referred to country report in Appendix A3.

3.1.6 Uganda

The River Network (see figure 5) in Uganda can be separated into two major parts: the Nile River and the Non-Nile Rivers. So the study on hydropower potential in Uganda is substantially divided into:

- Those based on the use of the Nile River
- Those located elsewhere in Uganda (Non-Nile Rivers)

Though the potential of the later cannot in any way be compared to that of the Nile River. Nevertheless schemes have been identified (and some developed) for smaller schemes providing local supply.

Uganda's hydrological resources are estimated to have a power production potential of over 2500MW. The large power sites (over 2000MW) are mainly concentrated along the Nile River while sites for small Hydro (0.5 – 5.0MW) are scattered in many parts of the country. However, to-date up to less than 10% of this potential is exploited.

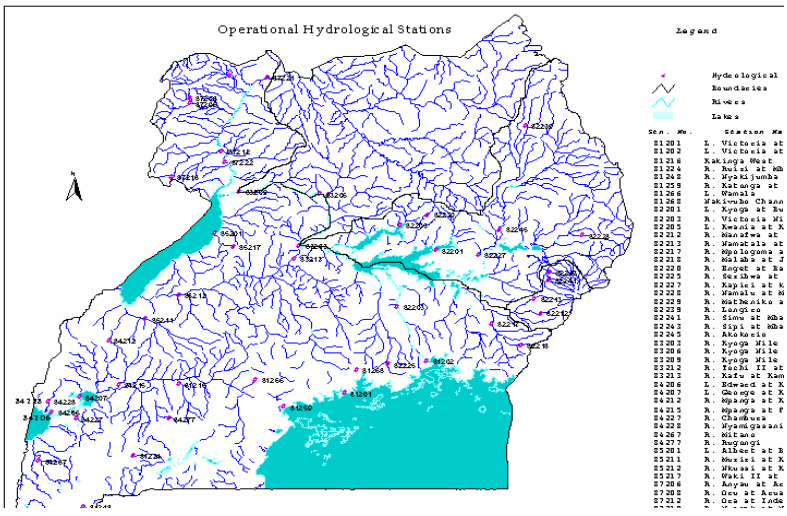


Figure 5: Uganda River Network System with Gauging Stations

Hydropower Potential on River Nile

As mentioned above, these sites represent some of Uganda's largest power potential sites of over 2000MW out of the full potential of 2500MW. Below is brief summary of the Nile River sites.

Table 10: Nile River Hydropower Potential Sites

Site	Location	Proposed Installed Capacity (Mw)	Status	Date Of Commissioning
Owen Falls	Jinja	180	In Operation	1954
Owen Falls Extension	Jinja	200	In Operation	2000
Bujagali	Jinja	250	Planning in Progress	N/A
Kalangala	Jinja	350	Feasibility study done	N/A
Kamdini (Karuma)	Masindi/ Apac	150	Feasibility study done	N/A
Ayago South	Gulu/Masindi	234	Preliminaries studies available	N/A
Ayago North	Gulu/Masindi	304	Preliminaries studies available	N/A
Murchision	Gulu/Masindi	642	Has adverse environmental effects	N/A

Source: Ministry of Energy and Mineral Resources of Uganda

3.1.7.1 Hydropower Potential on the Non-Nile Rivers

It is known however that the potential for small-scale hydropower development exists in the following areas:

- Rivers draining the Mt.Elgon
- The extreme Southwest of Uganda
- Rivers draining West Nile, near Arua
- Rivers draining the Rwenzori Mountains.

The table 11 below gives the country's potential for medium, small and micro hydropower stations.

Table 11: Various Small Hydropower Sites of Uganda

Micro Hydro		
Site	**River**	**Estimated Capacity, MW**
Arua	Anyau	0.3
Heissesero	Bunyonyi	0.3
Kitumba	Nyakabuguka	0.2
Mpanga	Mpanga	0.4
Nyakabale	Nyakabale	0.1
Moyo	Ataki	0.2
Kisiizi	Kisiizi	0.2
Small Hydro		
Lake Bunyonyi	Bunyonyi	1.0
Nsongezi	Kagera	2.0
Paidha A	Nyagak	1.0
Paidha B	Nyagak	2.0
Ishasha A (West)	Ishasha	2.4
Ishasha B	Ishasha	3.6
Nyamabuye A	Kaku	1.5
Nyamabuye B	Kaku	0.7
Maziga Gorge	Maziba	0.5
Kaka	Ruimi	1.5
Mbarara	Muzizi	0.7
Sogahi A	Sogahi	2.7
Sogahi B	Sogahi	3.3
Medium Hydro		
Muzizi	Muzizi	10
Bogoye	Mubuku	7.5 (5MW in service)
Nengo bridge	Ntungu	12.0

In summary, about 23 small hydropower sites totaling about 54MW power potential. Most of these sites are located off the River Nile on Non-Nile Rivers scattered around the country (the Nile sites are all large hydro). Of these rivers, only about 25MW has been developed or is in progress of development, though this still represents the large hydro sites of 23 small hydro sites. The smaller ones are scattered all over the country, and potential private investors are being invited to develop them through the ERT program.

4 CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

4.1 Conclusions and Recommendations

Lack of low cost and reliable sources of energy for rural and semi-urban areas is a major hindrance to social and economical development in the Nile Basin countries.

Nile Basin Countries are among the least developed countries in the World though endowed with huge hydropower potential resources totaling more than 12 GW. There exist enough small hydropower potentials near or at rural and semi-urban areas, if exploited can change developmental equation of the rural areas.

There is a need of intensified training/capacity building in the areas of manufacturing technology for equipment related to SHP schemes. Designing and Manufacturing industries for SHP lack footing in our countries and therefore need sustained efforts. These efforts should be coupled with equal efforts for markets within the basin counties.

The relevant authorities in these countries should take a number of measures to address these techno-economic constraints to give way to exploit these abundant energy sources that are quite close to the rural communities. Among others, the following are measurers that are recommended:

⇒ Government policies to better support SHP development
⇒ Developing Capacities in organizations and institutions mandated to undertake SHP development e.g. training
⇒ Involvement of local expertise wherever they are available, to carry out studies on SHP development.
⇒ In some of the Nile Basin countries there exist, operating small hydro plants and it is therefore recommended to learn and gather skills from them.
⇒ Explore possibilities of cooperation among the Nile basin countries for manufacturing SHP equipments. This cooperative venture could improve market potentials.

4.2 Limitations

It is perhaps the right time to highlight some difficult experiences and Limitations encountered in this project. Highlighting a few difficulties:

⇒ The funds set aside to facilitate the entire work sequence inadequate
⇒ Commitment of the personnel/experts within the subject region countries. There has been a significant difficulties in Communication among the participating members during the Phase I activities.
⇒ The impediment was also made worse due to inflexibility nature of Secretariat Office. The participating country members were repetitively echoing this that there is a need to change the funding philosophy. The request was to release 50% of the fund and release the rest at end of report. We had even agreed to do this during the 2nd Workshop held in Dar es Salaam, Tanzania in March

2004 but unfortunately the Secretariat didn't honor this understanding in which they were represented.

⇒ The data collected in this work are based on both secondary and primary sources of information. So degree of reliability may be not very accurate. But the data are just indicative only.

⇒ Although the study team has made every effort to collect and verify all relevant information, the report is not exhaustive, it is likely the actual situation is under- rather than over-reported.

4.3 The Way Forward beyond Cairo June 2004 Workshop

The following research objectives are recommended for continuation of Theme I beyond Cairo June 14, 2004:

⇒ Completion of the inventories started in Phase 1.

⇒ Publication of a Small Scale Hydropower Reference Booklets containing important data and information for every participating country in Theme 1.

⇒ Development of a Design Manual for Small Scale Hydropower for use in the Nile Basin countries.

⇒ Development of feasibility studies for the implementation of a small-scale pilot project in each of the Theme 1 participating member country.

⇒ Promotion of Training activities within the scope of Theme I.

5 REFERENCES

1. Local country reports from the NBCBN-RE participating member countries as submitted by Theme I country members, 2004.

2. Petry, Bela (2002-2004): Personal Communication